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MDCAT

According to UHS Syllabus

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CONTENTS

UNIT 01 MEASUREMENTS

01. **Which of the following pair has same units:**
(A) year and wavelength
(B) Momentum and force
(C) Energy density and Young's Modulus
(D) Force and Pressure

02. **Which physical quantity is measured in meter:**
(A) Light year (C) Diameter
(B) Breadth (D) All of these

03. **Which of the following quantity is not expressed in proper units:**
(A) Young's modulus = Nm^{-2}
(B) Surface tension = Nm^{-1}
(C) Pressure = Nm^{-2}
(D) Energy = kg m/s

04. **The base unit which has the same power in the dimensional formula of surface tension and co-efficient of viscosity:**
(A) Mass (C) Time
(B) Length (D) Temperature

05. $1 kg\ m^2 s^{-2}$ =
(A) $10^2 g\ cm^2 s^{-2}$ (C) $10^7 g\ cm^2 s^{-2}$
(B) $10^5 g\ cm^2 s^{-2}$ (D) $10^9 g\ cm^2 s^{-2}$

06. **For a well calibrated and standard instrument, which one of the following cannot occur during a measurement:**
(A) Random error (C) Systematic error
(B) Personal error (D) Unassigned error

07. **The frequency "f" of vibration of a mass "m" suspended from a spring of spring constant "k" is given by the relation $f = cm^x k^y$, the value of "x" and "y" are:**
(A) x= ½ , y = ½ (C) x= ½ , y = −½
(B) x= −½ , y = −½ (D) x= −½ , y = ½

08. **Which of the following has no units?**
(A) Efficiency (C) Refractive index
(B) Strain (D) All of these

09. **A radio aerial of length "L", when the current "I", emits a signal of wavelength "λ" and power "P". These quantities are related by $P = kI^2\left[\frac{L}{\lambda}\right]^2$ where "k" is a constant. What unit if any, should be used for the constant "k":**
(A) Volt (C) Watt
(B) Ohm (D) No unit

10. **How many femto seconds are there in one millisecond?**
(A) 10^9 (C) 10^{15}
(B) 10^{-15} (D) 10^{12}

11. **Which of the following is unit less? Letters have usual meanings:**
(A) $\frac{v^2}{rg}$ (C) $\frac{v^2 r}{g}$
(B) $\frac{v^2 g}{r}$ (D) $v^2 rg$

12. **The unit of $\sqrt{\frac{energy}{mass}}$ is the same as that of:**
(A) mass (C) length
(B) time (D) velocity

13. **How many nano coulomb in one micro coulomb:**
(A) $1\mu = 10^{-9} n$ (C) $1\mu = 10^3 n$
(B) $1\mu = 10^{-3} n$ (D) $1\mu = 10^6 n$

14. **The ratio of atto to exa is:**
(A) 10^0 (C) 10^{36}
(B) 10^{-18} (D) 10^{-36}

15. **A quantity which has SI unit but no dimension is:**
(A) Solid angle
(B) Radioactive decay constant
(C) Frequency
(D) Inertia

16. **An accurate measurement is one which has less:**
(A) Precision (C) fractional error
(B) Absolute uncertainty (D) zero error

17. **Solid angle subtended by a sphere's surface is multiplied by square of its radius is equal to :**
(A) density of sphere (C) mass of sphere
(B) volume of sphere (D) surface area of sphere

18. **One light year is equal to:**
(A) 9.5×10^{14}m (C) 9.5×10^{16}m
(B) 9.5×10^{15}m (D) 9.5×10^{17}m

19. **How many years are there in one second :**
(A) 3.1×10^{-5}years (C) 3.1×10^{-7}years
(B) 3.1×10^{-6}years (D) 3.1×10^{-8}years

20. **An example of derived unit is:**
(A) candela (C) coulomb
(B) ampere (D) mole

21. **The $\sqrt{2gh}$ is same that of:**
(A) Distance (C) Acceleration
(B) Velocity (D) Power

22. **Random errors can be reduced by:**
(A) taking zero correction
(B) comparing the instrument with another more accurate one
(C) taking mean of several measurement
(D) all methods explained in (A), (B) and (C)

23. **Which is not equal to the time:**
(A) Frequency
(B) Resistance × capacitance
(C) Inductance ÷resistance
(D) All of these

24. **Which of the following quantities have the same units:**
(A) Frequency and decay constant
(B) Force and mass
(C) Acceleration and displacement
(D) Impulse and force

25. **E, M, L and G denote energy, mass, angular momentum, and gravitational constant. The dimension of $\frac{EL^2}{M^5 G^2}$ is that of:**
(A) Time (C) Mass
(B) Length (D) Angle

26. **The SI unit of electric field strength is:**
(A) newton $(coulomb)^{-1}$ (C) newton $(ampere)^{-1}$
(B) volt $(coulomb)^{-1}$ (D) joule $(coulomb)^{-1}$

27. **A watt is defined as:**
(A) volt × ampere (C) coulomb × volt
(B) volt × $(ampere)^2$ (D) ampere × ohm

28. **Density of liquid is 15.7 g cm^{-3}. Its value in the international System of Units is:**
(A) 15.7 kgm^{-3} (C) 157 kgm^{-3}
(B) 1570 kgm^{-3} (D) 15700 kgm^{-3}

29. **Let "L" denote the self inductance of a coil which is in series with a capacitor of capacitance "C". Which of the following has the unit second:**
(A) $\sqrt{LC}$ (C) C/L
(B) CL (D) L^2/C^2

30. **The unit of fractional uncertainty in length is:**
(A) cm (C) mm
(B) dm (D) no units

31. **The dimensions of angular displacement are:**
(A) $[L^2]$ (C) $[LT^{-1}]$
(B) $[L^0]$ (D) $[L^{-1}T^{-1}]$

32. **The dimensions of gravitational constant "G" are:**
(A) $[M^{-1}L^3T^{-2}]$ (C) $[ML^2T^{-2}]$
(B) $[M^2L^{-1}T^{-2}]$ (D) $[ML^{-2}T^{-1}]$

33. **The dimensions of viscosity and pressure are:**
(A) $[ML^{-1}T$ & $MLT^{-2}]$
(B) $[ML^{-2}T^{-1}$ & $M^{-1}LT^{-1}]$
(C) $[ML^{-1}T^{-1}$ & $ML^{-1}T^{-2}]$
(D) $[ML^2T^{-1}$ & $ML^{-1}T^{-2}]$

34. **$[M^0L^0T^{-1}]$ refer to quantity:**
(A) Velocity (C) Time period
(B) Frequency (D) Force

35. **The percentage errors in the measurement of mass and speed are 2% and 3% respectively. How much will be the maximum error in the estimate of kinetic energy obtained by measuring mass and speed:**
(A) 11% (C) 8%
(B) 5% (D) 1%

36. **Given: Resistance R_1 = (8 ± 0.4) Ω and Resistance R_2 = (8 ± 0.6) Ω. What is the net resistance when R_1 and R_2 are connected in series?**
(A) (16 ± 0.4) Ω (C) (16 ± 0.6) Ω
(B) (16 ± 1.0) Ω (D) (16 ± 0.2) Ω

37. **The density of the material of a cube is measured by measuring its mass and length of this side. If the maximum errors in the measurement of mass and the length are 3% and 2% respectively, the maximum error in the measurement of density is:**
(A) 1% (C) 5%
(B) 7% (D) 9%

38. **Given: Potential difference V = (8 ± 0.5) V and current, I = (2 ± 0.2) A. The value of resistance R is:**
(A) 4 ± 16.25% (C) 4 ± 6.25%
(B) 4 ± 10% (D) 4 ± 8%

39. **V m^{-1} is the SI unit of:**
(A) thermal energy (C) thermal power
(B) electric potential (D) electric field intensity

40. **The physical quantity having the unit dyne g^{-1} is**
(A) velocity (C) force
(B) mass (D) acceleration

41. **The SI unit of luminous intensity is**
(A) watt (C) lumen
(B) lux (D) candela

42. **In the equation $N = N_oe^{-\lambda t}$ the unit of "λ" are same as unit of:**
(A) Mass (C) Time period
(B) Angular Frequency (D) torque

43. **One micron is related to centimeter as:**
(A) 1 micron = 10^{-8} cm (C) 1 micron = 10^{-5} cm
(B) 1 micron = 10^{-6} cm (D) 1 micron = 10^{-4} cm

44. **How many steradians are there in semi–sphere from a point inside that semi–sphere?**
(A) π (C) 2π
(B) 3π (D) 4π

45. **If $x = a^n$. Then relative error is (where n is power of "a")**
(A) $\frac{\Delta a}{a} - n$ (C) $n\frac{\Delta a}{a}$
(B) $\frac{\Delta a}{a} + n$ (D) $n^2\frac{\Delta a}{a}$

46. **Unit of power in terms of base units:**
(A) kg m^2 s^{-3} (C) kg m^3 s^{-3}
(B) kg m^2 s^{-2} (D) $kgms^{-3}$

47. **Poor calibration is the example of:**
(A) Personal error (C) Random error
(B) Systematic error (D) Zero error

48. **Resistance of a given wire is obtained by measuring the current flowing in it and the voltage difference applied across it. If the percentage errors in the measurement of the current and the voltage difference are 3% each, then error in the value of resistance of the wire is**
(A) 6% (C) 1%
(B) 0% (D) 3%

49. **In calculating the area of cross section 'A' of wire the total percentage uncertainty in the final result:**
(A) A= 2 × percentage uncertainty in radius
(B) A = 2 × percentage uncertainty in diameter
(C) A = 3 × percentage uncertainty in radius
(D) Both (A) and (B)

50. **The unit of coefficient of viscosity is:**
(A) Ns m^{-2} (C) Pa s
(B) kg m^{-1} s^{-1} (D) All of these

51. **The least count of a stop watch is 0.2 second. The time of 20 oscillations of a pendulum is measured to be 25 second. The percentage error in the measurement of time will be:**
(A) 8% (C) 0.8%
(B) 1.8% (D) 0.1%

52. **Sub-multiples and multiples of units are indicated using a prefix to the unit. For example, the prefix milli (m) represents 10^{-3}. Which of the following**

gives the sub-multiples represented by pico (p) and (giga) (G)?

	pico (p)	giga (G)
(A)	10^{-9}	10^{9}
(B)	10^{-9}	10^{9}
(C)	10^{-12}	10^{+9}
(D)	10^{-12}	10^{12}

53. **Which is highest sub–multiple?**
(A) Pico (C) Femto
(B) Atto (D) Nano

54. **Out of the following pairs which one does not have same unit?**
(A) Angular momentum ,Plank's constant
(B) Impulse and momentum
(C) Work and energy
(D) Pressure and kinetic energy

55. $\frac{1\text{ mm}}{1\text{ Gm}} =$
(A) 10^{-3} (C) 10^{-12}
(B) 10^{-9} (D) 10^{-15}

56. **Smaller is the least count of the instrument more is the reading:**
(A) Accurate (C) Precise
(B) Accurate and Precise (D) All of these

57. **Which of the following does not have same units?**
(A) Electric field, electric flux
(B) Pressure, young's modulus
(C) Electromotive force, potential difference
(D) Heat , potential energy

58. **The unit of B^2/μ_o :**
(A) kgm^2s^{-2} (C) $kgm^{-1}s^{-1}$
(B) $kgm^{-1}s^{-2}$ (D) $kg^2m^{-2}s^{-2}$

59. **Which of the following is not a derived unit?**
(A) joule (C) dyne
(B) erg (D) mole

60. **Which of the following is the correct way of writing units?**
(A) 25 μμ m (C) 5 Newton
(B) 30 Kg (D) 10 N

61. **$1\ km^2$=**
(A) $1\times10^2\ m^2$ (C) $1\times10^6\ m^2$
(B) $1\times10^4\ m^2$ (D) $1\times10^8\ m^2$

62. **Precise measurement has:**
(A) No Uncertainty
(B) Less absolute uncertainty
(C) high absolute uncertainty
(D) both (A) & (B)

63. **Units of $\frac{1}{\mu_o\varepsilon_o}$ where symbols have their usual meaning are:**
(A) ms^{-1} (C) $m^{-1}s$
(B) m^2s^2 (D) $m^{-2}s^{-2}$

64. **What is the unit of "k" in the relation $U = \frac{ky}{y^2 + a^2}$ where "U" represents the potential energy, "y" represents the displacement and "a" represents the maximum displacement i.e., amplitude?**
(A) $m\ s^{-1}$ (C) m s
(B) J m (D) $J\ s^{-1}$

65. **Unit of permittivity "ε_o" is:**
(A) $Nm^{-2}\ kg^2$ (C) $N^{-1}m^{-2}kg^2$
(B) Nm^2C^{-2} (D) $N^{-1}m^{-2}C^2$

66. **The velocity of a particle is given by $v = a + \frac{b}{t} + ct^2$. The unit of b will be:**
(A) m (C) $m\ s^2$
(B) $m\ s^{-1}$ (D) $m\ s^{-2}$

67. **Two physical quantities of which one is a vector and other is a scalar, having same dimensions are:**
(A) moment and momentum
(B) power and momentum
(C) impulse and momentum
(D) torque and work

68. **The quantity $X = m\ c^2$ has the same units as that of:**
(A) Momentum (C) Impulse
(B) work (D) moment of inertia

69. **Slug is the unit of:**
(A) length (C) mass
(B) time (D) foot

70. **Which one of the following is not the name of physical quantity?**
(A) Density (C) Energy
(B) candela (D) Impulse

71. **Which one of the following is not a unit of length?**
(A) Angstrom (C) Radian
(B) Micron (D) Light year

72. **Error in the measurement of radius of a sphere is 1%. The error in the calculating the surface area of sphere is:**
(A) 2% (C) 3%
(B) 4% (D) 7%

73. **Radian is defined as ratio of arc length to its:**
(A) Radius (C) Sector
(B) Diameter (D) Chord

74. **Accuracy is inversely related to:**
(A) % uncertainty (C) significant figures
(B) Least Count (D) Absolute uncertainty

75. **Precision is inversely related to:**
(A) % uncertainty (C) significant figures
(B) Least Count (D) Fractional uncertainty

76. **In assessment of total uncertainty in the final result for timing experiment, uncertainty is inversely proportional to:**
(A) % uncertainty (C) No. of vibrations
(B) Least Count (D) Stop watch

77. **The SI units of $\frac{mg}{\eta r}$ is same as that of:**
(A) mass (C) Velocity
(B) Length (D) Acceleration

78. **$1\ cm^3$=**
(A) $0.01\ m^3$ (C) $1000\ mm^3$
(B) $0.001\ m^3$ (D) $100\ dm^3$

79. **Which of the following set contains base and derived units?**
(A) radian & kilogram (C) kelvin & time
(B) mole & kilogram (D) ampere & coulomb

80. The rest mass of proton is 1.67×10^{-27} kg. Its mass in grams is:
(A) 1.67×10^{-30} g
(B) 1.67×10^{-28} g
(C) 1.67×10^{-24} g
(D) 1.67×10^{-29} g

81. The type of the systematic error is:
(A) Personal error
(B) Instrumental error
(C) Theoretical error
(D) All of these

82. Which pair of physical quantities given below has not the same units and dimensions?
(A) torque and angular momentum
(B) momentum and impulse
(C) pressure and modulus of elasticity
(D) acceleration and gravitational field strength

83. The initial temperature of a liquid is (80.0 ± 0.1)°C. After it has been cooled, its temperature is (10.0 ± 0.1)°C. The fall in temperature in degree centigrade is:
(A) 70.0 ± 0.0
(B) 70.0 ± 0.2
(C) 70.0 ± 0.3
(D) 70.0 ± 0.1

84. Which is correct record for the diameter of wire when measured by a screw gauge of least count 0.001 cm:
(A) 2.3 cm
(B) 2.312 cm
(C) 2.31 cm
(D) 2.3124 cm

85. Error in the measurement of radius of sphere is 2%. Then error in the measurement of volume is:
(A) 1%
(B) 3%
(C) 5%
(D) 6%

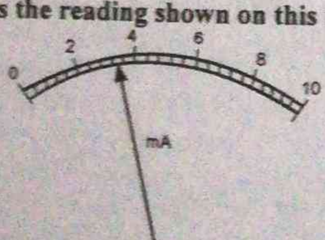
86. If the pointer of the voltmeter is not exactly at the zero of the scale then the error in the voltmeter is said to be:
(A) instrumental error
(B) systematic error
(C) personal error
(D) random error

87. If radius of the sphere is (5.3 ± 0.1) cm. Then percentage error in its volume will be:
(A) $3 + 6.01\times\frac{100}{5.3}$
(B) $\frac{1}{3}\times 0.01\times\frac{100}{5.3}$
(C) $\left(\frac{3\times0.1}{5.3}\right)\times 100$
(D) $\frac{0.1}{5.3}\times 100$

88. Percentage uncertainty in the area of rectangular plate with having length "a" and width "b":
(A) $\left[\frac{\Delta a}{a-b}+\frac{\Delta b}{a-b}\right]100$
(B) $\left[\frac{\Delta a}{a-b}-\frac{\Delta b}{a-b}\right]100$
(C) $\left[\frac{\Delta a}{a}-\frac{\Delta b}{b}\right]100$
(D) $\left[\frac{\Delta a}{a}+\frac{\Delta b}{b}\right]100$

89. Instrumental error can be minimized by
(A) taking large number of readings.
(B) using different accurate instrument for the same reading.
(C) by zero correction of instrument.
(D) Both (B) and (C)

90. What is the reading shown on this millimeter?



(A) 2.35 mA
(B) 2.7mA
(C) 3.4mA
(D) 3.7 mA

91. Units of $\sqrt{\frac{F\times \ell}{m}}$ are:
(A) $m^{-1}s$
(B) $(ms^2)^2$
(C) ms^{-2}
(D) ms^{-1}

92. In v = xt + y, if 'v' and 't' are the velocity and time respectively, then the units of "x" and "y" are:
(A) $m^{-1}s^{-1}, ms^{-2}$
(B) ms, ms^{-2}
(C) m, ms^{-1}
(D) ms^{-2}, ms^{-1}

93. If "ρ" is the density, then units of "ρgh" are same as the units of:
(A) Kinetic energy
(B) Energy
(C) Pressure
(D) Flow rate

94. Of the following quantities, which one has units different from the remaining three:
(A) Energy per unit volume
(B) Product of voltage and charge per unit volume
(C) Force per unit area
(D) Angular momentum

95. Which one of the following shows only unit of length:
(A) A°, kg, gm
(B) A°, km , m
(C) m, m^3 , s
(D) Gm, m^2, deci–m

96. Which of the following is least multiple:
(A) pico
(B) femto
(C) nano
(D) atto

97. Which of the following do not have the unit of energy?
(A) force × distance
(B) couple × angle turned through
(C) impulse × time
(D) moment of inertia × (angular velocity)^2

98. The radioactive decay constant has the same dimensional formula as:
(A) mole
(B) time
(C) frequency
(D) mass

99. If C and R denotes the capacitance and resistance respectively, then the dimensional formula for CR is same as that of:
(A) frequency
(B) time period
(C) (frequency)^2
(D) (time period)^2

100. The error in a certain measurement occurs due to:
(A) Faulty apparatus
(B) In-appropriate method
(C) negligence of person
(D) All of these

101. The pair of physical quantities not having the same units is:
(A) Planck's constant, Angular momentum
(B) spring constant, tension
(C) Pressure, Young's Modulus
(D) Frequency, decay constant

102. Which one is the highest power multiple?
(A) giga
(B) peta
(C) mega
(D) deca

103. The pressure is of 10^3 dynes/cm^2 is equivalent to:
(A) 10 N/m^2
(B) 10^2N/m^2
(C) 10^{-1} N/m^2
(D) 10^{-2} N/m^2

104. **In S.I system, a set of supplementary units contains:**
(A) 7 units
(B) 2 units
(C) many units
(D) 3 units

105. **100×10^{-11} is equal:**
(A) pico
(B) femto
(C) nano
(D) atto

106. **The heat generated in a circuit is given by $Q = I^2Rt$, where "I" is current, "R" is resistance and "t" is time. If the percentage errors in measuring I, R and t are 2%,1% and 1% respectively then the maximum error in measuring heat will be:**
(A) 2%
(B) 4%
(C) 3%
(D) 6%

107. **The pressure on a square plate is measured by measuring the force on the plate and the length of the sides of the plate by using the formula $P=\frac{F}{L^2}$. If the maximum errors in the measurement of force and length are 4% and 2% respectively, then the maximum errors in the measurement of pressure is:**
(A) 1%
(B) 8%
(C) 2%
(D) 10%

108. **Which of the following is the equivalent of (joule ohm)/(volt second)?**
(A) watt
(B) kWh
(C) henry
(D) volt

109. **If the percentage errors of A, B and C are "a", "b" and "c" respectively then the total percentage error in the product ABC is:**
(A) abc
(B) $\frac{1}{a}+\frac{1}{b}+\frac{1}{c}$
(C) a + b + c
(D) a + bc + ca

110. **Light year is the unit of:**
(A) Light
(B) Velocity
(C) Time
(D) Distance

111. **Jm^{-1} is a possible unit for:**
(A) momentum
(B) force
(C) power
(D) work

112. **Which one of the following is correct:**
(A) $1f = 10^{-6}$
(B) $1f = 10^{-12}$
(C) $1f = 10^{-15}$
(D) $1f = 10^{-14}$

113. **The ratio of killo to pico is:**
(A) 10^9
(B) 10^{15}
(C) 10^{-9}
(D) 10^{-15}

114. **For total assessment of uncertainty in the final result obtained by multiplication and division:**
(A) Absolute uncertainties are added
(B) Fractional uncertainties are added
(C) %age uncertainties are added
(D) both (B) and (C)

115. **The principal characteristics of an ideal standard:**
(A) accessible
(B) Invariable
(C) both (A) & (B)
(D) it must be of expensive metal

116. **If velocity (v), Force (F) and energy (E) are taken as fundamental units then formula for mass will be:**
(A) $v^{-2}F^0E$
(B) v^0FE^2
(C) $vF^{-2}E^0$
(D) $v^{-2}F^0E^{-2}$

117. **What are the S.I units of "k" so that the equation velocity = k × density is correct.**
(A) $kg^{-1}m^4s^{-1}$
(B) $kg\,m^4s^{-1}$
(C) kg ms
(D) $kg\,m\,s^{-1}$

118. **Product of nano and giga is:**
(A) 0
(B) 1
(C) 10^{-18}
(D) 10^{-9}

119. **In the relation "$v_f = v_o + 0.61t$" the unit of 0.61 are:**
(A) ms^{-2}
(B) $N\,^\circ C^{-1}$
(C) $ms^{-1}\,^\circ C^{-1}$
(D) No unit

120. **1 kg of mass is equivalent to:**
(A) $9\times10^{12}J$
(B) $9\times10^{16}J$
(C) $9\times10^{11}J$
(D) $1.9\times10^{16}J$

121. **Which of the following has not been expressed in suitable units?**
(A) Potential energy → $kg\,ms^{-1}$
(B) Surface tension → $N\,m^{-1}$
(C) Stress → $N\,m^{-2}$
(D) Resistance → $kg\,m^2\,A^{-2}\,s^{-3}$

122. **Which of the following is not equal to watt?**
(A) ampere/volt
(B) $(ampere)^2$ ohm
(C) ampere × volt
(D) joule/second

123. **The base unit of Planck's constant are the same as:**
(A) electrostatic energy
(B) angular momentum
(C) kinetic energy
(D) linear momentum

124. **The numerical value of "G" in SI is 6.67×10^{-11}. The numerical value in cgs system is:**
(A) 6.67×10^{-8}
(B) 6.67×10^{-10}
(C) 6.67×10^{-9}
(D) 6.67×10^{-14}

125. **Screw gauge is more precise than vernier callipers by:**
(A) 10 times
(B) 100 times
(C) 1000 times
(D) 50 times

126. **The ratio of dimensions of angular momentum to linear momentum is:**
(A) [L]
(B) $[L^{-1}]$
(C) $[LT^{-1}]$
(D) $[L^{-1}T^{-1}]$

127. **Which of the following quantities have same units:**
(A) Stress, strain
(B) Force, momentum
(C) Momentum, impulse
(D) Mass, weight

128. **Which of following quantity can be expressed in $kg\,s^{-2}$:**
(A) Viscosity
(B) Density
(C) Spring constant
(D) Momentum

129. **If L = inductance R = Resistance C = Capacitance and V = Potential difference then units of $\frac{RCV}{L}$ is same that of:**
(A) Current
(B) Charge
(C) $(current)^{-1}$
(D) $(charge)^{-1}$

130. **The dimension of product PV is same that of ("P" is Presser and "V" is Volume):**

(A) Energy (C) Temperature
(B) Power (D) Momentum

131. **Choose the correct statement about base quantities:**
(A) All base quantities are independent of temperature
(B) They are all scalar quantities
(C) They can be measured by a single universal instrument
(D) They are all immune to errors

132. **The angle subtended at the center of a circle by an arc of length $2\pi r$ is:**
(A) 1 radian (C) 2π radian
(B) π radian (D) $\pi/2$ radian

133. **All are the units of time except:**
(A) Light year (C) Decade
(B) Solar day (D) Lunar year

134. **The ratio of units of power and pressure gives the measurement of:**
(A) Cross sectional area
(B) Rate of change in momentum
(C) Volume flow per second
(D) Energy

135. **Two physical quantities can be added only when they have same:**
(A) Kind (C) Directions
(B) Magnitudes (D) All are correct

136. **Which of the following is not the name of a physical quantity?**
(A) time (C) mass
(B) impulse (D) kilogram

137. **Which of the following statements is wrong?**
(A) Unit of co-efficient of viscosity is poise
(B) Work and energy have same units
(C) Unit of kinetic energy is newton meter
(D) Unit of surface tension is newton meter

138. **If the force and velocity are double, then the power will be:**
(A) twice (C) 4 times
(B) thrice (D) 8 times

139. $\frac{B^2}{\mu_o}$ **has the same dimensional formula as that of:**
(B is magnetic field and μ_o is absolute permeability of free space):
(A) energy density
(B) stress × strain
(C) magnetic energy per unit volume
(D) All of these

140. **Which of the following is a derived unit;**
(A) unit of mass (C) unit of volume
(B) unit of length (D) unit of time

141. **If u_1 and u_2 are the units selected in two systems of measurement and n_1 and n_2 are their numerical values, respectively, then**
(A) $n_1u_1 = n_2u_2$ (C) $n_1n_2 = u_1u_2$
(B) $n_1u_1 + n_2u_2 = 0$ (D) $(n_1 + u_1) = (n_2 + u_2)$

142. **The time of 30 vibrations of a simple pendulum recorded by stopwatch accurate up to one tenth of a second is 60 seconds. The uncertainty in the time period may be:**
(A) 0.003 s (C) 0.3 s
(B) 0.03 s (D) 3.0 s

143. **The least count of a vernier callipers is 0.005 cm. The diameter of a wire is 0.020 cm as measured by it. The percentage error in measurement is**
(A) 25% (C) 15%
(B) 20% (D) 5%

144. **In an experiment four quantities a, b, c and d are measured with percentage error 1%, 2%, 3% and 4% respectively. Quantity P is calculated as** $P = \frac{a^3b^2}{cd}$ **% error in P is:**
(A) 14% (C) 7%
(B) 10% (D) 4%

145. **In the equation** $v = at - \frac{b}{c^2 + t}$**, units of "c" is:**
(A) s (C) s^2
(B) $s^{1/2}$ (D) ms^{-1}

146. **All are the base quantities except:**
(A) Mole (C) Intensity of light
(B) Electric current (D) All are base quantities

147. **A° is equal to:**
(A) 10^{-9} mm (C) 10^{-7} mm
(B) 10^{-8} mm (D) 10^{-6} mm

148. **Which of the following sets cannot enter into the list of fundamental quantities in any system?**
(A) Length, mass, time
(B) Amount of substance, mass, length
(C) Mass, time, intensity
(D) Temperature, charge, length

149. **In given equation** $f = \frac{1}{2\ell}\sqrt{\frac{F}{m}}$**, fundamental frequency of stretched string, the units of 'm' is:**
(A) kgm^{-1} (C) $kgms^{-1}$
(B) $kgm^{-1}s$ (D) No units

150. **Two particles are located at $x_1 = 10.5 \pm 0.1$ cm and $x_2 = 26.8 \pm 0.1$ cm. The distance between them will be recorded as:**
(A) 16.3 cm (C) 16.3 ± 0.1 cm
(B) 16.3 ± 0.2 cm (D) 37.3 ± 0.01 cm

151. **Which of the following in not a unit of time:**
(A) Leap year (C) Light year
(B) Lunar month (D) Micro–second

152. **To reduce the uncertainty in the timing experiment:**
(A) highly precise instrument
(B) count more number of vibration
(C) conduct at room temperature
(D) both A and C

153. **If $y = a + bt + ct^2$, where y is in meter and "t" is in second, the unit of "b" is:**
(A) m (C) s^{-2}
(B) ms^{-1} (D) ms^{-2}

154. In equation $\left(P + \frac{a}{V^2}\right)(V - b) = RT$ the SI unit of "a":
(A) N m (C) N m^4
(B) N m^{-3} (D) N m^{-2}

155. Number of physical quantities in system international:
(A) 7 (C) 3
(B) 2 (D) 9

156. Which one is not allowed as standard prefix?
(A) 1pF (C) 1μF
(B) 1μμF (D) 1nF

157. A physical quantity 'X' is represented as velocity $= \sqrt{\frac{X}{density}}$, the units of "X" are:
(A) $kgms^{-1}$ (C) $kgm^{-1}s^{-2}$
(B) kgm^2s^{-2} (D) kgm^2s^{-1}

158. The mean time period of second's pendulum is 2.00 s and mean absolute error in the time period is 0.05s. To express maximum estimate of error, the time period should be written as:
(A) (2.00 ± 0.01) s (C) (2.00 ± 0.05) s
(B) (2.00 + 0.025) s (D) (2.00 ± 0.10) s

159. Minimum length an instrument can measure is called its:
(A) Accuracy (C) Estimate
(B) Precision (D) Limitations

160. One nanometre is equal to:
(A) 10^{-9} mm (C) 10^{-6} cm
(B) 10^{-7} cm (D) 10^{9} cm

161. If "h" is the height and "g" is the acceleration due to gravity, then the unit of $\sqrt{\frac{2h}{g}}$ is the same as that of:
(A) Time (C) Volume
(B) Mass (D) Velocity

162. Which of the following pairs of units are both SI base units?
(A) ampere, degree celsius
(B) coulomb, degree celsius
(C) ampere, kelvin
(D) coulomb, kelvin

163. If 'P' is the momentum of an object and 'm' is the mass then expression $\frac{P^2}{2m}$ has base unit identical to:
(A) Energy (C) Force
(B) Power (D) Velocity

164. Choose the pair in decreasing order:
(A) centi, milli, micro (C) micro, milli, centi
(B) deca, kilo, mega (D) kilo, mega, deca

165. 3μμF can be written as:
(A) 3 pF (C) 3nF
(B) 3mF (D) 3cF

166. To change SI units by factors of ten into smaller or bigger units they uses:
(A) prefixes (C) suffixes
(B) symbols (D) ratios

167. The resistance R = V/I where V = 100 ± 5 volts and I = 10 ± 0.2 amperes. What is the total error in R?
(A) 5% (C) 7%
(B) 5.2% (D) $\frac{5}{2}$%

168. Measurement which is close to true value is:
(A) Accurate (C) Average
(B) Precise (D) Error

169. Systematic errors can be removed by:
(A) Buying new instrument
(B) Dusting the instrument
(C) Breaking the instrument
(D) Recalibrating the instrument

170. Depth of water in a bottle is 24.0 cm and uncertainty is 0.2 cm, percentage uncertainty in measurement of depth
(A) 0.8% (C) 9%
(B) 1% (D) 2%

171. An ideal standard of measurement of a base quantity has characteristics:
(A) Accessible
(B) Invariable
(C) Transportable
(D) Only (A) and (B) are correct

172. While measuring the acceleration due to gravity by a simple pendulum, a student makes a positive error of 1% in the length of the pendulum and a negative error of 3% in the value of time period. His percentage error in the measurement of g by the relation $g = 4\pi^2(\ell/T^2)$ will be:
(A) 2% (C) 7%
(B) 4% (D) 10%

173. A body travels uniformly a distance of (10.0 ± 0.2) m in a time (4.0 ± 0.3) s. The percentage error in velocity of the body is:
(A) 7.5% (C) 12%
(B) 5.7% (D) 9.5%

174. N kg^{-1} is the unit of:
(A) Velocity (C) Momentum
(B) Acceleration (D) Angular momentum

175. Which of the following relation is incorrect?
(A) $t = \frac{x}{v}$ (C) $v = \frac{a}{t}$
(B) $a = \frac{v^2}{x}$ (D) $t^2 = \frac{2x}{a}$

176. The unit of ampere-volt is equal to:
(A) Power (C) Current
(B) Energy (D) Quantity of electricity

177. Which of the following is unitless quantity?
(A) $\frac{\text{momentum}}{\text{...ation}}$ (C) $\frac{\text{volume}}{\text{area}}$
(B) $\frac{\text{energy}}{\text{work}}$ (D) $\frac{\text{power}}{\text{force}}$

178. Which of the following is not a unit of energy?
(A) kilo watt (C) joule
(B) election volt (D) kilo watt-hour

179. 1000 kilogram is equivalent to:
(A) 1 mega gram (C) 1 peta kg
(B) 1 tera kg (D) 1 exa gram

180. $\frac{1\text{ Tm}}{1\text{ Gm}} =$
(A) 10^{-6}m (C) k
(B) μ (D) 10μ

181. **The uncertainty recorded in the radius of a sphere is 1.6%. The uncertainty in the area of that sphere is:**
(A) 4.8% (C) 1.6%
(B) 3.2% (D) 0.8%

182. **Which one of the following quantities has been expressed in proper S.I base units?**
(A) $\frac{\text{stress}}{\text{strain}}$ = newton meter^{-2}
(C) Energy = g ms^{-2}
(B) Force = kgms^{-2}
(D) Pressure = newton meter^{-1}

183. **What is the unit of gravitational constant?**
(A) $Nm^2\,kg^2$ (C) $kg\,m^{-1}\,s^{-3}$
(B) $kg^{-1}\,m^3\,s^{-2}$ (D) $J\,kg^{-1}$

184. **Which of the following is a unit of energy?**
(A) pascal (C) Newton
(B) watt × day (D) newton/meter

185. **One thousand microns is equal to:**
(A) 10^{-3} m (C) 10^{-9} m
(B) 10^{-6} m (D) 10^{-12} m

186. **In the equation $x = x_o \sin\omega t$ the unit of "ω" is:**
(A) rad (C) Hz
(B) rad s^{-2} (D) rad s^{-1}

187. **The base unit of $\sqrt{LC}$ will be:**
(A) ms^{-1} (C) s
(B) m^{-1} (D) s^{-1}

188. **Unit of permittivity "ε_o" is:**
(A) farad (C) $\frac{\text{farad}}{\text{m}}$
(B) farad m (D) ampere m^{-2}

189. **$\frac{\text{Energy}}{\text{Mass} \times \text{Length}}$ is equal to:**
(A) Acceleration (C) Power
(B) Force (D) Work

190. **Convert 72km h^{-1} into ms^{-1}**
(A) 2 ms^{-1} (C) 20 ms^{-1}
(B) 200 ms^{-1} (D) 2 kms^{-1}

191. **Which of the following pair has same units?**
(A) Light year and wavelength
(B) Momentum and force
(C) Energy and Young's Modulus
(D) Force and Pressure

192. **Which of the following is the largest value?**
(A) 1mm×1pm (C) 1nm×1Em
(B) 1cm×1km (D) 1nm×1Mm

193. **Which of the following is most precise instrument?**
(A) Meter rod (C) Vernier calipers
(B) Screw gauge (D) All of these

UNIT 01 MEASUREMENTS (SOLUTIONS)

01. (C)

$$\text{Energy density} = \frac{\text{energy}}{\text{volume}}$$
$= Jm^{-3} = Nm\,m^{-3} = Nm^{-2}$ = Young's modulus

02. (D)

All represent length. So, all have unit in meters.

03. (D)

Units of Energy is kgm^2s^{-2}.

04. (A)

Dimensions of surface tension = $[MT^{-2}]$
Dimensions of co-efficient of viscosity = $[ML^{-1}T^{-1}]$
In both cases the power of "M" is same i.e., "1".

05. (C)

$$1kgm^2s^{-2} = (1000g)(100cm)^2s^{-2} = 10^7\,gcm^2s^{-2}$$

06. (C)

By definition of systematic error

07. (D)

$$f = \frac{1}{2\pi}\sqrt{\frac{k}{m}} = c\,m^{-1/2}k^{1/2} \quad \left(\frac{1}{2\pi} = c = \text{constant}\right)$$

08. (D)

All given quantities are the ratios of same physical quantities. So, these are the unit less and dimensionless.

09. (B)

$$P = kI^2\left[\frac{L}{\lambda}\right]^2 = I^2R$$
$$\left[\frac{L}{\lambda}\right]^2 = \text{unit less}$$
k = R = ohm

10. (B)

$$\frac{1\text{ ms}}{1\text{fs}} = \frac{10^{-3}}{10^{-15}} = 10^{12} \Rightarrow 1\text{ms} = 10^{12}\text{ fs}$$

11. (A)

$$\frac{v^2}{rg} = \frac{m^2s^{-2}}{m.ms^{-2}} = \text{no unit or unit less}$$

12. (D)

$$\sqrt{\frac{\text{energy}}{\text{mass}}} = \left(\frac{\text{energy}}{\text{mass}}\right)^{1/2}$$
$$= \left(\frac{kgm^2s^{-2}}{kg}\right)^{1/2} = (m^2s^{-2})^{1/2} = ms^{-1} = \text{velocity}$$

13. (C)

$$\frac{1\mu C}{1nC} = 10^3 \Rightarrow 1\mu C = 10^3\text{ nC}$$

14. (D)

$$\frac{\text{atto}}{\text{exa}} = \frac{10^{-18}}{10^{18}} = 10^{-36}$$

15. (A)

Steradian (sr) is the SI unit of solid angle. By definition of Sr

$$1\text{sr} = \frac{\text{Area of circular patch on sphere}}{\text{square of radius of sphere}} = \frac{[L^2]}{[L^2]}$$

= Dimension less

16. (C)

A precise measurement is the one which has less absolute uncertainty and accurate measurement is the one which has less fractional or percentage uncertainty or error.

17. (D)

(solid angle of sphere) × (square of radius)
$= 4\pi r^2$ = Surface Area of sphere

18. (B)

$S = ct = (3\times10^8)(365\times24\times3600) = 9.5\times10^{15}$ m

19. (D)

$1\text{ s} = \frac{1}{365\times24\times3600}$ years $= 3.1\times10^{-8}$ years

20. (C)

coulomb = ampere × second

21. (B)

The velocity of body at any instant during vertically downward motion under the influence of force of gravity is given:

$v = \sqrt{2gh}$

22. (C)

When repeated measurements of the quantity give different values under the same conditions, such type of error is called random error. It is due to some unknown causes. This error can be reduced by repeating the measurements several times and taking an average.

23. (A)

RC = t , L/R = t while f = 1/T

24. (A)

$f = 1/T = s^{-1}$

$\lambda = \frac{\Delta N/N}{\Delta t} = s^{-1}$

25. (D)

$\frac{EL^2}{M^5G^2} = \frac{[ML^2T^{-2}][ML^2T^{-1}]^2}{[M]^5[M^{-1}L^3T^{-2}]^2} = \frac{[M^3L^6T^{-4}]}{[M^3L^6T^{-4}]}$
= dimension less

26. (A)

$E = \frac{F}{q} = Fq^{-1}$ = newton $(\text{coulomb})^{-1}$

27. (A)

P = VI = (volt)×(ampere)

28. (D)

As $1\text{gcm}^{-3} = 1000\text{ kgm}^{-3}$
$15.7\text{gcm}^{-3} = 15.7\times1000\text{ kgm}^{-3} = 15700\text{ kgm}^{-3}$

29. (A)

As $f_r = \frac{1}{2\pi\sqrt{LC}} \Rightarrow \sqrt{LC} = \frac{1}{2\pi f_r} = \frac{T}{2\pi}$ = second

30. (D)

Fractional uncertainty = $\frac{\text{Absolute uncertainty or least count}}{\text{Measured value}}$

As it the ratio of same dimensional quantities. So, it has no unit or unit less.

31. (B)

$\theta = \frac{\text{arc length}}{\text{radius}} \Rightarrow [\theta] = \frac{[\ell]}{[r]} = \frac{[L]}{[L]} = [L^o]$

32. (A)

$[G] = \frac{[F][r^2]}{[m_1][m_2]} = \frac{[MLT^{-2}][L^2]}{[M][M]} = [M^{-1}L^3T^{-2}]$

33. (C)

$\eta = \frac{F}{6\pi vr} \Rightarrow [\eta] = \frac{[F]}{[v][r]} = [ML^{-1}T^{-1}]$

$P = \frac{F}{A} \Rightarrow [P] = \frac{[F]}{[A]} = [ML^{-1}T^{-2}]$

34. (B)

$f = \frac{1}{T} \Rightarrow [f] = [T^{-1}] = [M^oL^oT^{-1}]$

35. (C)

$K.E = \frac{1}{2}mv^2$

Uncertainty in K.E = %age uncertainty in mass + 2(%age uncertainty in velocity) = 2% + 2(3%)
= 8%

36. (B)

$R_e = R_1 + R_2$
In addition and subtraction absolute uncertainties are added.

37. (D)

$\rho = \frac{m}{V} = \frac{m}{L^3}$

Uncertainty in ρ = %age uncertainty in mass + 3(%age uncertainty in length)
= 3% + 3(2%) = 9%

38. (A)

%age uncertainty in V = $\frac{0.5}{8}\times100\% = 6.25\%$

%age uncertainty in I = $\frac{0.2}{2}\times100\% = 10\%$

Uncertainty in R = %age uncertainty in V + %age uncertainty in I
= 6.25% + 10% = 16.25%

$R = \frac{V}{I} = \frac{8}{2} = 4\ \Omega \pm 16.25\%$

39. (D)

$E = -\frac{\Delta V}{\Delta r} = Vm^{-1}$

40. (D)

$a = \frac{F}{m} = \frac{dy}{g}$ in CGS system

41. (D)

candela is the SI unit of luminous intensity.

42. (B)

unit of term "λt" = 1
$\lambda = 1/t = s^{-1}$ = unit of angular frequency

43. (D)

1 micron = 10^{-6} m
1 micron = $10^{-4}.10^{-2}\text{m} = 10^{-4}$cm

44. (C)

Total solid angle in a sphere = 4π sr

solid angle in semi sphere $= \frac{1}{2}(4\pi)$ sr = 2π sr

45. (C)

Fractional or relative error in "a" = $\frac{\Delta a}{a}$

Fractional or relative error in "x" = $n\left(\frac{\Delta a}{a}\right)$

46. (A)

$P = \frac{W}{t} = \frac{kgm^2s^{-2}}{s} = kgm^2s^{-3}$

47. (B)

By definition of systematic error.

48. (A)

Error in R = %age error in "V" + %age error in "I"
= 3% + 3% = 6%

49. (D)

Area of wire = $\pi r^2 = \pi(d/2)^2$
%age uncertainty in area of wire = 2× (%age uncertainty in radius or diameter)

50. (D)

$\eta = \frac{F}{6\pi vr} = \frac{N}{m^2s^{-1}} = Nm^{-2}s = kgm^{-1}s^{-1} = Pa\ s$

51. (C)

%age uncertainty in time = $\frac{\text{Least count}}{\text{Measured value}} \times 100\%$
$= \frac{0.2}{25} \times 100\ \% = 0.8\%$

52. (C)

1 pico = 10^{-12} and 1 G = 10^9

53. (D)

nano = 10^{-9}

54. (D)

Unit of pressure = Nm^{-2}
Unit of K.E = Nm = J

55. (C)

$\frac{1\ mm}{1\ Gm} = \frac{10^{-3}}{10^9} = 10^{-12}$

56. (C)

A precise measurement is the one which has less absolute uncertainty or least count.

57. (A)

Unit of electric filed intensity = NC^{-1}
Unit of electric flux = Nm^2C^{-1}

58. (B)

$\frac{B^2}{2\mu_o}$ = Energy density = $Jm^{-3} = kgm^{-1}s^{-2}$

59. (D)

mole is a base unit.

60. (D)

The symbol of unit named after a scientist has initial capital letter such as "N" for newton.

61. (C)

$1km^2 = 1\ (km)^2 = 1\ (10^3\ m)^2 = 10^6\ m^2$

62. (B)

The precision of a measurement is determined by the instrument being used. A precise measurement is that which has less absolute uncertainty.

63. (D)

As speed of light, $c = \frac{1}{\sqrt{\mu_o\varepsilon_o}} \Rightarrow c^2 = \frac{1}{\mu_o\varepsilon_o}$

By the principle of homogeneity both sides have same SI units and dimensions.

64. (B)

$U = \frac{ky}{y^2 + a^2} \Rightarrow k = \frac{U(y^2 + a^2)}{y} = \frac{J\ m^2}{m} = J\ m$

65. (D)

$F = \frac{1}{4\pi\varepsilon_o}\frac{q_1q_2}{r^2} \Rightarrow \varepsilon_o = \frac{1}{4\pi}\frac{q_1q_2}{Fr^2} = \frac{C^2}{Nm^2} = N^{-1}m^{-2}C^2$

66. (A)

$v = a + \frac{b}{t} + ct^2$

By the principle of homogeneity

$\frac{b}{t} = ms^{-1} \Rightarrow bs^{-1} = ms^{-1} \Rightarrow b = m$

67. (D)

By definition

$\vec{\tau} = \vec{r} \times \vec{F}$ (vector) and

$W = \vec{F}.\vec{d}$ (scalar)

68. (B)

mc^2 = X = Energy = work

69. (C)

Slug is the unit of mass in FPS system (British Engineering system).
1 slug = 14.6 kg

70. (B)

candela is the base unit not physical quantity.

71. (C)

Radian is the supplementary unit. It is the unit of plane angle.

72. (A)

Area of sphere = $4\pi r^2$
Error in area = 2(%age error in radius)
Error in area = 2(%1) = 2%

73. (A)

By definition of radian.

$\theta = \frac{\text{arc length}}{\text{radius of circle}}$ (rad)

74. (A)

An accurate measurement is that which has less fractional or percentage uncertainty.

75. (B)

A precise measurement is that which has less absolute uncertainty.

76. (C)

Uncertainty in the time period = $\frac{\text{Absolute Uncertainty of stop watch}}{\text{Total number of vibrations}}$

77. (C)

$F_D = W \Rightarrow 6\pi\eta rv = mg \Rightarrow v = \frac{mg}{6\pi\eta r}$

78. (C)

$1cm^3 = 1000\ mm^3$

79. (D)

ampere is a base unit while coulomb is a derived unit.

80. (C)

$1.67 \times 10^{-27}\ kg = 1.67 \times 10^{-27}(10^3g) = 1.67 \times 10^{-24}\ g$

81. (B)

Error refers to an effect that influences all measurements of a particular quantity equally is called systematic error. It produces a consistent difference in reading. It occurs to some definite rule. It may occur due to the zero error, poor calibration of instruments or incorrect marking etc.

82. (A)

Unit of torque $= N\,m = kgm^2s^{-2}$
Unit of angular momentum $= J\,s = kgm^2s^{-1}$

83. (B)

In addition and subtraction absolute uncertainties are added.

84. (B)

As the absolute uncertainty (least count) of screw gauge is 0.001 cm. so, it recorded up– to three decimal places.

85. (D)

$$V = \frac{4}{3}\pi r^3$$

Uncertainty in V = 3(%age uncertainty in radius)
= 3(2%) = 6%

86. (B)

Error refers to an effect that influences all measurements of a particular quantity equally is called systematic error. It produces a consistent difference in reading. It occurs to some definite rule. It may occur due to the zero error, poor calibration of instruments or incorrect marking etc.

87. (C)

Error in volume of sphere = 3(%age error in radius)

$$= 3\left(\frac{\text{Least count}}{\text{Mesaured value}} \times 100\right) = 3\left(\frac{0.1}{5.3} \times 100\right)$$

88. (D)

Area of plate = ab
Error in area of plate = (%age error in "a") + (%age error in "b")

$$= \left(\frac{\Delta a}{a} + \frac{\Delta b}{b}\right) \times 100$$

89. (D)

This error can be reduced by comparing the instrument with another which is known to be more accurate or applying a correction factor.

90. (C)

1 division = 0.4 mA
8.5 divisions = 8.5×0.4 mA = 3.4 mA

91. (D)

$$\text{Units of} \sqrt{\frac{F \times \ell}{m}} = \left[\frac{kgms^{-2}\,m}{kg}\right]^{½} = [m^2s^{-2}]^{1/2} = ms^{-1}$$

92. (D)

By the principle of homogeneity

$$xt = ms^{-1} \Rightarrow x = \frac{ms^{-1}}{t} = ms^{-2} \quad \text{and}$$

$$y = ms^{-1}$$

93. (C)

Unit of "ρgh" $= kgm^{-3} \times ms^{-2} \times m = kgms^{-2} \times m^{-2}$
$= Nm^{-2}$ = Pressure

94. (D)

Energy density and pressure have same SI units kg $m^{-1}s^{-2}$ while angular momentum have dimension kg m^2s^{-1}.

95. (B)

$1A° = 10^{-10}\,m, \quad 1km = 10^3\,m$

96. (D)

1 atto $= 10^{-18}$

97. (C)

Unit of energy is joule $= kgm^2s^{-2}$
But the unit of(Impulse × time) $= kgms^{-1}s = kgm$

98. (C)

$$\lambda = \frac{\Delta N/N}{\Delta t} = s^{-1} = \text{frequency}$$

99. (B)

RC = t = capacitive time constant

100. (D)

The error in a measurement may occur due to:
i. Negligence or inexperience of a person.
ii. The faulty apparatus.
iii. Inappropriate method or technique.

101. (B)

Unit of spring constant, $k = Nm^{-1}$
Unit of tension (force), F = N

102. (B)

peta $= 10^{15}$

103. (B)

$10^3\,dy\,cm^{-2} = 10^3\,(10^{-5}\,N)(10^4\,m^{-2}) = 10^2\,Nm^{-2}$

104. (B)

There are only two supplementary units. Radian and steradian.

105. (C)

$100 \times 10^{-11} = 10^{-9}$ = neno

106. (D)

Error in Q=2(Error in current)+ error in Resistance + error in Time
Error in Q = 2(2%) + 1%+ 1% = 6%

107. (B)

Error in Pressure = error in force + 2(Error in length)
Error in Pressure = 4% + 2(2%) = 8%

108. (D)

$$\frac{\text{joule} \times \text{ohm}}{\text{volt} \times \text{second}} = \frac{\text{volt} \times \text{coulomb} \times \text{ohm}}{\text{volt} \times \text{second}}$$

$$= \frac{\text{coulomb}}{\text{second}} \times \text{ohm} = \text{ampere} \times \text{ohm} = \text{volt}\ (V = IR)$$

109. (C)

Because errors are always be added.

110. (D)

Light year is the distance that light travels in one year (S = ct).

111. (B)

$$W = Fd \Rightarrow \frac{W}{d} = F$$

112. (C)

1 femto $= 10^{-15}$

113. (B)

$$\frac{\text{kilo}}{\text{pico}} = \frac{10^3}{10^{-12}} = 10^{15}$$

114. (D)

In multiplication and division percentage or fractional uncertainties are added.

115. (C)
An ideal standard has two characteristics:
i. It is accessible.
ii. It is invariable.

116. (A)
$[v^{-2}F^{o}E] = [L^{-2}T^{2}][1][ML^{2}T^{-2}] = [M]$

117. (B)
$k = \frac{velocity}{density} = \frac{ms^{-1}}{kgm^{-3}} = kg^{-1}m^{4}s^{-1}$

118. (B)
$(nano)(giga) = (10^{-9})(10^{9}) = 10^{0} = 1$

119. (C)
According to principle of homogeneity
$0.61t = ms^{-1} \Rightarrow 0.61 = \frac{ms^{-1}}{t} = ms^{-1} {}^{o}C^{-1}$
($\therefore$ t = temperature)

120. (B)
Energy $= mc^2 = (1)(3\times10^{8})^2 = 9\times10^{16}$ J

121. (A)
Unit of P.E = J = kgm^2s^{-2}

122. (A)
$P = VI = I^2R = V^2/R$

123. (B)
$L = mvr = \frac{nh}{2\pi} = Js$

124. (A)
As $1N = 10^5$ dy
$1m^2 = 10^4\ cm^2$
$1kg^2 = 10^6\ g^2$
$G = 6.67\times10^{-11}\frac{Nm^2}{kg^2}$
$= 6.67\times10^{-11}\times\frac{10^5\times10^4}{10^6}$ dy cm^2g^{-2}
$= 6.67\times10^{-11+9-6}$dy $cm^2g^{-2} = 6.67\times10^{-8}$ dy cm^2g^{-2}

125. (A)
$\frac{\text{Leat count of screw gauge}}{\text{Leat count of vernier calliper}} = \frac{0.1mm}{0.01mm} = 10$
Smaller the least count means more precise is the reading.

126. (A)
$L = rP \Rightarrow r = \frac{L}{P} = [L]$

127. (C)
Impulse = $\Delta P = kgms^{-1} = N\ s$

128. (C)
$k = \frac{F}{x} = \frac{kgms^{-2}}{m} = kg\ s^{-2}$

129. (A)
$\frac{RCV}{L} = \frac{(RC)V}{L} = \frac{TV}{V\Delta T/\Delta I} = \Delta I$ = current
$\therefore V = L\frac{\Delta I}{\Delta T} \Rightarrow L = \frac{V\Delta T}{\Delta I}$ and $\therefore RC = T$

130. (A)
In thermodynamic process
$W = P\Delta V$ = energy = joule

131. (B)
All the seven base quantities are scalar in nature.

132. (C)
$\theta = \frac{\text{Arc length}}{\text{Radius}} = \frac{2\pi r}{r} = 2\pi$ rad

133. (A)
Light year is the unit of distance.

134. (C)
$\frac{Power}{Pressure} = \frac{[ML^2T^{-3}]}{[ML^{-1}T^{-2}]}$
$= [L^3T^{-1}] = m^3s^{-1}$ = volume flow per second

135. (A)
Quantities of same kind (dimensions) are added or subtracted according to principle of homogeneity.

136. (D)
kilogram is the base unit not base quantity.

137. (D)
Unit of surface tension = Nm^{-1}

138. (C)
$P = Fv$
$P' = (2F)(2v) = 4Fv = 4P$

139. (D)
As energy density $= \frac{1B^2}{2\mu_o} = Jm^{-3} = kgm^{-1}s^{-2}$
As "A", "B" and "C" options have same dimensional units as that of energy density.

140. (C)
Volume is a derived quantity. So, its unit is derived unit.

141. (A)
For example
$n_1u_1 = n_2u_2 \Rightarrow 1m = 100\ cm \Rightarrow (1)(m) = (100)(cm)$

142. (A)
Uncertainty in time period $= \frac{\text{Least count}}{\text{No. of vibrations}}$
$= \frac{0.1}{30}\ s = 0.003\ s$

143. (A)
Error in diameter of wire $= \frac{\text{Least count}}{\text{Mesaured value}} \times 100\ \%$
$= \frac{0.005}{0.020}\times 100\% = 25\%$

144. (A)
Error in P = 3(%age error in "a") + 2(%age error in "b") + (%age error in "c") + (%age error in "d")
Error in P = 3(1%) + 2(2%) + (3%) + (4%) = 14%

145. (B)
By principle of homogeneity
$c^2 = s \quad \Rightarrow c = s^{1/2}$

146. (D)
All are base quantities.

147. (C)
$1A^{o} = 10^{-10}m = 10^{-7}\times10^{-3}\ m = 10^{-7}$ mm

148. (D)
All are fundamental quantities except "Charge".
$Q = I\times t$

149. (A)
The speed of wave in stretched string is given by:
$v = \sqrt{F/m}$
F = tension in the string

m = mass per unit length of string

$f = \frac{v}{2\ell} = \frac{1}{2\ell}\sqrt{\frac{F}{m}}$

unit of "m" = kgm^{-1}

150. (B)

$\Delta x = x_2 - x_1 = (26.8 - 10.5) \pm (0.1 + 0.1)$

$= 16.3 \pm 0.2$ cm

In addition and subtraction absolute uncertainties are added.

151. (C)

Light year the unit of distance.

152. (B)

Uncertainty in time period = $\frac{\text{Least count}}{\text{No. of vibrations}}$

153. (B)

By the principle of homogeneity

Unit of "y" = unit of term "bt"

$m = bs \Rightarrow b = ms^{-1}$

154. (C)

By the principle of homogeneity

Unit of term "a/V^2" = unit of "P"

$a/m^6 = Nm^{-2} \Rightarrow a = Nm^{-2}.m^6 = N\ m^4$

155. (A)

Total numbers of base physical quantities in SI are "7".

156. (B)

Compound prefixes are not allowed.

157. (C)

The speed of wave in any medium is given by:

$v = \sqrt{\frac{\text{Elastic modulus}}{\text{density}}} = \sqrt{\frac{E}{\rho}} \Rightarrow X = E = kgm^{-1}s^{-2}$

158. (C)

Maximum error in any measurement = Least count of instrument being used (absolute uncertainty)

So, $T = (2.00 \pm 0.05)$ s

159. (B)

Precision relates to the least count of instrument. Smaller the least count, more precise will be the instrument.

The minimum reading (length) that can be measured by any instrument (L.C) is the precision of that instrument.

160. (B)

$1nm = 10^{-9}\ m = 10^{-7} \times 10^{-2}m = 10^{-7}$ cm

161. (A)

$h = \frac{1}{2}gt^2 \Rightarrow t^2 = \frac{2h}{g} \Rightarrow t = \sqrt{\frac{2h}{g}}$

162. (C)

The only pair of SI base units is "ampere" and "kelvin".

163. (A)

$K.E = \frac{1}{2}mv^2 = \frac{m^2v^2}{2m} = \frac{p^2}{2m}$

164. (A)

Centi, milli, micro → 10^{-2}, 10^{-3}, 10^{-6} (decreasing order)

165. (A)

Compound prefixes are not allowed.

$3\mu\mu F = 3pF$

166. (A)

Example:

$1m = 10^2$ cm $= 10^3$ mm $= 10^6$ µm (Prefixes)

167. (C)

%age error in $V = \frac{5}{100} \times 100 = 5\%$

%age error in $I = \frac{0.2}{10} \times 100 = 2\%$

Total error in R = 5% + 2% = 7%

(errors always be added)

168. (A)

Accurate measurement is the one which is near to true value.

169. (D)

Systematic error is the instrumental error that may occur due to poor calibration. So, to remove this recalibrating the instrument.

170. (A)

%age uncertainty in depth = $\frac{0.2}{24} \times 100 = 0.8\%$

171. (D)

Characteristics of an ideal standard:

i. Accessible ii. Invariable

172. (C)

%age error in $L = \frac{5}{100} \times 100 = 5\%$

%age error in $I = \frac{0.2}{10} \times 100 = 2\%$

Total error in g= %age error in L+2(%age error in T)

= 1% + 2(3%) = 7%

(errors always be added)

173. (D)

%age error in distance = $\frac{0.2}{10} \times 100 = 2\%$

%age error in time = $\frac{0.3}{4} \times 100 = 7.5\%$

Total error in velocity = 2% + 7.5% = 9.5%

(errors always be added)

174. (B)

$F = ma \Rightarrow a = \frac{F}{m}$ ($N\ kg^{-1}$)

175. (C)

$v = \frac{a}{t}$

$m/s \neq m/s^3$

The only equation exist that have same units on both sides of equality.

176. (A)

$P = VI \Rightarrow$ watt = ampere × volt

177. (B)

Both energy and work have same units. So, their ratio will be unit less.

178. (A)

All are the units of energy except kilo watt (kW). kilo watt (kW) is the unit of power.

179. (A)

1000 kg = 1000(1000 g) = 10^6 g = 1 Mg

180. (C)

$$\frac{1\text{ Tm}}{1\text{Gm}} = \frac{10^{12}\text{ m}}{10^{9}\text{ m}} = 10^3 = k = \text{kilo}$$

181. (B)

$A = 4\pi r^2$

Uncertainty in area = 2(%age uncertainty in radius)

Uncertainty in area = 2(1.6 %) = 3.2 %

182. (B)

F = ma

Units of "F" = $kgms^{-2}$

183. (B)

$$F = G\frac{m_1m_2}{r^2} \Rightarrow G = \frac{Fr^2}{m_1m_2}$$

Units of "G" $= Nm^2kg^{-2}$

$= (kgms^{-2})(m^2kg^{-2}) = kg^{-1}m^3s^{-2}$

184. (B)

$$P = \frac{W}{t} \Rightarrow W = (P)(t) \Rightarrow \text{Energy} = (\text{power})(\text{time})$$

Unit of energy = (watt)(day)

185. (A)

$1000 \text{ microns} = 1000 \times 10^{-6} \text{ m} = 10^{-3} \text{ m}$

186. (D)

$$\omega = \frac{\theta}{t}$$

Unit of "ω" = rad s^{-1}

187. (C)

$$f = \frac{1}{2\pi\sqrt{LC}} \Rightarrow \sqrt{LC} = \frac{1}{2\pi f} = \frac{T}{2\pi}$$

unit of $\sqrt{LC}$ = s

188. (C)

$$C = \frac{A\varepsilon_o}{d} \Rightarrow \varepsilon_o = \frac{Cd}{A}$$

Units of "ε_o" $= \frac{Fm}{m^2} = \frac{F}{m}$

189. (A)

$$\frac{\text{Energy}}{\text{Mass} \times \text{Length}} = \frac{Fd}{m \times d} = \frac{(ma)d}{m \times d} = a \text{ (acceleration)}$$

190. (C)

$$72 \text{ kmh}-1 = 72 \times \frac{1000}{3600} ms^{-1} = 20 ms^{-1}$$

191. (A)

Light year and wavelength both have the dimensions of distance [L].

192. (C)

$1nm \times 1Em = 10^{-9} \times 10^{18} m^2 = 10^9 m^2$

193. (B)

As the least count of screw gauge is smallest than meter rod and vernier calipers. So, it is most precise among them.

UHS PAST MDCAT (2008-2019)

1. The units of "E" in E =mc² are: (UHS 2008)

(A) kg ms^{-2} (C) kg m^2s^{-2}

(B) N ms^{-2} (D) Both "B" and "C"

(C)

$E = mc^2$

Units of "E" $= kg(ms^{-1})^2 = kgm^2s^{-2}$

2. Light year is the measure of: (UHS 2008)

(A) Distance (C) Intensity of light

(B) Time (D) Velocity

(A)

Light year is the distance travelled by light in one year. It is the unit of distance.

3. The dimensions of gravitational constant "G" are: (UHS 2009)

(A) $[ML^{-2}T^{-1}]$ (C) $[ML^{-2}T^{-2}]$

(B) $[M^2L^{-2}T^{-1}]$ (D) $[M^{-1}L^3T^{-2}]$

(D)

$$F = G\frac{m_1m_2}{r^2} \Rightarrow G = \frac{Fr^2}{m_1m_2}$$

$$[G] = \frac{[F][r]^2}{[m_1][m_2]} = \frac{[MLT^{-2}][L]^2}{[M][M]} = [M^{-1}L^3T^{-2}]$$

4. Principal of homogeneity of equation used to check: (UHS 2010)

(A) Variables of equation

(B) Both variable and constants equation

(C) Constants of equation

(D) Correctness of equation

(D)

According to principle of homogeneity every equation would be correct if it has same dimensions or SI base units on both sides.

5. Which one is the highest power multiple: (UHS 2010)

(A) giga (C) mega

(B) tera (D) deca

(B)

deca < mega < giga < tera→$10^1 < 10^6 < 10^9 < 10^{12}$

6. SI unit of charge is: (UHS 2010)

(A) ampere (C) coulomb

(B) volt (D) calorie

(C)

$$I = \frac{Q}{t} \Rightarrow Q = It$$

Unit of charge "Q" = A s = C = coulomb

7. When the dimensions of both sides of an equation are equal, then equation is said to be: (UHS 2011)

(A) Simultaneous (C) Instantaneous

(B) Homologous (D) Quadratic

(B)

By principle of homogeneity, the dimension of both side of equation will be same. So, the equation is said to be homologous.

8. Radian is a unit of angular displacement which can also be measured in degrees. How many radians are equal to one degree: (UHS 2011)

(A) $\frac{\pi}{180}$ (C) $\frac{2\pi}{180}$

(B) $\frac{180}{\pi}$ (D) $\frac{\pi}{57.3}$

(A)

As we know that

$$360^\circ = 2\pi \text{ rad}$$

$$1^\circ = \frac{2\pi}{360} \text{ rad} = \frac{\pi}{180} \text{ rad}$$

9. Electric charge on an object is measured as 5 micro coulombs. How the value of this charge can be expressed in terms of base units: (UHS 2012)

(A) 5 × 100 ampere second

(B) 5×10^{-6} ampere second

(C) $5 \times 10^{+6}$ coulomb second

(D) 5 × 100 coulomb second

(B)

5 micro coulomb = 5×10^{-6} ampere second

10. If "m" is the mass, "c" is the velocity of light and $x = mc^2$, then the dimensions of "x" will be: (UHS 2012)

(A) $[LT^{-1}]$ (C) $[MLT^{-1}]$

(B) $[ML^2T^{-2}]$ (D) $[MLT^{-2}]$

(B)

$[x] = [m][c]^2 = [M][LT^{-1}]^2 = [M][L^2T^{-2}]$

11. The wavelength "λ" of a wave depends on the speed "v" of the wave and its frequency "f". Decide which of the following is correct? (UHS 2013)

(A) $f = \frac{v}{\lambda}$ (C) $f = \frac{\lambda}{v}$

(B) $f = v\lambda$ (D) $f = v\lambda^{-2}$

(A)

Unit of "f" = Hz = s^{-1}

Unit of "v/λ" = s^{-1}

12. Name the quantity which can be measure by using base unit "kg m^2 s^{-3}": (UHS 2013)

(A) Weight (C) Power

(B) Pressure (D) Work

(C)

$$P = \frac{W}{t} = \frac{kgm^2s^{-2}}{s} = kgm^2s^{-3}$$

13. The formula for electric field strength is E= F/Q, where E is electric field strength, F is force and Q is charge. Which of the following options gives the correct base units for electric field strength? (UHS 2014)

(A) $kgms^{-3}A^{-1}$ (C) $kgs^{-2}A^{-2}$

(B) $kg^2m^{-1}s^2A$ (D) $m^2s^{-1}A^{-1}$

(A)

$$E = \frac{F}{Q}$$

$$\text{Unit of "E"} = \frac{N}{C} = \frac{kgms^{-2}}{As} = kgms^{-3}A^{-1}$$

14. Which set of the prefixes give values in increasing order? (UHS 2014)

(A) pico, mego, kilo, tera

(B) pico, micro, mega, giga

(C) tera, pico, micro, kilo

(D) giga, kilo, milli, nano

(B)

Pico, Micro, Mega, Giga → 10^{-12}, 10^{-6}, 10^{6}, 10^{9}

15. The unit of temperature in base unit is: (UHS 2015)

(A) celsius (C) kelvin

(B) degree (D) Fahrenheit

(C)

kelvin is the SI base unit of temperature.

16. the dimensions of pressure is: (UHS 2015)

(A) $[M^{-1}L^2T^{-2}]$ (C) $[M^{-1}L^{-2}T^{-2}]$

(B) $[ML^{-1}T]$ (D) $[ML^{-1}T^{-2}]$

(D)

$$P = \frac{F}{A} \Rightarrow [P] = \frac{[MLT^{-2}]}{[L^2]} = [ML^{-1}T^{-2}]$$

17. The time period "T" of a simple pendulum depends on its length "ℓ" and acceleration due to gravity "g". Using units, the correct equation for time period is: (UHS 2016)

(A) $T = k\sqrt{\frac{g}{\ell}}$ where "k" is constant

(B) $T = k\sqrt{\frac{\ell}{g}}$ where "k" is constant

(C) $T = \frac{1}{k}\sqrt{\frac{g}{\ell}}$ where "k" is constant

(D) $T = \frac{1}{k}\sqrt{\frac{\ell}{g}}$ where "k" is constant

(B)

$$T = k\sqrt{\frac{\ell}{g}} = 2\pi\sqrt{\frac{\ell}{g}}$$

Where k = 2π = constant

18. The unit for electric charge is coulomb and one coulomb in terms of base unit is equivalent to: (UHS 2016)

(A) Am (C) As

(B) Js^{-1} (D) C

(C)

$$I = \frac{Q}{t} \Rightarrow Q = It$$

Unit of "Q" = C = As

19. An observer notes reading of a scale from different angles (parallax) while measuring the length of wire, what kind of error can occur? (UHS 2017)

(A) Systematic Error (C) Precised Error

(B) Zero Error (D) Random Error

(D)

As observer takes readings from different angles of same experiment under same conditions, results would be different due to random error.

20. The quantities which can be measured accurately are called: (UHS 2017)

(A) Base Quantities
(B) Derived Quantities
(C) Physical Quantities
(D) Supplementary Quantities

(C)

All measurable quantities in terms of which the laws of physics are expressed are called physical quantities.

21. Force is a derived quantity, its derived unit can be expressed in terms of the base units as: (UHS 2018)

(A) $kgcms^{-2}$ (C) $kgms^{2}$
(B) $kgm^{2}s^{2}$ (D) $kgms^{-2}$

(D)

F = ma
Units of "F" = $kgms^{-2}$

22. The different magnitudes of same physical quantities are measured by comparing them to: (UHS 2018)

(A) Available scale
(B) Other physical quantities
(C) Each other
(D) Standard size

(C)

Same physical quantities are measured by comparing them to each other.

Example:

1 m = 100 cm = 1000 mm

23. Percentage uncertainty in the length and width of a rectangle is 2% and 3%. The total uncertainty in area of that rectangle is: (UHS 2019)

(A) 1.5% (C) 6%
(B) 5% (D) 1%

(B)

Area of rectangle = length × width
Total uncertainty in area = 2% + 3% = 5%
(Errors always be added)

24. The diameter of a wire is measured by using a micrometer screw gauge with least count of 0.01 mm, then which of the following reading will be correct? (UHS 2019)

(A) 0.067 cm (C) 0.67 cm
(B) 0.0067 mm (D) 6.70 cm

(A)

Least count of screw gauge = 0.01 mm
= 0.001 cm

Screw gauge measures reading up-to three decimal places. So, the correct answer is 0.067 cm.

UNIT 02 MOTION AND FORCE

01. **What is the angle of projection for which the range and maximum height become equal?**

(A) $\tan^{-1}\left(\frac{1}{4}\right)$ (C) $\cos^{-1}\left(\frac{1}{4}\right)$
(B) $\tan^{-1}(4)$ (D) $\sin^{-1}\left(\frac{1}{4}\right)$

02. **When two bodies move toward each other with constant speed the distance between them decreases at the rate of 6m/sec. If they move in the same direction the distance between them decreases at the rate of 4m/s. Then their speeds are:**

(A) 5m/s, 1m/s (C) 6m/s, 1m/s
(B) 3m/s, 3m/s (D) 4m/s, 2m/s

03. **The distance covered by a body with uniform acceleration in time "t" starting from rest is:**

(A) $at^2/2$ (C) $a^2t/2$
(B) vt (D) Both (A) and (B)

04. **Flight of a rocket in the space is an example of:**

(A) second law of motion
(B) third law of motion
(C) first law of motion
(D) law of conservation of linear momentum

05. **Time rate of change of momentum is equal to:**

(A) force (C) impulse
(B) velocity (D) both "a" and "c"

06. **A cricket ball is hit so that it travels straight up in air and it acquires 3 s to reach the maximum height. Its initial velocity is:**

(A) $10\ ms^{-1}$ (C) $15\ ms^{-1}$
(B) $29.4\ ms^{-1}$ (D) $12.2\ ms^{-1}$

07. **The unit of momentum in SI unit is:**

(A) $kgms^{-2}$ or N m (C) kg^2ms^{-1} or N m^2
(B) kgm^2s or N^2m (D) $kgms^{-1}$ or N s

08. **The mass of fuel consumed by a typical rocket to overcome Earth's gravity is:**

(A) $1000kgs^{-1}$ (C) $100kgs^{-1}$
(B) $10000kgs^{-1}$ (D) $10kgs^{-1}$

09. **A body is thrown vertically upward with a velocity $9.8ms^{-1}$. It will reach the height:**

(A) 19.8m (C) 29.4m
(B) 9.8m (D) 4.9m

10. **For maximum horizontal distance to travel, a projectile must be fired at an angle of:**

(A) 30° (C) 45°
(B) 60° (D) 90°

11. **A racing car traveling with constant acceleration increases its speed from 10m/s to 50m/s over a distance of 60 m. How long does this take?**

(A) 2.0 s (C) 4.0 s
(B) 5.0 s (D) 8.0 s

12. **A car moving with an initial velocity of 25 m/s north has a constant acceleration of 3 m/s^2 south. After 6 s its velocity will be:**

(A) 7 m/s north (C) 7 m/s south
(B) 43 m/s north (D) 20 m/s north

13. **At a stop light, a truck traveling at 15 m/s passes a car as it starts from rest. The truck travels at constant velocity and the car accelerates at 3 m/s^2. How much time does the car take to catch up to the truck?**

(A) 5 s (C) 10 s
(B) 15 s (D) 20 s

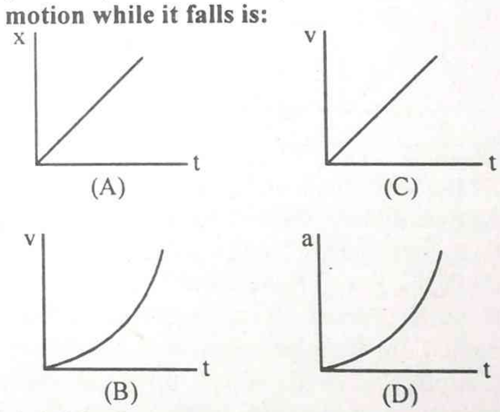
14. **A ball is in free fall. Its acceleration is:**

(A) downward during both ascent and descent
(B) downward during ascent and upward during descent
(C) upward during ascent and downward during descent
(D) upward during both ascent and descent

15. **Which one of the following statements is correct for an object released from rest?**

(A) The average velocity during the first second of time is 4.9m/s
(B) During each second the object falls 9.8m
(C) The acceleration changes by 9.8m/s^2 every second
(D) The object falls 9.8m during the first second of time

16. **A stone is dropped from a cliff. The graph (carefully note the axes) which best represents its motion while it falls is:**



17. **A 1.0 kg ball moving at 2.0m/s perpendicular to a wall rebounds from the wall at 1.5m/s. The change in the momentum of the ball is:**

(A) zero
(B) 0.5 N s toward wall
(C) 0.5 N s away from wall
(D) 3.5 N s away from wall

18. **If the total momentum of a system is changing:**

(A) particles of the system must be exerting forces on each other
(B) the system must be under the influence of gravity
(C) the center of mass must have constant velocity
(D) a net external force must be acting on the system

19. **When you step on the accelerator to increase the speed of your car, the force that accelerates the car is:**

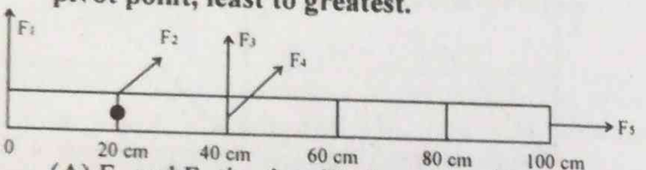
(A) the force of your foot on the accelerator
(B) the force of friction of the road on the tires
(C) the force of the engine on the drive shaft

(D) the normal force of the road on the tires

20. **A projectile in flight explodes into several fragments. The total momentum of the fragments immediately after this explosion:**
(A) is the same as the momentum of the projectile immediately before the explosion
(B) has been changed into kinetic energy of the fragments
(C) is less than the momentum of the projectile immediately before the explosion
(D) is more than the momentum of the projectile immediately before the explosion

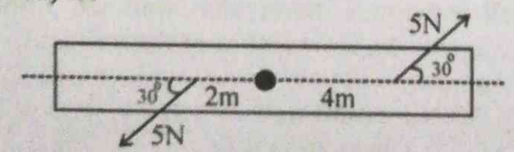
21. **Bullets from two revolvers are fired with the same velocity. The bullet from gun #1 is twice as heavy as the bullet from gun #2. Gun #1 weighs three times as much as gun #2. The ratio of the momentum imparted to gun #1 to that imparted to gun #2 is:**
(A) 2:3 (C) 3:2
(B) 2:1 (D) 3:1

22. **The meter stick shown below rotates about an axis through the point marked "•", 20 cm from one end. Five forces act on the stick: one at each end, one at the pivot point, and two 40 cm from one end, as shown. The magnitudes of the forces are all the same. Rank the forces according to the magnitudes of the torques they produce about the pivot point, least to greatest.**



(A) F_2 and F_5 tie, then F_4, then F_1 and F_3 tie
(B) F_2 and F_5 tie, then F_4, F_1, F_3
(C) F_1 and F_2 tie, then F_3, F_4, F_5
(D) F_2, F_5, F_1 and F_3 tie, then F_4

23. **A rod is pivoted about its center. A 5 N force is applied 4m from the pivot and another 5 N force is applied 2 m from the pivot, as shown. The magnitude of the total torque about the pivot (in N m) is:**



(A) 0 (C) 5
(B) 8.7 (D) 15

24. **Two cars are moving in opposite directions with speed "v". What is the magnitude of their relative velocity:**
(A) 0 (C) v/2
(B) v (D) 2v

25. **A train is moving east at a speed of 5 ms^{-1}. A bullet fired westwards with a velocity of 10 ms^{-1} crosses the train in 8s. The length of the train is:**
(A) 120 m (C) 30 m
(B) 60 m (D) 15 m

26. **A baseball is thrown vertically into the air. The acceleration of the ball at its highest point is:**
(A) zero (C) g, down
(B) g, up (D) 2g, down

27. **The numerical ratio of velocity and speed of a particle is always:**
(A) equal to or less than one
(B) equal to one
(C) less than one
(D) zero

28. **For a freely falling body, the vertical velocity at the fifth second is:**
(A) 39.2 ms^{-1} (C) 19.6 ms^{-1}
(B) 49 ms^{-1} (D) 94.9 ms^{-1}

29. **When a certain force is applied to the standard kilogram its acceleration is 5.0 m/s^2. When the same force is applied to another object its acceleration is one–fifth as much. The mass of the object is:**
(A) 0.2 kg (C) 0.5 kg
(B) 1.0 kg (D) 5.0 kg

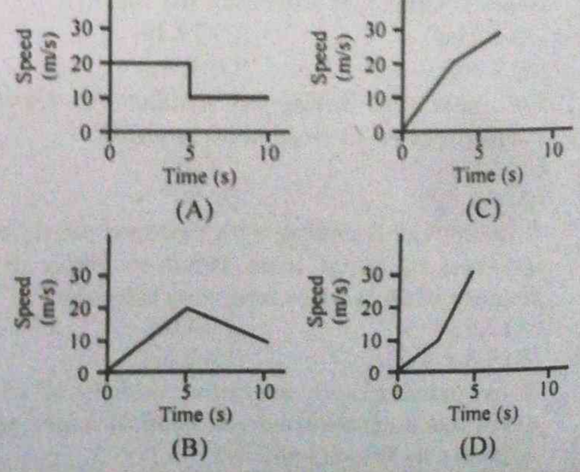
30. **At what angle height of a projectile is 1/4th of its maximum height:**
(A) 30° (C) 45°
(B) 40° (D) 60°

31. **Which shows the correct relation between time of flight T and maximum height H?**
(A) $H = \frac{gT^2}{8}$ (C) $H = \frac{8g}{T^2}$
(B) $H = \frac{8T^2}{g}$ (D) $H = \frac{8}{gT^2}$

32. **A car travels east at constant velocity. The net force on the car is:**
(A) east (C) west
(B) up (D) zero

33. **A block slides down a frictionless plane that makes an angle of 30° with the horizontal. The acceleration of the block is:**
(A) 980 cm/s^2 (C) 566 cm/s^2
(B) 0 cm/s^2 (D) 490 cm/s^2

34. **A skier is travelling downhill. The acceleration on hard snow is 4 m/s^2 and on soft snow is 2 m/s^2 Which graph shows the motion of the skier when moving from hard snow to soft snow?**



35. **Which vehicle has an acceleration of 5 m/s^2?**
(A) a bicycle, when its speed changes from rest to 2.5 m/s in 2 s
(B) a car, when its speed changes from rest to 15 m/s in 5 s
(C) a lorry, when its speed changes from rest to 20 m/s in 15 s
(D) a motorbike, when its speed changes from rest to 50 m/s in 10 s

36. **In projectile motion the acceleration in the vertical direction is:**
(A) Remains constant (C) zero
(B) Varies with time (D) Is taken as positive

37. **The velocity component with which a projectile covers certain horizontal distance, is maximum at the moment of :**
(A) Hitting the ground (C) Projection
(B) Highest point (D) remain constant

38. **The velocity component with which a projectile covers certain vertical distance is minimum at the moment of:**
(A) Hitting the ground (C) Projection
(B) Highest point (D) None of these

39. **If a projectile is projected at an angle of 35°, It hits certain target. It will have the same range if it is projected at an angle of:**
(A) 45° (C) 65°
(B) 55° (D) 70°

40. **A ball is allowed to fall freely from certain height. It covers a distance in first second equal to:**
(A) 2g (C) g
(B) g/2 (D) 3g

41. **The height of projectile is maximum at an angle of:**
(A) 45° (C) 60°
(B) 30° (D) 90°

42. **How large a force is required to accelerate a body of weight 5 N with 4 ms^{-2} (g = 10 ms^{-2}):**
(A) 10 N (B) 5 N
(B) 2 N (D) 1 N

43. **Acceleration of bodies of different masses allowed to fall freely is (air friction is negligible):**
(A) same in magnitude and direction
(B) same in direction only
(C) Same in magnitude only
(D) Different for both bodies

44. **A body having uniform acceleration of 10 ms^{-2} has a velocity of 100 ms^{-1}. In what time its velocity will be doubled:**
(A) 8 s (C) 10 s
(B) 12 s (D) 14 s

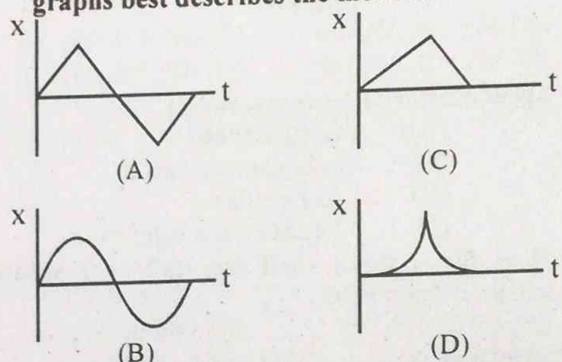
45. **For a rocket, the change in momentum per second of the ejecting gases is equal:**
(A) Acceleration of the rocket
(B) Velocity of the rocket
(C) Momentum of the rocket
(D) Thrust acting on rocket

46. **The velocity of projectile is maximum:**
(A) At the highest point
(B) At a point of launching and just before striking the ground
(C) At the half of the height
(D) After striking the ground

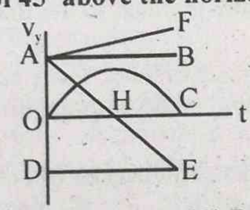
47. **Velocity of an object dropped from a building at any instant "t" is given by:**
(A) $\frac{1}{2}gt^2$ (C) $v_i t + \frac{1}{2}gt^2$
(B) at (D) gt

48. **A ball is thrown up with 20 ms^{-1} at an angle of 60° with x-axis. The horizontal velocity of the ball at the top position is:**
(A) 0 ms^{-1} (C) 10 ms^{-1}
(B) 20 ms^{-1} (D) 16 ms^{-1}

49. **A car accelerates from rest on a straight road. A short time later, the car decelerates to a stop and then returns to its original position in a similar manner, by speeding up and then slowing to a stop. Which of the following distance versus time graphs best describes the motion?**



50. **Which of the curves on the graph below best represents the vertical component "v_y" of the velocity versus the time t for a projectile fired at an angle of 45° above the horizontal?**



(A) OC (C) DE
(B) AB (D) AE

51. **A projectile is fired from ground with an initial velocity that has a vertical component of 20m/s and a horizontal component of 30m/s. Using g = 10m/s^2, the distance from launching to landing points is:**
(A) 40m (C) 60m
(B) 80m (D) 120m

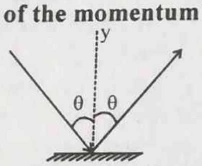
52. **The mass of a body:**
(A) is slightly different at different places on Earth
(B) is a vector
(C) is independent of the free-fall acceleration
(D) is the same for all bodies of the same volume

53. **Feather and a lead ball are dropped from rest in vacuum on the Moon. The acceleration of the feather is:**
(A) more than that of the lead ball

(B) less than that of the lead ball
(C) the same as that of the lead ball
(D) $9.8 m/s^2$

54. A student's life was saved in an automobile accident because an airbag expanded in front of his head. If the car had not been equipped with an airbag, the windshield would have stopped the motion of his head in a much shorter time. Compared to the windshield, the airbag:
(A) causes a much smaller change in momentum
(B) exerts a much smaller impulse
(C) causes a much smaller change in kinetic energy
(D) exerts a much smaller force

55. A ball hits a wall and rebounds with the same speed, as diagramed below. The changes in the components of the momentum of the ball are:



(A) $\Delta P_x > 0, \Delta P_y > 0$ (C) $\Delta P_x < 0, \Delta P_y > 0$
(B) $\Delta P_x = 0, \Delta P_y > 0$ (D) $\Delta P_x = 0, \Delta P_y < 0$

56. Speedometer of a car measures:
(A) average speed
(C) instantaneous speed
(B) acceleration
(D) instantaneous velocity

57. How far a stone shall free fall in 1 second if released from rest?
(A) 4.9 m (C) 19.6 m
(B) 9.8 m (D) 3 × 9.8 m

58. Which of the following velocity-time graph represents infinite acceleration?
(A) Straight line normal to the time–axis
(B) Straight line inclined to the time axis at an angle of 45°
(C) Straight line parallel to the time axis
(D) Straight line inclined to the time axis at an angle of 135°

59. The numerical ratio displacement to distance
(A) always = 1 (C) always > 1
(B) always < 1 (D) always ≤ 1

60. The correct statement from the following is:
(A) a body have zero velocity will not necessary will have zero acceleration
(B) a body have zero velocity will necessary have zero acceleration
(C) a body have uniform speed can have only uniform acceleration
(D) a body can have non–uniform velocity will have zero acceleration

61. A ball thrown vertically up with a speed "v" come back to the starting point with speed "v" the ratio of the distance covered and displacement is
(A) 0 (C) –1
(B) 1 (D) infinite

62. Area under the velocity-time graph shows the:
(A) acceleration of a body (C) Work done
(B) distance covered (D) Force of the body

63. A freely falling body has a constant acceleration of $9.8 m/s^2$. This means that:
(A) the body falls 9.8 m during each second
(B) the body falls 9.8 m during the first second only
(C) the speed of the body increases by 9.8 m/s during each second
(D) the acceleration of the body increases by 9.8 m/s^2 during each second

64. A train of length 150 m is going to north with a speed of $10 ms^{-1}$. A parrot flies $5 ms^{-1}$ toward south parallel to the railway line. The time taken by parrot to cross the train is
(A) 8 s (C) 12 s
(B) 10 s (D) 15 s

65. A body covers one half of its journey at $40 ms^{-1}$ and the next half at $50 ms^{-1}$. Its average velocity is:
(A) 44.4 ms^{-1} (C) 50 ms^{-1}
(B) 45 ms^{-1} (D) 40 ms^{-1}

66. At one instant of time a rocket is traveling in outer space at 2500 m/s and is exhausting fuel at a rate of 100 kg/s. If the speed of the fuel as it leaves the rocket is 1500 m/s, relative to the rocket, the thrust is:
(A) 0 (C) 1.0×10^5 N
(B) 1.5×10^5 N (D) 2.9×10^5 N

67. Force bear by wall on which water strike normally at speed of 10 m sec^{-1} and at a discharge 0.0001 m^3/sec is:
(A) 1 N (C) 100 N
(B) 10 N (D) 1000 N

68. The acceleration produced in a body can have an angle with the force:
(A) 90° (C) 0°
(B) 180° (D) All of these

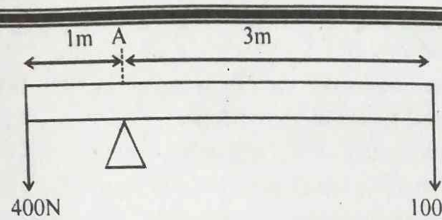
69. Two forces are said to be equal if:
(A) Have same magnitude only
(B) Have same direction only
(C) Have same magnitude and direction
(D) Can't be sure

70. The rate of change of momentum for a freely falling object is always:
(A) = mg (C) < mg
(B) > mg (D) zero

71. Which pairs of the following forces can give a resultant force 2N?
(A) 1 N and 1 N (C) 1 N and 3 N
(B) 4 N and 2 N (D) all of these

72. When a constant force acts on a body of mass "m" initially at rest, then the velocity acquired is proportional to:
(A) $\sqrt{m}$ (C) m
(B) $\frac{1}{\sqrt{m}}$ (D) $\frac{1}{m}$

73. A uniform rod loaded as shown in the fig. below is pivoted at the point "A" so that it is in equilibrium. The weight of the rod will be:



(A) 700N (C) 500N
(B) 300N (D) 100N

74. **Laws of motions are valid in a system is:**
(A) Non inertial frame (C) at rest
(B) inertial frame (D) in the space

75. **When a climber reaches the top of mountain:**
(A) his mass is now greater
(B) his mass is now slightly smaller
(C) his weight is now greater
(D) his weight is now slightly smaller

76. **The slope of the displacement–time graph gives:**
(A) distance (C) work
(B) average velocity (D) average acceleration

77. **Pull of earth on a mass of 20kg on the surface of Earth is:**
(A) 20 N (C) 196 N
(C) 19.6 N (D) 1960 N

78. **A body is falling freely under gravity. How much distance it falls during an interval of time between 1st and 2nd seconds of its motion? (taking g = $10ms^{-2}$)**
(A) 15 m (C) 20 m
(B) 5 m (D) 25 m

79. **The acceleration in the rocket at any instant is proportional to the nth power of the velocity of the expelled gases. Where the value of n must be?**
(A) -1 (C) 1
(B) -2 (D) 2

80. **If the speed of a particle at the end of four successive hours is 20, 25, 30, 35 km/hr, then the acceleration of the particle is:**
(A) 5 m/sec^2 (C) 5 km/hr^2
(B) 5 m/hr^2 (D) 5 km/sec^2

81. **A bomb is dropped from an aeroplane moving horizontally with a speed of 200 mph (miles per hour). If the air resistance is negligible, the bomb will reach the ground in 5 sec when the altitude is ($g = 10ms^{-2}$):**
(A) 4 miles (C) 125 m
(B) 40 m (D) 10 m

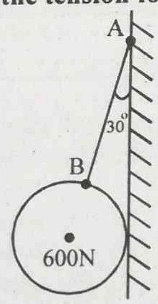
82. **A particle accelerates uniformly from 10 km/hr to 20 km/hr with acceleration of 2 km/hr^2. The total time it takes is:**
(A) 20 hr (C) 10 hr
(B) 10 min (D) 5 hr

83. **Two bodies of unequal mass, placed at rest on a frictionless surface, are acted on by equal horizontal forces for equal times. Just after these forces are removed, the body of greater mass will have:**
(A) the smaller acceleration
(B) the greater acceleration
(C) the smaller momentum
(D) the greater momentum

84. **A 0.2 kg rubber ball is dropped from the window of a building. It strikes the sidewalk below at 30m/s and rebounds up at 20m/s. The impulse on the ball during the collision is:**
(A) 10 Ns upward (C) 10 Ns downward
(B) 2.0 Ns upward (D) 2.0 Ns downward

85. **A 10 kg block of ice is at rest on a frictionless horizontal surface. A 1.0 N force is applied in East direction for 1.0 s. During this time interval, the block:**
(A) acquires a speed of 1m/s
(B) acquires a momentum of 1.0 kg m/s
(C) moves 10 cm
(D) acquires a kinetic energy of 0.1J

86. **The 600 N ball shown is suspended on a string AB and rests against a frictionless vertical wall. The string makes an angle of 30° with the wall. The magnitude of the tension force of the string is:**



(A) $400\sqrt{3}$ N (C) 1200N
(B) $400\sqrt{2}$N (D) 2400N

87. **In rotational motion, the counterpart of force is:**
(A) torque (C) momentum
(B) angular acceleration (D) angular inertia

88. **A door has height and width of 1.5m and 0.5m respectively. Choose a force that will produce highest value of torque:**
(A) 25 N force, at 0.5m from axis of rotation
(B) 50 N force, at 1m from axis of rotation
(C) 100 N force, at 2m from axis of rotation
(D) 12.5 N force, at 0.25m from axis of rotation

89. **A force of 5N is acting along Y-axis. Its component along X-axis is:**
(A) 5N (C) zero
(B) 10N (D) 2.5N

90. **Two stones are projected from the same point with same speed making angles $45^\circ + \theta$ and $45^\circ - \theta$ with the horizontal respectively. If $\theta \le 45^0$, then the horizontal ranges of the two stones are in the ratio of:**
(A) 1 : 1 (C) 1 : 2
(B) 1 : 3 (D) 1 : 4

91. **Two projectiles "P" and "Q" are thrown with the same speed up at angles of 40^0 and $50^0$with the horizontal. Range of "P" will be:**
(A) Equal to that of Q (C) Greater than that of Q
(B) Less than that of Q (D) 3/7 times that of Q

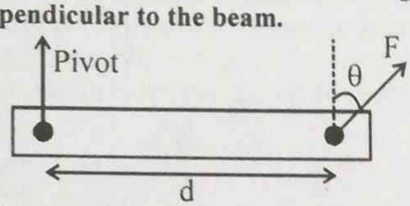
92. **Ballistic missiles are of:**
(A) short range (C) long range

(B) no range (D) fixed range

93. **The range of projectile is directly proportional to:**
(A) $\sin\theta$ (C) $\sin 2\theta$
(B) $\sin 3\theta$ (D) $\sin\theta$ and $\sin 2\theta$

94. **Horizontal range of a projectile is related with maximum range according to relation:**
(A) $R = R_{max}\sin 2\theta$
(B) $R_{max} = \frac{R}{\sin 2\theta}$
(C) $R_{max} = R\sin\theta$
(D) $R = R_{max}\sin 2\theta$ and $R_{max} = \frac{R}{\sin 2\theta}$

95. **A force F is applied to a beam at a distance d from a pivot. The force acts at an angle θ to a line perpendicular to the beam.**



Which combination will cause the largest turning effect about the pivot?

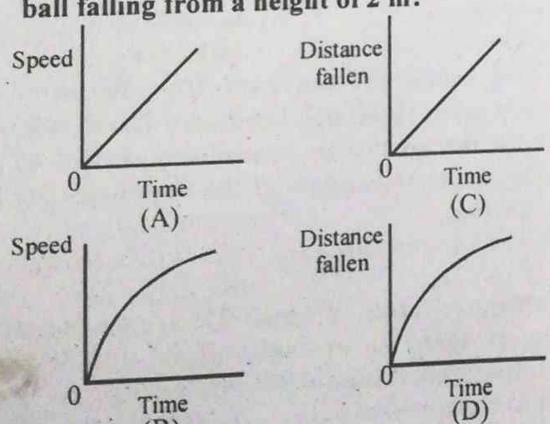
	F	d	θ
(A)	large	large	large
(B)	large	large	small
(C)	small	small	large
(D)	small	large	small

96. **Newton's 2nd gives the measurement of:**
(A) acceleration (C) force
(B) momentum (D) inertia

97. **Two forces each of magnitude 10N acting on a string in opposite direction, the tension in the string is:**
(A) 10N (C) 20 N
(B) 40 N (D) 0 N

98. **Distance covered by a freely falling body in 2 sec will be:**
(A) 4:9 m (C) 3.92m
(B) 19.6m (D) 44.1m

99. **Which graph shows the motion of a heavy, steel ball falling from a height of 2 m?**



100. **A man is in a car is moving with velocity of 36 km/hr. His speed with respect to the car is:**
(A) 10m/s (C) 36m/s
(B) zero (D) infinite

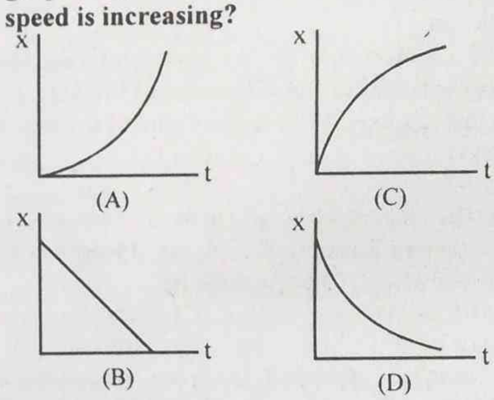
101. **When velocity time graph is a straight line parallel to time axis then:**
(A) acceleration is constant
(B) acceleration is zero
(C) acceleration is variable
(D) velocity is zero

102. **Newton's laws do not hold good for particles:**
(A) at rest
(B) move with velocity comparable to velocity of light
(C) moving slowly
(D) high velocity

103. **Motorcycle safety helmet extend the time of collision hence decreasing the:**
(A) chance of collision (C) force acting
(B) velocity (D) impulse

104. **An object is thrown vertically upward with a certain initial velocity in a planet where the acceleration due to gravity is 19.6 m/s^2. The height to which it raises is_____ that to which the object would rise if thrown upward with the same initial velocity on the Earth. Neglect friction.**
(A) half (C) $\sqrt{2}$ times
(B) twice (D) four times

105. **Which of the following distance versus time graphs represents the motion of an object whose speed is increasing?**

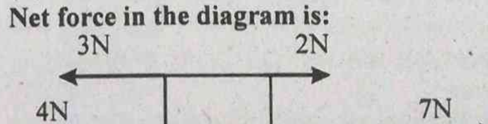


106. **The angular momentum of a body changes from 30 Js to 50 Js in 0.5 sec. The torque acting on it is:**
(A) 40 N m (C) 50 N m
(B) 100 N m (D) 150 N m

107. **The direction of torque is perpendicular to:**
(A) $\vec{r}$ (C) both $\vec{r}$ and $\vec{F}$
(B) $\vec{F}$ (D) No direction

108. **A fan rotates at 10 rad/sec. The torque acting on it is:**
(A) maximum (C) zero
(B) minimum (D) negative

109. **Net force in the diagram is:**



(A) Zero (C) 2 N to right
(B) 6 N to left (D) 11 N to right

110. **The minimum number of forces that keeps the body in equilibrium are:**
(A) Two (C) Three
(B) Four (D) Five

111. **When two or more than two forces acting on a common point, the forces are called:**
(A) Collinear forces (C) Concurrent forces
(B) Couple (D) Antiparallel forces

112. **Torque acting on a body determines its:**
(A) acceleration
(B) Uniform angular velocity
(C) angular acceleration
(D) Force

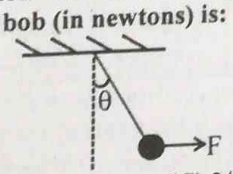
113. **A net torque applied to a rigid object always tends to produce:**
(A) linear acceleration (C) rotational equilibrium
(B) angular acceleration (D) rotational inertia

114. **For a body to be in equilibrium under the combined action of several forces:**
(A) all the forces must be applied at the same point
(B) all of the forces form pairs of equal and opposite forces
(C) the sum of the components of all the forces in any direction must equal zero
(D) any two of these forces must be balanced by a third force

115. **A constant force of 8.0 N is exerted for 4.0 s on a 16 kg object initially at rest. The change in speed of this object will be:**
(A) 0.5m/s (C) 2m/s
(B) 4m/s (D) 8m/s

116. **Two forces are applied to a 5.0 kg crate; one is 6.0N to the north and the other is 8.0N to the west. The magnitude of the acceleration of the crate is:**
(A) $0.50 m/s^2$ (C) $2.0 m/s^2$
(B) $2.8 m/s^2$ (D) $10 m/s^2$

117. **A 1N pendulum bob is held at an angle θ from the vertical by a 2N horizontal force "F" as shown. The tension in the string supporting the pendulum bob (in newtons) is:**

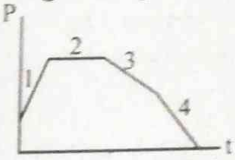


(A) cos θ (C) 2/cos θ
(B) $\sqrt{5}$ (D) 1

118. **The "reaction" force does not cancel the "action" force because:**
(A) the action force is greater than the reaction force
(B) they are on different bodies
(C) they are in the same direction
(D) the reaction force exists only after the action force is removed

119. **Two objects, "P" and "Q", have the same momentum. "Q" has more kinetic energy than P if it:**
(A) weight more than P
(B) weight the same as P
(C) is moving faster than P
(D) is moving slower than P

120. **A particle moves along the x axis. Its momentum is graphed below as a function of time. Rank the numbered regions according to the magnitude of the force acting on the particle, least to greatest.**



(A) 1, 2, 3, 4 (C) 2, 3, 4, 1
(B) 1, 4, 3, 2 (D) 1, 3, 4, 2

121. **If a body is moving with uniform velocity then its average velocity is equal to:**
(A) its acceleration (C) variable velocity
(B) Instantaneous velocity (D) zero velocity

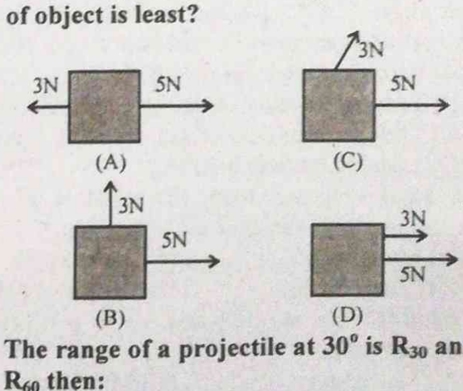
122. **Two objects moving along the same direction with different masses but same velocity. There relative velocity becomes:**
(A) 2 time (C) 0
(B) 4 time (D) variable

123. **If the acceleration of a body is zero then the slope of its v–t graph:**
(A) parallel to time axis
(B) perpendicular to time axis
(C) Straight line for the origin
(D) Straight line inclined to the time axis at an angle of 45°

124. **Two bodies are projected at angles θ and $(90^\circ - \theta)$ to the horizontal with the same speed. The ratio of their times of flight is:**
(A) sin θ :1 (C) cos θ: 1
(B) Sin θ : Cos θ (D) cos θ : sin θ

125. **In the case of a projectile fired at an angle equally inclined to the horizontal and vertical with velocity "u", the horizontal range is:**
(A) $\frac{u^2}{g}$ (C) $\frac{u^2}{2g}$
(B) $\frac{u^2}{3g}$ (D) $\frac{u^2}{4g}$

126. **Two forces, one with a magnitude of 3N and the other with a magnitude of 5N, are applied to an object. For which orientations of the forces shown in the diagrams is the magnitude of acceleration of object is least?**



127. **The range of a projectile at 30° is R_{30} and at 60° is R_{60} then:**

(A) $R_{30} = R_{60}$
(B) $2R_{30} = R_{60}$
(C) $R_{30} = 2R_{60}$
(D) $R_{30} = R_{60}$ if initial velocity are same

128. The unit of couple is:
(A) $J\ m^{-1}$ (C) J m
(B) $N\ m^{-1}$ (D) N m

129. If the body of mass 2 kg dropped from the height of 5 m find its momentum ($g = 10ms^{-2}$):
(A) 15 N s (C) 30 N s
(B) 20 N s (D) 40 N s

130. A 2.5 kg stone is released from rest and falls toward Earth. After 4.0 s, the magnitude of its momentum is ($g = 10ms^{-2}$):
(A) 100 kgm/s (C) 98 kgm/s
(B) 50 kgm/s (D) 49 kgm/s

131. Two objects moving along the opposite direction with different mass but same velocity. there relative velocity becomes:
(A) 2 times (C) 0
(B) 4 times (D) Both (A) and (B)

132. If instantaneous acceleration equal to average acceleration then body is moving with:
(A) variable acceleration (C) uniform velocity
(B) uniform acceleration (D)increasing acceleration

133. The momentum of an object is increased from 10 N s to 20 N s by the application of the force in 1s. What is the magnitude of applied force?
(A) 10N (C) 30N
(B) 20N (D) 40N

134. A bear can be knocked down by hitting one of the following bullets of same momentum:
(A) lead (C) gold
(B) steel (D) rubber

135. One object is thrown vertically upward with an initial velocity of 100 m/s and another object with an initial velocity of 10 m/s. The maximum height reached by the first object will be that of the other:
(A) 10 times (C) 100 times
(B) 1000 times (D) 10000 times

136. In the projectile motion the vertical component of velocity:
(A) Remains constant (C) Varies point to point
(B) Become zero (D) Increases with time

137. An object is thrown along a direction inclined at an angle of 45° with the horizontal direction. The horizontal range of the particle is:
(A) Four times the vertical height
(B) Twice the vertical height
(C) Thrice the vertical height
(D) Equal to vertical height

138. A stone released from the window of a moving train shall hit the ground following:
(A) Straight path (C) curved path
(B) Circular path (D) Elliptical path

139. What is the acceleration of a projectile at its highest point:
(A) Maximum (C) Minimum
(B) Zero (D) g

140. What is the angle of projection of a projectile for which its height and horizontal range are equal:
(A) 46° (C) 56°
(B) 66° (D) 76°

141. For flat earth approximation the trajectory of the projectile is:
(A) Straight line (C) Parabolic
(B) Elliptic (D) Hyperbolic

142. The time taken by the projectile to reach its maximum height is:
(A) $\frac{2v_i\sin\theta}{g}$ (C) $\frac{v_i\cos\theta}{g}$
(B) $\frac{v_i\sin\theta}{g}$ (D) $\frac{2v_i\cos\theta}{g}$

143. To throw a stone horizontally from the vertical height of 10m as it covers the horizontal distance of 10m find the x–component of velocity ($g = 10\ ms^{-2}$):
(A) $2.5\ ms^{-1}$ (C) $7.1\ ms^{-1}$
(B) $5\ ms^{-1}$ (D) $10\ ms^{-1}$

144. Identical guns fire identical bullets horizontally at the same speed from the same height above level planes, one on the Earth and one on the Moon. Which of the following three statements is/are true?
I. The horizontal distance traveled by the bullet is greater for the Moon.
II. The flight time is less for the bullet on the Earth.
III. The velocity of the bullets at impact are the same.
(A) III only (C) I and II only
(B) I and III only (D) II and III only

145. A student drops a table–tennis ball in air. What happens to the velocity and to the acceleration of the ball during the first few seconds after release?

	Velocity	Acceleration
(A)	decreases	decreases
(B)	decreases	increases
(C)	increases	constant
(D)	increases	increases

146. A car is brought to rest in 5 s from a speed of 10 m / s. What is the average deceleration of the car?
(A) $0.5\ m/s^2$ (C) $2\ m/s^2$
(B) $15\ m/s^2$ (D) $50\ m/s^2$

147. A car travels east at constant velocity. The net force on the car is:
(A) east (C) west
(B) up (D) zero

148. The area between the velocity-time graph and the time axis is numerically equal to:
(A) velocity (C) distance
(B) time (D) acceleration

149. Water flows out from a pipe at $3kg\ s^{-1}$ and its velocity changes from $5ms^{-1}$ to zero on striking the wall. The force due to the water flow is:
(A) 3 N (C) 5 N

(B) 10 N (D) 15 N

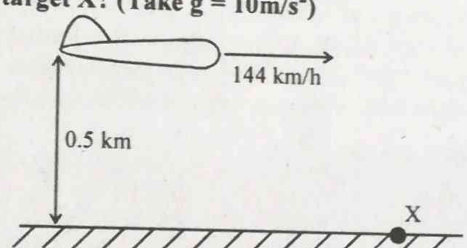
150. **Which of the following is NOT an example of accelerated motion?**

(A) Vertical component of projectile motion
(B) A swinging pendulum
(C) Circular motion at constant speed
(D) Horizontal component of projectile motion

151. **Two bodies are falling with negligible air resistance, side by side, above a horizontal plane. If one of the bodies is given an additional horizontal acceleration during its descent, it:**

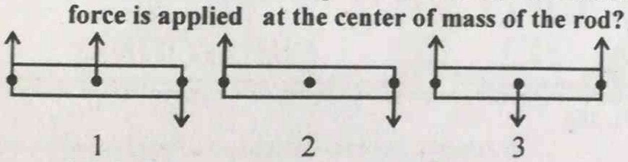
(A) strikes the plane at the same time as the other body
(B) strikes the plane earlier than the other body
(C) has the vertical component of its velocity altered
(D) has the vertical component of its acceleration altered

152. **The airplane shown is in level flight at an altitude of 0.50 km and a speed of 144 km/h. At what distance should it release a heavy bomb to hit the target X? (Take $g = 10 m/s^2$)**



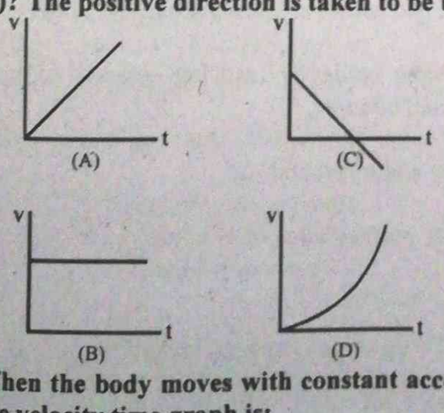
(A) 150m (C) 305m
(B) 400m (D) 2550m

153. **Three identical uniform rods are each acted on by two or more forces, all perpendicular to the rods and all equal in magnitude. Which of the rods could be in static equilibrium if an additional force is applied at the center of mass of the rod?**



(A) Only 1 (C) Only 2
(B) Only 3 (D) Only 1 and 2

154. **An object is thrown vertically into the air. Which of the following four graphs represents the velocity (v) of the object as a function of the time (t)? The positive direction is taken to be upward.**



155. **When the body moves with constant acceleration, the velocity time graph is:**

(A) parabola (C) ellipse
(B) straight line (D) curve

156. **Rocket equation is given as:**

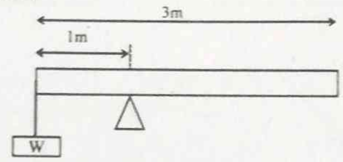
(A) $\vec{a} = \frac{M\vec{v}}{m}$ (C) $\vec{a} = \frac{m\vec{v}}{M}$

(B) $\vec{a} = \frac{M}{m\vec{v}}$ (D) $\vec{a} = \frac{m}{M\vec{v}}$

157. **If a shell explodes in mid air, its fragments fly off in different directions. Total momentum of the fragments:**

(A) decreases (C) increases
(B) remains constant (D) becomes zero

158. **A uniform beam of weight 50 N is 3.0 m long and is supported on a pivot situated 1.0 m from one end. When a load of weight W is hung from that end, the beam is in equilibrium as shown in the diagram.**



What is the value of W?

(A) 25 N (C) 50 N
(B) 75 N (D) 100 N

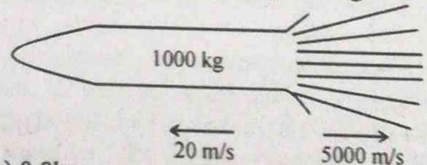
159. **A bullet shot straight up returns to its starting point in 10 s. Its initial speed was:**

(A) $9.8\ ms^{-1}$ (C) $24.5\ ms^{-1}$
(B) $49\ ms^{-1}$ (D) $98\ ms^{-1}$

160. **A force of 10 N acts on a body of mass 5 kg for one second, then its time rate of change of momentum will be:**

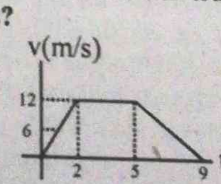
(A) $10\ kgms^{-2}$ (C) $50\ kgms^{-2}$
(B) $5\ kgms^{-2}$ (D) $2\ kgms^{-2}$

161. **A 1000 kg space probe is motionless in space. To start moving, its main engine is fired for 5s during which time it ejects exhaust gases at 5000m/s. At the end of this process it is moving at 20m/s. The approximate mass of the ejected gas is:**



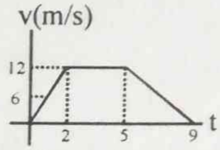
(A) 0.8kg (C) 4 kg
(B) 5 kg (D) 20 kg

162. **The graph represents the straight line motion of a car. How far does the car travel between t = 2 s and t = 5 s?**



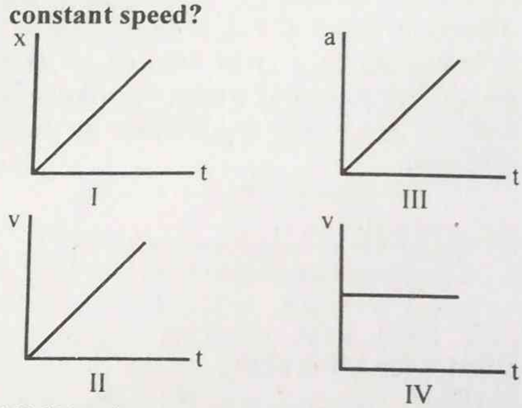
(A) 4 m (C) 12 m
(B) 24 m (D) 36 m

163. **The diagram represents the straight line motion of a car. Which of the following statements is true?**



(A) The car accelerates, stops, and reverses
(B) The car is moving for a total time of 12 s
(C) The car accelerates at 6 m/s^2 for the first 2 s
(D) The car decelerates at 12 m/s^2 for the last 4s

164. **Consider the following graphs (note the axes carefully). Which of these represents motion at constant speed?**



(A) IV only (C) III only
(B) I, II, and III only (D) I and IV only

165. **If a body of mass 2 kg moves with 15 m/s collides with stationary body of same mass, then after elastic collision second body will move with velocity of:**
(A) 15 m/s (C) 30 m/s
(B) 2 m/s (D) 0 m/s

166. **K.E is conserved in:**
(A) inelastic collision (C) elastic collision
(B) all collisions (D) none of these

167. **When a heavy particle collides with a light particle at rest, then after collision the target particle moves with:**
(A) the same speed
(B) double the velocity of incident particle
(C) zero velocity
(D) Bounce back with same velocity

168. **Sphere "A" has mass m and is moving with velocity "v". It makes a head-on elastic collision with a stationary sphere "B" of mass 2m. After the collision their speeds (v_A and v_B) are:**
(A) 0, v/2 (C) – v/3, 2v/3
(B) – v, v (D) –2v/3, v/3

169. **A body of mass "m" having an initial velocity "v" makes head on elastic collision with a stationary body of mass "M". After the collision, the body of mass "m" comes to rest and only the body having mass "M" moves. This will happen only when:**
(A) m >> M (C) m << M
(B) m = M (D) m = M/2

170. **A body of mass "m" moving with velocity "v" makes a head on elastic collision with another body of mass "2m" which is initially at rest. The loss of kinetic energy of the colliding body (mass "m") is:**
(A) 1/2 of its initial kinetic energy
(B) 8/9 of its initial kinetic energy
(C) 1/9 of its initial kinetic energy
(D) 1/4 of its initial kinetic energy

171. **A mass of 20 kg moving with a speed of 10 m/s collides with another stationary mass of 5 kg. As a result of the collision, the two masses stick together. The kinetic energy of the composite mass will be:**
(A) 600 J (C) 1000 J
(B) 800 J (D) 1200 J

172. **The velocities of two equal masses "A" and "B" are 13 m/s and – 14 m/s respectively. What will be their respective velocities after they suffer one dimensional elastic collision?**
(A) – 14 m/s and 13 m/s (C) 0 and 13 m/s
(B) – 13 m/s and 14 m/s (D) 0 and 14 m/s

173. **A body of mass "m_1" moving with uniform velocity of 40 m/s collides with another body of mass "m_2" at rest and then two together begin to move with uniform velocity of 30 m/s. the ratio of their masses $\frac{m_1}{m_2}$ is:**
(A) 0.75 (C) 3.0
(B) 1.33 (D) 4.0

174. **If distance of a point from pivot is "L" and a force "F" is applied such that it passes from the pivot then the torque produced in the body will be:**
(A) Zero (C) LF sin θ $\hat{n}$
(B) L F cos θ (D) LF

UNIT 02 MOTION AND FORCE (SOLUTIONS)

01. (B)

The relation between height and range of a projectile projected at any angle "θ" is

$$4H = R\tan\theta$$

If R= H

$$4H = H\tan\theta \Rightarrow \tan\theta = 4 \Rightarrow \theta = \tan^{-1}(4) = 76^\circ$$

02. (A)

When bodies are moving parallel to each other

$$v_r = v_1 - v_2 \Rightarrow 4 = v_1 - v_2 \text{ ......(i)}$$

When bodies are moving opposite to each other to each other

$$v_r = v_1 + v_2 \Rightarrow 6 = v_1 + v_2 \text{ ......(ii)}$$

by adding (i) and (ii)

$$10 = 2v_1 \Rightarrow v_1 = 5\ ms^{-1}$$

By putting value of v_1 in eq.(i)

$$v_2 = 1\ ms^{-1}$$

03. (A)

$$S = vit + \frac{1}{2}at^2 = 0 + \frac{1}{2}at^2 = \frac{1}{2}at^2$$

04. (D)

The motion of rocket is an application of law of conservation of momentum. Rocket moves upward by ejecting hot gases at the tail of the rocket with very high velocity in downward direction. The rocket gain momentum equal to the momentum of gas ejected from the tail of the rocket, but in opposite direction.

05. (A)

$$\vec{F} = \frac{\vec{P_f} - \vec{P_i}}{t} = \frac{\Delta \vec{P}}{t}$$

$\vec{F}$ = Time rate of change of momentum
Time rate of change of momentum of a body is equal to the applied force.

06. (B)

$v_f = v_i + at \Rightarrow 0 = v_i - gt$
$v_i = gt = (9.8)(3) = 29.4\ ms^{-1}$

07. (D)

$P = mv = kgms^{-1} = N\ s$

08. (B)

A rocket carries its own fuel in the form of solid or liquid hydrogen and oxygen. A typical rocket consumes about 10000 kgs^{-1} of fuel and ejects gases at speed more than 4000 ms^{-1}.

09. (D)

$-2gh = v_f^2 - v_i^2 \Rightarrow -2gh = 0 - v_i^2 = -v_i^2$
$2(9.8)h = (9.8)^2 \Rightarrow h = \frac{9.8}{2} = 4.9\ m$

10. (C)

The horizontal distance (range) of projectile is given by:

$$R = \frac{v_i^2 \sin 2\theta}{g}$$

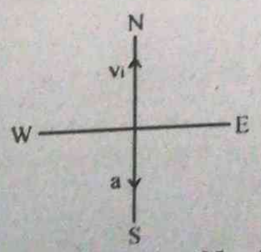
The range is maximum when sin2θ has maximum value that is

$$\sin 2\theta = 1$$
$$2\theta = \sin^{-1}(1)$$
$$2\theta = 90^o$$
$$\theta = 45^o$$
$$R_{max} = \frac{v_i^2 \sin 90^o}{g} = \frac{v_i^2}{g}$$

11. (A)

$2aS = v_f^2 - v_i^2$
$2(a)60 = 50^2 - 10^2 \Rightarrow 120a = 2500 - 100 = 2400$
$a = \frac{2400}{120} = 20\ ms^{-2}$
$a = \frac{v_f - v_i}{\Delta t} \Rightarrow \Delta t = \frac{v_f - v_i}{a} = \frac{50 - 10}{20} = \frac{40}{20} = 2\ s$

12. (A)



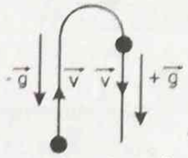
$v_f = v_i + at = 25 + (-3)(6) = 25 - 18 = 7$ m/s north

13. (C)

When the car catch up the truck, both cover the same distances. So,

$S_{truck} = S_{car}$
$vt = v_i t + \frac{1}{2}at^2 = 0 + \frac{1}{2}at^2 = \frac{1}{2}at^2$
$v = \frac{1}{2}at \Rightarrow t = \frac{2v}{a} = \frac{2(15)}{3} = \frac{30}{3} = 10\ s$

14. (A)



Gravitational acceleration is always towards the center of Earth (downward).

15. (A)

$v_f = v_i + gt = 0 + (9.8)(1) = 9.8$ m/s
$v_{av} = \frac{v_i + v_f}{2} = \frac{0 + 9.8}{2} = 4.9$ m/s

16. (C)

As stone is moving with constant acceleration (gravitational acceleration).
As the slope of graph (C) is constant. So, stone moves with constant acceleration.

17. (D)

$P_i = mv_i = (1)(2) = 2\ N\ s$
$P_f = mv_f = (1)(-1.5) = -1.5\ N\ s$
$\Delta P = mv_f - mv_i = -1.5 - 2 = -3.5\ N\ s$

18. (D)

In an isolated system (no external force) the total linear momentum of system remains constant.

19. (C)

When step on the accelerator then we send a feedback to the engine that we required more power. Then the engine supplies more power and then the force by the engine help us to accelerate.

20. (A)

When a projectile explodes in mid air. Its parts fly off in different directions. The total momentum of all of its parts is equal to the initial momentum of the projectile.

21. (B)

For Gun#1
By law of conservation of momentum
Momentum of Gun = Momentum of bullet
$P_1 = m_1 v$

For Gun#2
By law of conservation of momentum
Momentum of Gun = Momentum of bullet
$P_2 = m_2 v$
$\frac{P_1}{P_2} = \frac{m_1 v}{m_2 v} = \frac{m_1}{m_2} = \frac{2m_2}{m_2} = 2$
$P_1 : P_2 = 2:1$

22. (A)

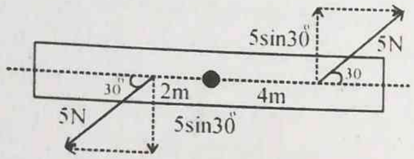
Torque, $\tau = rF\sin\theta$
Torque due to "F_2" and "F_5" = 0 (line of action of force is passing through pivot)
Torque due to "F_1" and "F_3" = $rF \sin 90^o = rF$

(Greatest)

Line of action of force is perpendicular and at equi-distance from pivot.

Torque due to "F_4" = rF sinθ (in between zero (0) and maximum)

23. (D)



Torque due to couple, τ = (magnitude perpendicular component of Force)(couple arm)

Torque due to couple, $\tau = (5\sin30^\circ)(2+4)$

$= (5)(6)\sin30^\circ = 15$ Nm

24. (D)

$$v_r = \sqrt{v_1^2 + v_2^2 - 2v_1v_2\cos\theta} = \sqrt{v^2 + v^2 - 2vv\cos180^\circ}$$
$$= \sqrt{v^2 + v^2 + 2v^2} = \sqrt{4v^2} = 2v$$

25. (A)

$S = v_r t = (10+5)(8) = (15)(8) = 120$m

26. (C)

Basic concept of gravitational acceleration.

27. (A)

As

Displacement ≤ Distance

So, velocity ≤ speed $\Rightarrow \frac{\text{velocity}}{\text{speed}} \le 1$

28. (B)

$v_f = v_i + gt = 0 + (9.8)(5) = 49\ ms^{-1}$

29. (D)

$$a = \frac{F}{m} \Rightarrow a \propto \frac{1}{m}$$

30. (A)

$$H = \frac{v_i^2\sin^2\theta}{2g} = H_{max}\sin^2\theta = H_{max}(\sin30^\circ)^2 = H_{max}(1/2)^2$$
$$= \frac{H_{max}}{4} \qquad \left(H_{max} = \frac{v_i^2}{2g}\right)$$

31. (A)

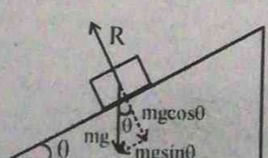
$$H = \frac{v_i^2\sin^2\theta}{2g}$$
$$T = \frac{2v_i\sin\theta}{g} \Rightarrow \quad T^2 = \frac{4v_i^2\sin^2\theta}{g^2}$$
$$\frac{H}{T^2} = \frac{\frac{v_i^2\sin^2\theta}{2g}}{\frac{4v_i^2\sin^2\theta}{g^2}} = \frac{g}{8} \Rightarrow H = \frac{gT^2}{8}$$

32. (D)

v = constant $\Rightarrow \Delta v = 0 \Rightarrow a = 0$

F = ma = m(0) = 0

33. (D)



$F = mg\sin\theta \Rightarrow ma = mg\sin\theta$

$$a = g\sin\theta = g\sin30^\circ = \frac{g}{2} = 4.9\ ms^{-2} = 490\ cms^{-2}$$

34. (C)

Magnitude of acceleration = slope of speed-time graph

The slope of speed-time graph at hard snow is greater than at soft snow. In graph (C) first slope increase then decrease i.e., slope = $4ms^{-2}$ to $2ms^{-2}$.

35. (D)

$$a = \frac{v_f - v_i}{\Delta t} = \frac{50-0}{10} = 5\ ms^{-2}$$

36. (A)

Projectile motion is two dimensional motion under constant acceleration due to gravity.

37. (D)

According to Newton's first law of motion, there will be no acceleration in the horizontal direction ($a_x = 0$), unless a horizontal directed force acts on the body. In the absences of air friction only force acting on the body during flight is the force of gravity. As there is no horizontal force acting on the body so its horizontal velocity remains unchanged.

38. (B)

The velocity of projectile at any instant is

$$v = \sqrt{v_{fx}^2 + v_{fy}^2}$$

at highest point of trajectory

$v_{fx} = v_i\cos\theta$ (remains same)

but $v_{fy} = 0$ (minimum)

so,

velocity of projectile = $v_i\cos\theta$ (no vertical component)

39. (B)

Ranges at angles (45° + θ) and (45° − θ) are equal.

Here θ = 10°

So,

$R_{35^\circ} = R_{55^\circ}$

40. (B)

$$h = \frac{1}{2}gt^2 = \frac{1}{2}g(1)^2 = \frac{g}{2}$$

41. (D)

The height "h" of projectile is

$$h = \frac{v_i^2\sin^2\theta}{2g}$$

for maximum height θ = 90°

$$h_{max} = \frac{v_i^2(\sin90^\circ)^2}{2g} = \frac{v_i^2}{2g}$$

42. (B)

$$W = mg \Rightarrow m = \frac{W}{g} = \frac{5}{10} = 0.5\ kg$$

F = ma = (0.5)(4) = 2N

43. (A)

$$g = \frac{GM}{(R+h)^2} \Rightarrow g \propto \frac{1}{(R+h)^2}$$

Gravitational acceleration does not depend upon the mass of object. It depends upon the altitude.

44. (C)

$$a = \frac{v_f - v_i}{\Delta t} \Rightarrow \Delta t = \frac{v_f - v_i}{a} = \frac{200-100}{10} = \frac{100}{10} = 10\ s$$

45. (C)

Rocket moves upward by ejecting hot gases at the tail of the rocket with very high velocity in downward direction. The rocket gain momentum equal to the momentum of gas ejected from the tail of the rocket, but in opposite direction.

46. (B)

The speed of projectile is maximum at the point of projection and at the point where it strikes the ground because the vertical component of velocity has maximum value at these points.

47. (D)

$v_f = v_i + at \Rightarrow v_f = 0 + gt = gt$

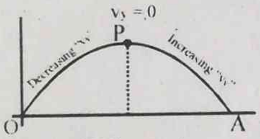
48. (C)

$v_x = v\cos\theta = (20)\cos60^\circ = (20)(0.5) = 10\ ms^{-1}$

49. (D)

Speed = slope of distance-time graph
The slope of graph (D) first increasing and finally decreasing.

50. (D)



In this figure "OP" portion represents the "AH" portion of graph and "PA" represents "HE".

51. (D)

$$R = \frac{v_i^2 \sin2\theta}{g} = \frac{v_i^2\, 2\sin\theta\cos\theta}{g} = \frac{2(v_i\sin\theta)(v_i\cos\theta)}{g}$$

$$= \frac{2(v_{ix})(v_{iy})}{g} = \frac{2(30)(20)}{10} = 120\ m$$

52. (C)

The mass of body remains same in the universe while the weight is different for different planets in the universe.

53. (C)

Gravity is the intrinsic property of the planet and it does not depend upon the any medium. All object (same or different masses) fall with same gravitational acceleration.

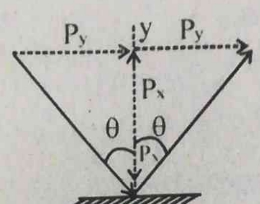
54. (D)

The average force generated in a collision is equal to the momentum change during the collision divided by the time interval in which collision is taken place.

$$\vec{F} = \frac{\Delta\vec{P}}{\Delta t}$$

The air bag extends the time interval over which the collision occurs and reduces the force experienced by the student.

55. (B)



From figure

$\Delta P_x = 0$ and $\Delta P_y > 0$

56. (C)

Speedometer measures speed of car at a given instant.

57. (A)

$$h = v_i t + \frac{1}{2}gt^2 = 0 + 4.9(1)^2 = 4.9\ m$$

58. (A)

Acceleration = slope of velocity-time graph
Slope of line parallel to velocity axis is infinite.

59. (D)

$$\text{Displacement} \le \text{Distance} \Rightarrow \frac{\text{Displacement}}{\text{Distance}} \le 1$$

60. (A)

When body is thrown vertically upward, at maximum height it has zero velocity but non-zero acceleration (gravitational acceleration).

61. (D)

Displacement depends upon the initial and final position of body while distance does not do so.
In this case displacement = 0 while distance ≠ 0

$$\frac{\text{Distance}}{\text{Displacement}} = \frac{\text{Distance}}{0} = \infty$$

62. (B)

Area of velocity-time graph = distance covered by body

63. (C)

Basic concept of acceleration.

64. (B)

$$S = v_r t \Rightarrow t = \frac{S}{v_r} = \frac{150}{10+5} = \frac{150}{15} = 10\ s$$

65. (A)

When body covers equal distance with different velocities, then the formula for the average velocity is

$$v_{av} = \frac{2v_1v_2}{v_1+v_2} = \frac{2(40)(50)}{40+50} = \frac{4000}{90} = 44.4\ ms^{-1}$$

66. (B)

$$Ma = \frac{m}{t}v \Rightarrow F = (100)(1500) = 1.5 \times 10^5\ N$$

67. (B)

From equation of continuity

$$\frac{m}{t} = \rho Av = \rho\left(\frac{V}{t}\right) = 1000(0.0001) = 0.1\ kgs^{-1}$$

$$\left(Av = \frac{V}{t}\right)$$

Force due to water flow $= \frac{m}{t}v = (0.1)(10) = 10\ N$

68. (C)

According to Newton's 2nd law of motion

$$\vec{F} = m\vec{a}$$

Acceleration always produces in the direction of force.

69. (C)

By definition of equal vectors "Vectors having the same magnitude and direction are called equal vectors regardless of the position of their initial points. This means that parallel vectors of same magnitude are equal".

70. (A)

Time rate of change of momentum = Applied force

$$\frac{\vec{P_f} - \vec{P_i}}{t} = \frac{\vec{\Delta P}}{t} = \vec{F}$$

In freely falling motion

Force = Weight ⇒ F = W = mg

$$\frac{\vec{\Delta P}}{t} = \vec{W} = m\vec{g}$$

71. (D)

Resultant force = 1N + 1N = 2 N if forces are parallel

Resultant force = 3N − 1N = 2 N if forces are anti-parallel

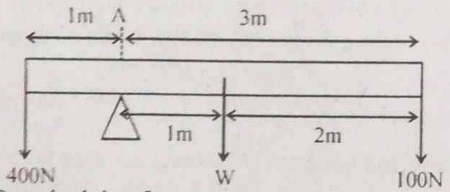
Resultant force = 4N − 2N = 2 N if forces are anti-parallel

72. (D)

By Newton's 2[nd] law of motion

$$F = ma = \frac{m\Delta v}{\Delta t} \Rightarrow \Delta v = \frac{F\Delta t}{m} \Rightarrow \Delta v \propto \frac{1}{m}$$

73. (D)



By principle of moments

Clockwise torque = Anticlockwise torque

$(100)(3) + (W)(1) = (400)(1)$

$300 + W = 400$

$W = 400 - 300 = 100$ N

74. (B)

A frame of reference, in which Newton's 1[st] law of motion holds, is known as inertial frame of reference. It is non accelerated frame of reference.

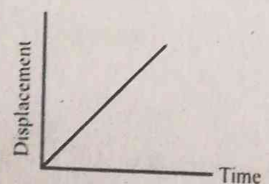
a = 0

75. (D)

$$g = \frac{GM}{(R+h)^2} \Rightarrow g \propto \frac{1}{(R+h)^2}$$

"g" decreases with increase in altitude. So, weight decreased (W = mg)

76. (B)



Slope of displacement-time graph $= \frac{\Delta y}{\Delta x} = \frac{\Delta d}{\Delta t} = v$ = velocity

77. (C)

W = mg = (20)(9.8) = 196 N

78. (A)

Distance covered in 1[st] second, $h_1 = \frac{1}{2}gt^2$

$$= \frac{1}{2}(10)(1)^2 = 5 \text{ m}$$

Distance covered in 2[nd] second, $h_2 = \frac{1}{2}gt^2$

$$= \frac{1}{2}(10)(2)^2 = 20 \text{ m}$$

Distance between 1[st] and 2[nd] second, $h = h_2 - h_1$

$= 20 - 5 = 15$ m

79. (C)

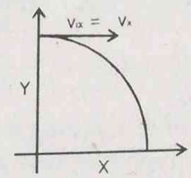
$$\vec{a} = \frac{m\vec{v}}{M}$$

$a \propto v^1$

80. (C)

$$a = \frac{v_f - v_i}{\Delta t} = \frac{25\text{km/hr} - 20\text{km/hr}}{1 \text{ hr}} = 5 \text{ km/hr}^2$$

81. (C)



$$Y = \frac{1}{2}gt^2 = \frac{1}{2}(10)(5)^2 = 125 \text{ m}$$

82. (D)

$$a = \frac{v_f - v_i}{\Delta t}$$

$$\Delta t = \frac{v_f - v_i}{a} = \frac{20 \text{ km/hr} - 10 \text{ km/hr}}{2 \text{ km/hr}^2} = \frac{10}{2} = 5 \text{ hr}$$

83. (A)

F = ma

$$a = \frac{F}{m}$$

For same force the body of greater mass has lesser acceleration.

84. (A)

$P_i = mv_i = (0.2)(-30) = -6$ Ns

$P_f = mv_f = (0.2)(20) = +4$ Ns

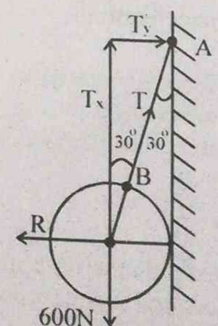
$\Delta P = mv_f - mv_i = +4 - (-6) = +10$ Ns

Taking downward velocity is −ve and upward is +ve.

85. (B)

$\Delta P = Ft = (1)(1) = 1$ kgm/s

86. (A)



$T_x = W$

$T\cos\theta = 600$

$$T = \frac{600}{\cos 30^\circ} = \frac{600}{\sqrt{3}/2} = \frac{1200}{\sqrt{3}} = \frac{(400)(3)}{\sqrt{3}}$$

$$= \frac{(400)(\sqrt{3})(\sqrt{3})}{\sqrt{3}} = 400\sqrt{3} \text{ N}$$

87. (A)

i. Torque plays the same role in rotational motion as the force plays in translational motion.

ii. Force determines the linear acceleration in the body while Torque determines the angular acceleration in the body for rotational motion.
So, torque is the analogues of force for rotational motion.

88. (A)

In (B) and (C) the distance given from axis of rotation is greater than the width of the door. So, in these cases the force does not act upon on door.
Maximum value of moment arm = width of the door = 0.5 m
For different forces the torque will be maximum, if the product of force and moment arm is maximum.
The torque in case of (A) is maximum than (B).

89. (C)

As force is acting along y-axis. So, its angle with x-axis is 90°.

$$F_x = F\cos 90^\circ = 0$$

90. (A)

Ranges at angles $(45^\circ + \theta)$ and $(45^\circ - \theta)$ are equal.
So, $R_1 : R_2 = 1:1$

91. (A)

Ranges at angles $(45^\circ + 5^\circ)$ and $(45^\circ - 5^\circ)$ are equal.
So, $R_P = R_Q$

92. (A)

The ballistic missiles are useful only for short ranges. For long ranges and greater precision, powered and remote control guided missiles are used.

93. (C)

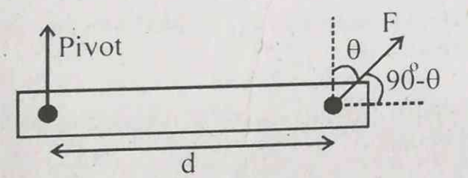
$$R = \frac{v_i^2 \sin 2\theta}{g} \Rightarrow R \propto \sin 2\theta$$

94. (D)

$$R = \frac{v_i^2 \sin 2\theta}{g} \quad \text{and} \quad R_{max} = \frac{v_i^2}{g}$$

$$R = R_{max}\sin 2\theta \quad \text{or} \quad R_{max} = \frac{R}{\sin 2\theta}$$

95. (B)



$$\tau = Fd\sin(90^\circ - \theta)$$
$$= Fd\cos\theta \qquad [\sin(90^\circ - \theta) = \cos\theta]$$

For maximum value of torque
F=large, d=large and θ=small
(at smaller angle $\cos\theta$ has large value)

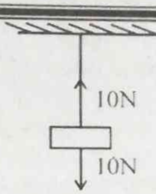
96. (C)

Newton's 2nd law of motion gives the measurement of force.

$$F = ma = \frac{P_f - P_i}{t}$$

97. (A)

When one end of the string is connected with a rigid body and by applying 10N force on a free end then the force with same magnitude but in opposite direction will be acted in the string.



98. (B)

$$h = v_i t + \frac{1}{2}gt^2 = 0 + \frac{1}{2}gt^2 = \frac{1}{2}(9.8)(2)^2 = 19.6 \text{ m}$$

99. (A)

$v_f = v_i + at$
for freely falling body
$v_f = 0 + gt = gt \Rightarrow v_f \propto t$

100. (B)

Both man and car are in same speed. So, their relative speed will be zero.

101. (B)

Acceleration = slope velocity-time graph = $\tan 0^\circ = 0$

102. (B)

Newton's laws are adequate for speeds that are low compared with the speed of light. For very fast moving objects relativistic mechanics developed by Einstein is applicable.

103. (C)

The average force generated in a collision is equal to the momentum change during the collision divided by the time interval in which collision is taken place.

$$\vec{F} = \frac{\Delta\vec{P}}{\Delta t}$$

The pad inside the helmet extends the time interval over which the collision occurs and reduces the force experienced by the brain during collisions. That is why the safety helmet of a motorcycle's is padded.

104. (A)

$$\frac{2g_p h_p}{2g_e h_e} = \frac{v_i^2}{v_i^2} = 1 \quad \text{(initial velocities are same)}$$

$$\frac{h_p}{h_e} = \frac{g_e}{g_p} = \frac{9.8}{19.6} = \frac{1}{2} \Rightarrow h_p = \frac{h_e}{2}$$

105. (A)

Speed = slope of distance-time graph
The slope of graph (A) is increasing. So, the speed is increasing.

106. (A)

As we know that "the rate of change of angular momentum is equal to the applied torque".

$$\tau = \frac{\Delta L}{\Delta t} = \frac{L_f - L_i}{\Delta t} = \frac{50 - 30}{0.5} = \frac{20}{0.5} = 40 \text{ N m}$$

107. (C)

The turning effect of force on a body about an axis is called Torque or moment of force. Torque is also defined as the cross product of position vector "$\vec{r}$" and force" $\vec{F}$ ".

$$\vec{\tau} = \vec{r} \times \vec{F}$$

It is a vector quantity. Its direction is perpendicular to the plane containing "$\vec{r}$" and "$\vec{F}$". It can be found by right hand rule.

108. (C)

If a body is at rest or rotating with uniform angular velocity, the angular acceleration will be zero. In this case the torque acting on the body will be zero.

109. (C)

Total force in right side, $F_{right} = 7 + 2 = 9N$

Total force in left side, $F_{left} = 3 + 4 = 7N$

Net force on body $= F_{right} - F_{left} = 9 - 7 = 2N$ (right side)

110. (A)

"The vector sum of all the forces acting on a body must be equal to zero". Mathematically:

$$\Sigma \vec{F} = \vec{0}$$

Upward forces balance downward forces, rightward forces balance by leftward forces.

If two equal and opposite forces acting on a body, the net force is zero, and the body is said to be in equilibrium.

111. (C)

When two or more than two forces acting on a common point, the forces are called concurrent forces.

112. (C)

i. Torque plays the same role in rotational motion as the force plays in translational motion.

ii. Force determines the linear acceleration in the body while Torque determines the angular acceleration in the body for rotational motion.

So, torque is the analogues of force for rotational motion.

113. (B)

Force determines the linear acceleration in the body while Torque determines the angular acceleration in the body for rotational motion.

114. (C)

"The vector sum of all the forces acting on a body must be equal to zero". Mathematically:

$$\Sigma \vec{F} = \vec{0}$$

Upward forces balance downward forces, rightward forces balance by leftward forces.

In case of coplanar forces the condition is expressed in term of "x" and "y" component of forces.

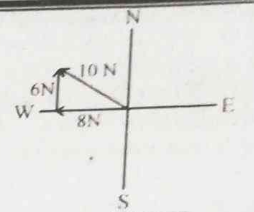
$$\Sigma \vec{F_x} = \vec{0}, \qquad \Sigma \vec{F_y} = \vec{0}$$

115. (C)

$$F = \frac{P_f - P_i}{\Delta t} = \frac{mv_f - mv_i}{\Delta t} = \frac{m(v_f - v_i)}{\Delta t} = \frac{m\Delta v}{\Delta t}$$

$$\Delta v = \frac{F\Delta t}{m} = \frac{(8)(4)}{16} = 2 \text{ m/s}$$

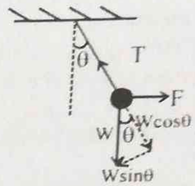
116. (C)



Resultant force, $F = \sqrt{8^2 + 6^2} = 10$ N

$$F = ma \Rightarrow a = \frac{F}{m} = \frac{10}{5} = 2 \text{ m/s}^2$$

117 (A)



$T = W\cos\theta = (1)\cos\theta = \cos\theta$

118. (B)

For every action there is a reaction. This action and reaction are equal magnitude but opposite in direction. Action and reaction never act on the same body; they act on the different bodies.

119. (C)

$$K.E = \frac{P^2}{2m} \Rightarrow K.E. \propto \frac{1}{m} \qquad (P = \text{constant})$$

If $(K.E.)_Q > (K.E.)_P$ then $m_Q < m_P$

So, for same momentum $v_Q > v_P$

120. (C)

As

Force = Slope of momentum-time graph

Slope of "2" < Slope of "3" < Slope of "4" < Slope of "1"

121. (B)

Uniform velocity means that the velocity of body remains same at any instant. So,

Instantaneous velocity = average velocity

122. (C)

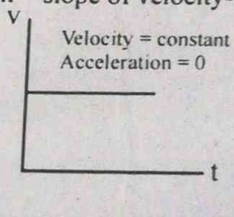
Relative velocity of bodies moving in opposite direction is

$$v_r = v_1 - v_2 = v - v = 0$$

Relative velocity does not depend upon the masses of bodies.

123. (A)

Acceleration = slope of velocity-time graph



124. (B)

$$\frac{T_1}{T_2} = \frac{2v_i \sin\theta/g}{2v_i \sin(90^\circ - \theta)/g} = \frac{\sin\theta}{\cos\theta} = \sin\theta : \cos\theta$$

125. (A)

An angle equally inclined to the horizontal and vertical means $\theta = 45^\circ$. so,

$$R_{max} = \frac{u^2}{g}$$

126. (A)

Net force, F = ma

In figure (A) net force is least. So, the acceleration is also least.

127. (D)

$$R = \frac{v_i^2 \sin 2\theta}{g}$$

$$R_{30^o} = \frac{v_i^2 \sin 2(30^o)}{g}$$

$$R_{60^o} = \frac{v_i^2 \sin 2(60^o)}{g}$$

$\sin 2(30^o) = \sin 2(60^o)$

$R_{30^o} = R_{60^o}$ (if initial velocities are same)

128. (D)

Couple = torque = $rF\sin\theta$ = N m

129. (B)

$2gh = v_f^2 - v_i^2 = v_f^2 - 0$

$v_f^2 = 2gh$

$v_f = \sqrt{2gh}$

$P = mv = m\sqrt{2gh} = 2[\sqrt{2(10)(5)}] = 2(10) = 20$ N s

130. (A)

$v_f = v_i + gt = 0 + (10)(4) = 40\ ms^{-1}$

$P = mv = (2.5)(40) = 100\ kgms^{-1}$

131. (A)

Relative velocity of bodies moving in opposite direction is

$$v_r = v_1 + v_2 = v + v = 2v$$

Relative velocity does not depend upon the masses of bodies.

132. (B)

Uniform acceleration means that the acceleration of body remains same at any instant. So,

Instantaneous acceleration = average acceleration

133. (A)

$$F = \frac{P_f - P_i}{t} = \frac{20 - 10}{1} = 10\ N$$

134. (D)

The rubber bullet will be more effective as it will bounce back after hitting the bear.

If initially the bullet was moving to the right with a velocity v, after bouncing off the bear it will move to the left with a velocity = -v. If m is the mass of the bullet its initial momentum is mv while the final momentum is - mv. So change in momentum is mv - (-mv) = 2mv. Since the force on the bear is proportional to the change in momentum, the rubber bullet will exert more force.

The lead bullet will pass through, as its direction is the same as before, it only slows down so the change in momentum is always less, even if it gets stuck in the bear in which case it has the max value of mv – 0 = mv.

However if we are looking at which can cause more damage it is obviously the lead bullet.

135. (C)

Maximum height attained by body thrown vertically upward is

$$h = \frac{v_i^2}{2g}$$

$$\frac{h_1}{h_2} = \frac{v_1^2/2g}{v_2^2/2g} = \frac{(100)^2}{(10)^2} = 100 \Rightarrow h_1 = 100h_2$$

136. (C)

Due to force of gravity the vertical component of velocity varies point to point.

137. (A)

The relation between height and range of a projectile projected at any angle "θ" is

$$4H = R\tan\theta$$

For 45°

$$4H = R\tan 45^o \Rightarrow R = 4H$$

138. (C)

When a stone released from the window of a moving train, then its motion will be a projectile motion. So its path will be curved.

139. (D)

Projectile motion is the 2-dimensional motion under the action of gravity. So, acceleration during projectile motion will be gravitational acceleration (g).

140. (D)

The relation between height and range of a projectile projected at any angle "θ" is:

$$4H = R\tan\theta$$

If R= H

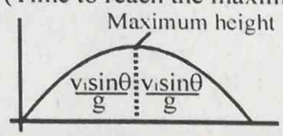
$4H = H\tan\theta \Rightarrow \tan\theta = 4 \Rightarrow \theta = \tan^{-1}(4) = 76^o$

141. (C)

For short ranges and flat Earth approximation, the trajectory is parabolic. But the drag less ballistic trajectory for spherical Earth should actually be elliptical.

142. (B)

Time of flight = 2 (Time to reach the maximum height)



143. (C)

$$y = \frac{1}{2}gt^2 \Rightarrow t = \sqrt{\frac{2y}{g}} = \sqrt{\frac{2(10)}{10}} = 1.4\ s$$

$$x = v_x \times t \Rightarrow v_x = \frac{x}{t} = \frac{10}{1.4} = 7.1\ m/s$$

144. (C)

$$g_{moon} = \frac{g_{Earth}}{6}$$

$$y = \frac{1}{2}gt^2 \Rightarrow t = \sqrt{\frac{2y}{g}} \Rightarrow t \propto \frac{1}{\sqrt{g}}$$

$t_{Moon} > t_{Earth}$

$x = v_x \times t \Rightarrow x \propto t \Rightarrow x_{Moon} > x_{Earth}$

145. (C)

When student drops a table tennis ball in air, then its speed increases due to force of gravity but acceleration due to gravity remains same ($g = 9.8\ ms^{-2}$).

146. (C)

Acceleration, $a = \frac{v_f - v_i}{\Delta t} = \frac{0 - 10}{5} = -2\ ms^{-2}$

deceleration = $2\ ms^{-2}$

147. (D)

$v = \text{constant} \Rightarrow \Delta v = 0 \Rightarrow a = 0$

$F = ma = m(0) = 0$

148. (C)

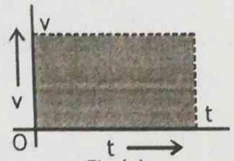


Fig.(a)

In fig(a) when the body moves with constant velocity "v" for a time "t", then

Area under the velocity time graph = (v)(t)

Area under the velocity time graph = S

149. (D)

$F = \frac{m}{t}(\Delta v) = (3)(5) = 15\ N$

150. (D)

According to Newton's first law of motion, there will be no acceleration in the horizontal direction ($a_x = 0$), unless a horizontal directed force acts on the body. In the absences of air friction only force acting on the body during flight is the force of gravity. As there is no horizontal force acting on the body so its horizontal velocity remains unchanged.

151. (A)

As

$Y = \frac{1}{2}gt^2 \Rightarrow t = \sqrt{\frac{2Y}{g}}$

As "Y" and "g" are constant in both cases. So, both are strike the plan with same time.

152. (B)

$Y = \frac{1}{2}gt^2 \Rightarrow t = \sqrt{\frac{2Y}{g}} = \sqrt{\frac{2(500)}{10}} = \sqrt{100} = 10\ s$

$x = v_x \times t = (40)(10) = 400\ m$

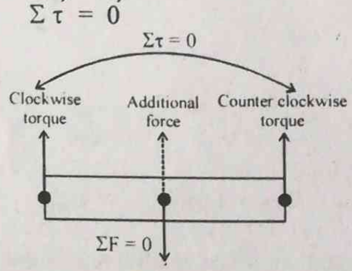
153. (B)

For a body to be in complete equilibrium both 1st and 2nd conditions of equilibrium must be satisfied.

i. $\Sigma \vec{F} = \vec{0}$

i.e $\Sigma \vec{F_x} = \vec{0}, \quad \Sigma \vec{F_y} = \vec{0}$

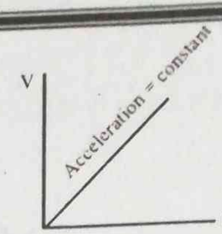
ii. $\Sigma \vec{\tau} = \vec{0}$



154. (C)

When an object is thrown vertically upward its velocity decreases to zero and then it moves downward its velocity increases in reverse direction.

155. (B)



156. (C)

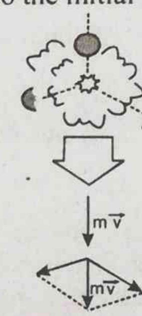
If "m" is the mass of the gases ejected per second with velocity $\vec{v}$ relative to the rocket, the change in momentum per second of the ejecting gases is $m\vec{v}$. This equals the thrust produced by the engine on the body of rocket. So, the acceleration $\vec{a}$ of the rocket is

$$\vec{a} = \frac{m\vec{v}}{M}$$

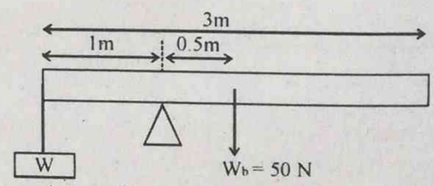
With the passage of time, mass of the rocket "M" decreases, so acceleration "$\vec{v}$" of the rocket increases.

157. (B)

When a shell explodes in mid air. Its parts fly off in different directions. The total momentum of all of its parts is equal to the initial momentum of the shell.



158. (A)



The weight of beam lies at center of gravity which is at the middle of beam 1.5 m from each side.

By principle of moments

Clockwise torque = Anticlockwise torque

$(0.5)(50) = (W)(1)$

$W = 25\ N$

159. (B)

Time to reach the highest point of its path $= \frac{10}{2} = 5\ s$

$v_f = v_i + at \Rightarrow 0 = v_i - gt$

$v_i = gt = (9.8)(5) = 49\ ms^{-1}$

160. (A)

$\frac{\Delta P}{\Delta t} = F = 10\ kgms^{-2}$

161. (C)

Rocket moves upward by ejecting hot gases at the tail of the rocket with very high velocity in downward direction. The rocket gain momentum equal to the momentum of gas ejected from the tail of the rocket, but in opposite direction.

Momentum of expelled gases = Momentum of Rocket

$$(5000)m = (1000)(20)$$
$$m = 4 \text{ kg}$$

162. (D)

Distance covered by body = area under v-t graph with time axis

Distance covered by body from time 2s to 5 s = (12)(3)

$$= 36 \text{ m}$$

163. (C)

Acceleration = slope velocity-time graph

$$\text{Acceleration in first 2s} = \frac{12-0}{2} = 6 \text{ m/s}^2$$

164. (D)

Speed = slope of distance-time graph

The slope of graph (I) is constant. So, speed is constant.

Also in graph (IV) speed is constant.

165. (A)

$m_1 = m_2 = m$ and $v_2 = 0$

$$v'_2 = \left(\frac{2m_1v_1}{m_1+m_2}\right) + \left(\frac{m_2-m_1}{m_1+m_2}\right)v_2$$
$$v'_2 = \left(\frac{2mv_1}{m+m}\right) + \left(\frac{m-m}{m+m}\right)(0) = \left(\frac{2mv_1}{2m}\right) + 0 = v_1$$
$$v'_2 = 15 \text{ ms}^{-1}$$

166. (C)

The collision in which both linear momentum and kinetic energy of the system remains constant is called elastic collision.

167. (B)

$m_1 >> m_2$ so $m_2 \approx 0$ and $v_2 = 0$

$$v'_2 \approx \left(\frac{2m_1v_1}{m_1+0}\right) + \left(\frac{0-m_1}{m_1+0}\right)(0) = \left(\frac{2m_1v_1}{m_1}\right) + 0 = 2v_1$$

168. (C)

$$v'_1 = \left(\frac{m_1-m_2}{m_1+m_2}\right)v_1 + \left(\frac{2m_2v_2}{m_1+m_2}\right)$$
$$v'_1 = \left(\frac{m-2m}{m+2m}\right)v + \left(\frac{2m(0)}{m+m}\right) = \left(\frac{-1}{3}\right)v = -\frac{v}{3}$$
$$v'_2 = \left(\frac{2m_1v_1}{m_1+m_2}\right) + \left(\frac{m_2-m_1}{m_1+m_2}\right)v_2$$
$$v'_2 = \left(\frac{2mv}{m+2m}\right) + \left(\frac{m-m}{m+m}\right)(0) = \left(\frac{2mv}{m+2m}\right) = \frac{2v}{3}$$

169. (B)

$v_M = 0$

$v'_m = 0$

$$v'_M = \left(\frac{2mv_m}{m+M}\right) + \left(\frac{M-m}{m+M}\right)v_M$$

If m=M

$$v'_M = \left(\frac{2mv_1}{m+m}\right) + \left(\frac{m-m}{m+m}\right)(0) = \left(\frac{2mv_m}{2m}\right) + 0 = v_m$$

170. (B)

$$v'_1 = \left(\frac{m_1-m_2}{m_1+m_2}\right)v_1 + \left(\frac{2m_2v_2}{m_1+m_2}\right)$$
$$v_1' = \left(\frac{m-2m}{m+2m}\right)v + 0 = \left(\frac{-m}{3m}\right)v = \frac{-v}{3}$$
$$(K.E)_i = \frac{1}{2}mv^2$$
$$(K.E)_f = \frac{1}{2}m\left(\frac{-v}{3}\right)^2 = \frac{1}{9}\left(\frac{1}{2}mv^2\right) = \frac{1}{9}(K.E)_i$$
$$\Delta K.E = (K.E)_f - (K.E)_i = \frac{1}{9}(K.E)_i - (K.E)_i = \left(\frac{1}{9} - 1\right)$$
$$(K.E)_i = -\frac{8}{9}(K.E)_i$$
$$\text{Loss of K.E} = \frac{\Delta K.E}{(K.E)_i} = \frac{8}{9}$$

171. (B)

By law of conservation of linear momentum

$$(20)(10) + 0 = (20+5)v$$
$$v = \frac{200}{25} = 8 \text{ m/s}$$
$$K.E = \frac{1}{2}mv^2 = \frac{1}{2}(20+5)(8)^2 = \frac{1}{2}(25)(64) = 800 \text{ J}$$

172. (A)

When masses of the two balls are equal.

$$m_A = m_B = m$$
$$v'_A = v_B$$
$$v'_B = v_A$$

The velocities of the balls are interchanged after collision.

$$v'_A = v_B = -14 \text{ m/s}$$
$$v'_B = v_A = 13 \text{ m/s}$$

173. (C)

By law of conservation of linear momentum

$$(m_1)(40) + 0 = (m_1 + m_2)(30)$$
$$\frac{40}{30} = \frac{m_1+m_2}{m_1} = 1 + \frac{m_2}{m_1}$$
$$\frac{m_2}{m_1} = \frac{4}{3} - 1 = \frac{1}{3}$$
$$\frac{m_1}{m_2} = 3$$

174. (A)

If line of action of force passes through pivot then moment arm will be zero (L = 0).

$$\tau = LF\sin\theta = (0)F\sin\theta = 0$$

UHS PAST MDCAT (2008-2019)

1. **Force in terms of base units is expressed as:** **(UHS 2008)**

(A) kg ms^{-2} (C) kg m^2s^{-3}
(B) kg m^2s^{-2} (D) kg ms^{-3}

(A)

F = ma

Units of "F" = kg ms^{-2}

2. **An _____ missile is called a ballistic missile.** **(UHS 2008)**

(A) un-powered and guided
(B) un-guided and powered
(C) Powered and guided
(D) Un-powered and un-guided

(D)

An un-powered and un-guided missile is called a ballistic missile.

3. If the force of magnitude 8 N acts on a body in direction making an angle 30°, its "x" and "y" components will be: (UHS 2009)

(A) $F_x = 3\sqrt{3}$ N, $F_y = 4$ N
(B) $F_x = 4\sqrt{3}$ N, $F_y = 4$ N
(C) $F_x = 4\sqrt{3}$ N, $F_y = 8$ N
(D) $F_x = 8$ N, $F_y = 4\sqrt{3}$ N

(B)

$$F_x = F\cos\theta = (8)\cos 30^\circ = (4)(2)\left(\frac{\sqrt{3}}{2}\right) = 4\sqrt{3}\text{ N}$$

$$F_y = F\sin\theta = (8)\sin 30^\circ = (4)(2)\left(\frac{1}{2}\right) = 4\text{ N}$$

4. If the body is rotating with uniform angular velocity, then its torque is: (UHS 2009)

(A) zero (C) Maximum
(B) Clockwise (D) Remains the same

(A)

$\tau = I\alpha$
ω = constant $\Rightarrow \Delta\omega = 0 \Rightarrow \alpha = 0$
$\tau = I(0) = 0$

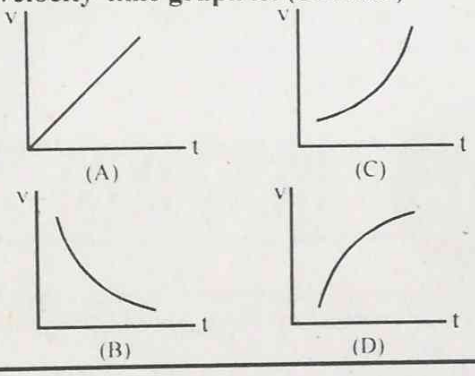
5. A body is moving with an initial velocity of 2 kms^{-1}. After a time of 50 s its velocity becomes 1.5 kms^{-1}. Its acceleration will be: (UHS 2009)

(A) 30 ms^{-2} (C) – 20 ms^{-2}
(B) 40 ms^{-2} (D) – 10 ms^{-2}

(D)

$$a = \frac{v_f - v_i}{\Delta t} = \frac{1500 - 2000}{50} = \frac{-500}{50} = -10\text{ ms}^{-2}$$

6. When a car moves with constant acceleration, the velocity-time graph is: (UHS 2009)



(A)

Slope of v-t graph = Acceleration
As body moves with constant acceleration, so v-t graph will be a straight line (slope = constant)

7. In elastic collision, when a massive body collides with light body at conditions $m_1 >> m_2$ and $v_2 = 0$ ms^{-1}, then the change in velocity will be written as: (UHS 2009)

(A) $v_1' \approx -v_1$; $v_2' \approx v_1$ (C) $v_1' \approx v_1$; $v_2' \approx 2v_1$
(B) $v_1' \approx v_1$; $v_2' \approx 0$ (D) $v_1' \approx -v_1$; $v_2' \approx 0$

(C)

$$v'_1 \approx \left(\frac{m_1 - 0}{m_1 + 0}\right)v_1 + \left(\frac{2m_2(0)}{0 + m_2}\right)$$

$$v'_1 \approx \left(\frac{m_1}{m_1}\right)v_1 + 0$$

$$v'_1 \approx v_1 + 0$$

$$v'_1 \approx v_1$$

$$v'_2 \approx \left(\frac{2m_1v_1}{m_1 + 0}\right) + \left(\frac{0 - m_1}{m_1 + 0}\right)(0)$$

$$v'_2 \approx \left(\frac{2m_1v_1}{m_1}\right) + 0$$

$$v'_2 \approx 2v_1$$

8. The horizontal range of a projectile, at a certain place, is completely determined by: (UHS 2010)

(A) The angle of projection
(B) The initial velocity of projection
(C) The mass of the projectile
(D) Speed and mass of the projectile

(A)

$$R = \frac{v_i^2}{g}\sin 2\theta$$

The most important parameter in the range of projectile is angle of projection as compared to initial velocity of projectile.

9. For a body to be in complete equilibrium: (UHS 2010)

(A) Linear acceleration is zero
(B) Angular acceleration is zero
(C) Linear acceleration is zero but angular acceleration is not zero
(D) Linear acceleration and angular acceleration both should be zero

(D)

For a body to be in complete equilibrium both 1st and 2nd conditions of equilibrium must be satisfied.

i. $\Sigma \vec{F} = \vec{0}$ (Linear acceleration = 0)

ii. $\Sigma \vec{\tau} = \vec{0}$ (Angular acceleration = 0)

10. Time of projectile's flight is: (UHS 2010)

(A) $\dfrac{v_i^2\sin^2\theta}{g}$ (C) $\dfrac{v_i^2\sin\theta}{g}$
(B) $\dfrac{2v_i\sin\theta}{g}$ (D) $\dfrac{v_i^2}{g}\sin 2\theta$

(B)

$$\text{Time of flight} = \frac{2v_i\sin\theta}{g}$$

11. If the velocity of the body changes by equal amount in equal intervals of time, the body is said to have: (UHS 2010)

(A) variable velocity (C) uniform velocity
(B) Uniform acceleration (D) Negative acceleration

(C)

Definition of uniform velocity.

12. For finding the height of projectile, the equation used is: (UHS 2010)

(A) $2S = a\,(v_f^2 - v_i^2)$ (C) $S = 2a\,(v_f^2 - v_i^2)$

(B) $2aS = v_f^2 - v_i^2$ (D) $a = 2S(v_f^2 - v_i^2)$

(B)

$$2aS = v_f^2 - v_i^2$$
$$2a_y y = v_{fy}^2 - v_{iy}^2$$
$$2(-g)h = (0)^2 - (v_i \sin\theta)^2$$
$$-2gh = -v_i^2 \sin^2\theta$$
$$2gh = v_i^2 \sin^2\theta$$
$$h = \frac{v_i^2 \sin^2\theta}{2g}$$

13. **If a force of 12N is applied on a body and its momentum is changed form 60 kgms^{-1} to 36 kg ms^{-1}, then find the time during, which this force acts: (UHS 2010)**

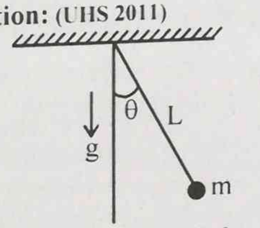
(A) 1 second (C) 12 seconds
(B) 2 seconds (D) 24 seconds

(B)

$$F = \frac{\Delta P}{\Delta t} \Rightarrow \Delta t = \frac{P_f - P_i}{F} = \frac{36 - 60}{12} = \frac{-24}{12} = -2\text{ s}$$

Time can never be negative.

14. **A simple pendulum length "L" with bob of mass "m" is slightly displaced from its mean position so that its string makes an angle "θ" with vertical line as shown in figure. Then bob of pendulum released. What will be the expression of torque with which the bob starts to move towards the mean position: (UHS 2011)**

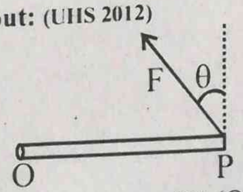


(A) mgL (C) 0
(B) mgLsinθ (D) mgLcosθ

(B)

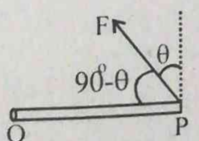
τ = rF
In simple pendulum the force responsible for the oscillatory motion of pendulum is mgsinθ.
τ = Lmgsinθ

15. **A force "F" is acting at point "P" of a uniform rod capable to rotate about "O". What is the torque about: (UHS 2012)**



(A) (OP)(Ftanθ) (C) (OP)(Fsinθ)
(B) (OP)(F) (D) (OP)(Fcosθ)

(D)



$\tau = (OP)F\sin(90^\circ - \theta) = (OP)(F\cos\theta)$

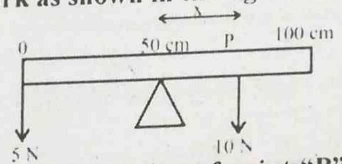
16. **Ratio of moment of inertia of two objects "A" and "B" is 2:3. Which of one of the following is the ratio of torques of "A" and "B" respectively, if both are being rotated with constant angular acceleration? (UHS 2013)**

(A) 3:4 (C) 3:2
(B) 2:3 (D) 4:3

(B)

$$\tau = I\alpha \Rightarrow \tau \propto I$$
$$\frac{\tau_A}{\tau_B} = \frac{I_A}{I_B} = \frac{2}{3} \Rightarrow \tau_A : \tau_B = 2:3$$

17. **Two forces 5N and 10 N are acting at "O" and "P" respectively on a uniform mete rod suspended at the position of centre of gravity 50 cm mark as shown in the figure.**



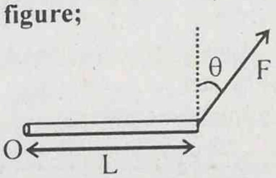
Then find the position of point "P" on meter rod. (UHS 2014)

(A) 80 cm (C) 70 cm
(B) 75 cm (D) 65 cm

(B)

Clockwise torque = Anticlockwise torque
(10cm)(x) = (5)(50cm)
x = 25 cm
So, the position of point "P" on meter rod is 75 cm.

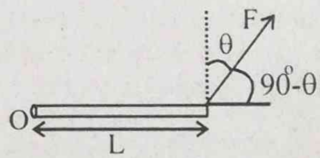
18. **A bar of length "L" pivoted at "O" is acted by a force "F" at an angle "θ" with vertical line as shown in figure;**



What is the moment of force? (UHS 2015)

(A) L sinθ (C) LF cosθ
(B) L cosθ (D) LF sinθ

(C)



$\tau = LF\sin(90^\circ - \theta) = LF\cos\theta$

19. **If we double the moment arm the value of torque becomes: (UHS 2016)**

(A) half (C) two times
(B) three times (D) four times

(C)

$\tau = rF\sin\theta \Rightarrow \tau \propto r$

20. **The ratio of displacement along diameter and total distance along circle: (UHS 2017)**

(A) 1 : π (C) 2 : π
(B) π : 1 (D) π : 2

(A)

$$\frac{\text{Displacement}}{\text{Total distance of circle}} = \frac{2r}{2\pi r} = \frac{1}{\pi} = 1:\pi$$

21. Arshad is driving down 7th street. He drives 150 meter in 18 seconds. Assume he does not speed up or slow down. What is his speed? (UHS 2017)

(A) 0.38m/s
(B) 126m/s
(C) 8.33m/s
(D) 58.33m/s

> **(C)**
>
> $v = \frac{S}{t} = \frac{150}{18} = 8.33$ m/s

22. The distance travelled by a moving car with velocity 15 m/s in 2 seconds, decelerates at $2m/s^2$ is equal to: (UHS 2017)

(A) 30m
(B) 34m
(C) 16m
(D) 26m

> **(D)**
>
> $S = v_i t + \frac{1}{2}at^2 = (15)(2) + \frac{1}{2}(-2)(2)^2$
>
> $S = 30 - 4 = 26$ m

23. If slope of velocity time graph is not constant at different points then body is moving with: (UHS 2018)

(A) constant acceleration
(B) Average acceleration
(C) Increasing acceleration
(D) uniform velocity

> **(C)**
>
> Slope of v-t graph = Acceleration
> In case of increasing acceleration, slope will be different at different points of graph.

24. Newton first law of motion is also known as: (UHS 2018)

(A) Law of conservation of momentum
(B) Law of inertia
(C) Law of electromagnetism
(D) Law of universal gravity

> **(B)**
>
> Newton first law of motion is also known as Law of inertia.

25. A cyclist is travelling at 15 ms^{-1}. She applies brakes so that she doesn't collide with the wall in front of her at a distance of 18 m. Calculate the magnitude of deceleration: (UHS 2018)

(A) 6.3 ms^{-2}
(B) 12.5 ms^{-2}
(C) 5.3 ms^{-2}
(D) 13 ms^{-2}

> **(A)**
>
> $2aS = v_f^2 - v_i^2 \Rightarrow 2(a)(18) = 0 - 15^2$
>
> $a = \frac{-225}{36} = -6.3$ m/s^2

26. For projectile motion in the absence of air resistance: (UHS 2019)

(A) vertical speed is constant
(B) horizontal force is constant
(C) horizontal acceleration is zero
(D) vertical acceleration is zero

> **(C)**
>
> $F_x = ma_x$
> As there is no net force along the horizontal direction. So, horizontal acceleration (a_x) is zero.

27. The range of the projectile depends upon the velocity of the projection and angle of the projection i.e 45°. For a fixed velocity, when the angle of projection is larger than 45°, which of the following is correct? (UHS 2019)

(A) Both the height and the range attained by the projectile will be less
(B) Both the height and the range attained by the projectile will be more
(C) The height attained by the projectile will be less but the range is more
(D) The height attained by the projectile will be more but the range is less

> **(D)**
>
> $R = \frac{v_i^2}{g}\sin 2\theta \Rightarrow R \propto \sin 2\theta$
>
> $H = \frac{v_i^2}{g}\sin^2\theta \Rightarrow H \propto \sin^2\theta$
>
> If angle of projection is larger than 45°, then value $\sin^2\theta$ is more than $\sin 2\theta$.

28. If two objects of equal masses "m" are moving towards each other with the same speeds "v" then what will be the total final momentum after elastic head-on collision: (UHS 2019)

(A) −mv kg/s
(B) mv kg m/s
(C) 2mv kg/s
(D) 0 kg m/s

> **(D)**
>
> Initial momentum = mv + (−mv) = 0
> In elastic collision momentum remains constant.
> So,
> Final momentum = 0

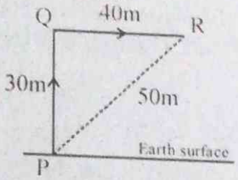
UNIT 03 WORK, ENERGY AND POWER

01. **Slope of work time graph is equal to:**
(A) displacement (C) acceleration
(B) power (D) energy

02. **Work done on the body equals to the:**
(A) change in its K.E always
(B) change in it K.E and change in its P.E
(C) change in its P.E always
(D) neither change in K.E nor change in its P.E

03. **The escape velocity of a body in gravitational field of Earth is independent of:**
(A) its mass
(B) the angle at which it is thrown
(C) both its mass and the angle at which it is thrown
(D) gravitational field of Earth

04. **A stone of weight 4 N in the Earth's gravitational field is moved from "P" to "Q" and then to "R" along the path shown.**



How much potential energy does the stone gain?
(A) 120 J (C) 200 J
(B) 280 J (D) 1200 J

05. **If velocity is double, then.**
(A) momentum increase 4 times and K.E increases 2 times
(B) momentum and K.E remain same
(C) momentum increases 2 times and K.E increase constant
(D) momentum increases 2 times and K.E increases 4 times

06. **One mega watt hour is equal to.**
(A) 36×10^6 J (C) 36×10^{12} J
(B) 36×10^9 J (D) 36×10^8 J

07. **Which of the following is not conservative force:**
(A) Friction (C) electric
(B) gravitational (D) elastic spring force

08. **The relation between the escape velocity "v_{esc}" and orbital speed "v_o" is given by:**
(A) $v_{esc} = \frac{1}{2} v_o$ (C) $v_{esc} = \sqrt{2} v_o$
(B) $v_{esc} = v_o$ (D) $v_{esc} = 2v_o$

09. **When arrow is released from its bow, its energy is transformed from:**
(A) heat energy to K.E
(B) chemical energy to elastic P.E
(C) elastic P.E to K.E
(D) K.E to elastic P.E

10. **A man lifts, vertically, a weight of 40 kg through 1m in 10s: while a child lifts, vertically, a weight of 10 kg through a distance of 1m in 1s. What will be correct inference? ($g = 10$ m/s^2)**
(A) man has more power than child
(B) both have same power
(C) child has more power than man
(D) it is a foolish question.

11. **A man carries a 1 kg suitcase 10 m horizontally across the corridor and then goes up the stairs of total height 10 m. The work done by the man due to force of gravity is:**
(A) 0 J (C) 4.9 J
(B) 196 J (D) 98 J

12. **A 100 kg car starting from rest runs down a 30° slope. If the total length of the slope is 20 m, the speed of the car at the bottom, ignoring friction, is:**
(A) $14000\sqrt{3}$ m/sec (C) 1.4 m/sec
(B) 20 sin 30° m/sec (D) 14 m/sec

13. **A body is falling freely under gravity from point "A" to point "B". The energy of the body at the point "C" (ground level) is:**
(A) is less than its energy at A
(B) is greater than its energy at A
(C) is equal to its energy at A
(D) Zero

14. **If you weigh 500 N and in 5 seconds you can run up a flight of stairs consisting of 40 steps, each 15 cm high, what is your power?**
(A) 3000 J (C) 3000 J sec^{-1}
(B) 600 watt (D) 60 kilowatt

15. **To pump up 2400 kg of water up 74.6 m in 5 minutes, the required in horse power is:**
(A) 8 hp (B) 25 hp
(B) 15 hp (D) 16 hp

16. **An object of mass 1 g is whirled in a horizontal circle of radius 0.5m at a constant speed of 2m/s. The work done on the object during one revolution is:**
(A) 0 J (C) 1 J
(B) 2 J (D) 4 J

17. **The F-d graph for an object is a straight line with positive slope. If the height and width of the graph are 4 units and 2 units respectively, the work done on the object is:**
(A) zero (C) 8 units
(B) 4 units (D) 2 units

18. **A 2 kg object is moving at 3 m/s. A 4 N force is applied in the direction of motion and then removed after the object has traveled an additional 5 m. The work done by this force is:**
(A) 12 J (C) 15 J
(B) 18 J (D) 20 J

19. **In order to calculate the exact value of work done by a variable force:**
(A) Δd is made such small to approach zero
(B) calculate average work
(C) Δt is made such small to approach zero
(D) both (A) and (B)

20. **A field is said to be conservative if:**
(A) work done inside that field is independent of the path followed

(B) work done in closed path inside that field is zero
(C) both (A) and (B)
(D) work done is always negative

21. **Object "A" has half the mass of object "B". If the two objects have equal momentum, then K.E. of object "A" in terms of K.E. of object "B" will be:**
(A) $K.E_A = K.E_B$ (C) $K.E_A = 2K.E_B$
(B) $K.E_A = \frac{1}{2} K.E_B$ (D) $K.E_A = 4K.E_B$

22. **A child is revolving a tiny 10g stone, tied at one end of a string, in a vertical loop of 2m diameter. If the stone completes 100 revolutions in 1 second, the work done on it will be:**
(A) zero (C) 4.9 J
(B) 19.8 J (D) 9.8 J

23. **Which of the following statement is not true?**
(A) work is a scalar quantity
(B) if θ is 0^0 work done will be maximum
(C) if θ is 90^0 then work done will be zero
(D) if $\theta < 90^0$ then work done will be negative

24. **A body of mass 1.0 kg drops from the top of a tower of height 50 m. What will be its K.E. 10 m below the top?**
(A) 490 J (C) 49 J
(B) 98 J (D) 980 J

25. **Which of the following bodies has the largest kinetic energy?**
(A) Mass 3M and speed v
(B) Mass 2M and speed 3v
(C) Mass 3M and speed 2v
(D) Mass M and speed 4V

26. **Work is defined as:**
(A) dot product of force & displacement
(B) product of magnitude of displacement and component of force in the direction of displacement
(C) product of displacement and force
(D) both (A) and (B)

27. **1 horse power =**
(A) 746 J (C) 3×10^6W
(B) 746000mW (D) 10^{-5}W

28. **The velocity of a particle moving along the x axis changes from "v_i" to "v_f". For which values of "v_i" and "v_f" is the total work done on the particle positive?**
(A) $v_i = 5$m/s, $v_f = 2$m/s (C) $v_i = 5$m/s, $v_f = -2$m/s
(B) $v_i = -5$m/s, $v_f = -2$m/s (D) $v_i = 2$m/s, $v_f = -5$m/s

29. **The amount of work required to stop a moving object is equal to:**
(A) the velocity of the object
(B) the kinetic energy of the object
(C) the mass of the object times its acceleration
(D) the mass of the object times its velocity

30. **Two objects with masses of m_1 and m_2 have the same kinetic energy and are both moving to the right. The same constant force "F" is applied to the left to both masses. If $m_1 = 4m_2$, the ratio of the stopping distance of m_1 to that of m_2 is:**
(A) 1:4 (C) 4:1
(B) 1:2 (D) 1:1

31. **A 2 kg block is thrown upward from a point 20m above Earth's surface. At what height above Earth's surface will the gravitational potential energy of the Earth-block system have increased by 500 J? ($g = 10$ m/s^2)**
(A) 5m (C) 25m
(B) 45m (D) 70m

32. **A person carries a load of 15 kg of bricks to the top of building 10 m high. The work done is: ($g = 10$ m/s^2)**
(A) 150 J (C) 1500 J
(B) 100 J (D) 750 J

33. **A body at rest may have:**
(A) Momentum (C) speed
(B) velocity (D) energy

34. **The amount of work done is pumping out water of a cubicle vessel of height 1 m is: ($g = 10$ m/s^2)**
(A) 1000 J (C) 10,000 J
(B) 5000 J (D) 100 J

35 **A force $\vec{F} = 6\hat{i} + 2\hat{j} - 3\hat{k}$ acts on a particle and produces a displacement $\vec{S} = 2\hat{i} - 3\hat{j} + x\hat{k}$, what is the value of "x". If work done is zero?**
(A) 2 (C) $\frac{1}{2}$
(B) −2 (D) d

36. **The kinetic energy of a body of mass 2 kg and momentum equal to 2 N s is:**
(A) 1 J (C) 3 J
(B) 2 J (D) 4 J

37. **A 4 kg mass and 1 kg mass are moving with equal kinetic energies. What is the ratio of their momenta?**
(A) 1:2 (C) 4:1
(B) 2:1 (D) 1:1

38. **A car moving with speed of 40 km/h can be stopped by applying brakes after at least 2 m. If the same car is moving at a speed equal to 80 km/h, the minimum stopped displace will be:**
(A) 4 m (C) 8 m
(B) 6 m (D) 2 m

39. **A body constrained to move along $(-2\hat{i} + 15\hat{j} + 6\hat{k})$ N. The work done by this force in moving this body through a distance equal to 10 m along the y–axis will be:**
(A) 50 J (C) 150 J
(B) 100 J (D) 160 J

40. **A toy box is pushed along a horizontal floor through 2 m by means of a force equal to 10 N directed at an angle of 30° to the vertical. Total work done is:**
(A) 6 J (C) 12 J
(B) 10 J (D) 8 J

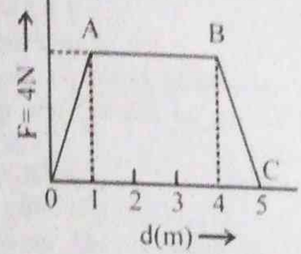
41. **A crane can raise a body of mass 100 kg vertically upward with a speed of 5 m/s. The power of its engine is ($g = 10$ m/s^2):**
(A) 2 kW (C) 5 kW
(B) 10 kW (D) 4 kW

42. **A person with mass 60 kg climbs the stairs to the first floor 10 m above the ground in 20 s. The power developed by him is: ($g = 10\ m/s^2$)**
(A) 120 W (C) 300 W
(B) 60 W (D) 294 W

43. **Work done against gravity in lifting a 5 kg box through a distance of 1.5 m is ($g=10\ ms^{-2}$)**
(A) – 75 J (C) 73.5 J
(B) –73.5 J (D) 75 J

44. **A 50 kg body is accelerated from rest to 20 m/s in 10 s. What is the amount of work done?**
(A) 1000 J (C) 10,000 J
(B) 2000 J (D) 20,000 J

45. **A force F acts on a body as a function of "x" as shown in the Fig. Work done in moving the body from d=0 to d=1 m is:**



(A) 4 J (C) 2 J
(B) 3 J (D) 1 J

46. **During rainfall, a certain drop of radius "r" falls through a height "h" above the ground. The work done by the gravitational force is proportional to the:**
(A) r^3 (C) r
(B) r^2 (D) r^4

47. **A body is allowed to fall freely under gravity from a height of 12 m. It loses of 25% of its energy when it first hits the ground. To what height will it rise after the first impact with the ground?**
(A) 3 m (C) 9 m
(B) 6 m (D) 10 m

48. **A rubber ball is dropped from a height of 5 m on a planet where the acceleration due to the gravity is not known. On bouncing it rises to 1.8 m. The ball loses its velocity on bouncing by a factor of:**
(A) $\frac{16}{25}$ (C) $\frac{3}{5}$
(B) $\frac{2}{5}$ (D) $\frac{9}{2}$

49. **A 5 kg block is moved from the rest through a distance of 4 m along the x–direction. A force equal to 20 N acts on it. If the block acquires a K.E. equal to 40 J, what is the angle the force makes with x–axis?**
(A) 0° (C) 45°
(B) 30° (D) 60°

50. **An electric motor car has a rating of 500 watt. How much energy per minute is delivered by it?**
(A) 500 J (C) 5 kJ.
(B) 3 kJ (D) 30 kJ

51. **If the linear momentum changes by 10%, the kinetic energy will change by**
(A) 10% (C) 100%
(B) 50% (D) 20%

52. **A particle of mass "m" accelerates uniformly from rest to a speed "v" in "t" seconds. What is the average power delivered?**
(A) $\frac{mv^2}{t}$ (C) $\frac{mv^2}{2t}$
(B) $\frac{4mv^2}{t}$ (D) $\frac{t}{mv^2}$

53. **A body of mass 40 kg, is acted upon by a constant force equal to 4 N over a distance of 2 m. What is the kinetic energy of acquired by the body?**
(A) 8 J (C) 160 J
(B) 80 J (D) 4 J

54. **A 10 kg bomb explodes into two pieces of masses 6 kg and 4 kg. The velocity of 4 kg mass is 12 m/s. What is the kinetic energy of the other mass?**
(A) 72 J (C) 120 J
(B) 48 J (D) 192 J

55. **Two bodies of masses 1kg and 2kg have same momenta. The ratio of their K.E is:**
(A) 1:1 (C) 2:1
(B) 1:2 (D) 4:1

56. **A body builder lifts a 250 kg weight from the ground to a height of 2 m in 2.5 s. The average power generated is (Take $g=10\ m/s^2$):**
(A) 500 watt (C) 1250 watt
(B) 1000 watt (D) 2000 watt

57. **Two spherical bodies of identical diameter weighing 2 kg and 5 kg respectively are allowed to fall freely from the top of a tower at the same time. When they are 1.5 m above the ground, they will have the same value of:**
(A) Kinetic energy (C) acceleration
(B) Momentum (D) potential energy

58. **A 1 kg ball changes its velocity from 6 m/s to 2 m/s. What are the changes in kinetic energy of the ball?**
(A) 2 J (C) 8 J
(B) 4 J (D) 16 J

59. **A ball of mass m is dropped from a height "h" above the ground. What is the velocity of the ball when it loses half of its initial potential energy?**
(A) $\sqrt{2gh}$ (C) $\sqrt{gh}$
(B) $\sqrt{gh/2}$ (D) $2\sqrt{gh}$

60. **If a power of 1kW is maintained for 1 sec then work done is equal to:**
(A) 10^3J (C) 3.6×10^5J
(B) 10^5J (D) 3.5×10^6J

61. **Momentum and K.E. of a body are numerically equal to each other. Velocity of body is:**
(A) 1 m/s (C) 3 m/s
(B) 2 m/s (D) 4 m/s

62. **The height of the dam is 20 m at a hydroelectric power plant. How many of kg of water must fall per second on the blades of a turbine to generate**

one mega watt of electrical power? ($g=10\ m/s^2$)
(A) 1000 kg/s (C) 4000 kg/s
(B) 2000 kg/s (D) 5000 kg/s

63. **A bullet of mass "m" is fired from horizontally with a velocity "v" on to a wooden block of mass "m" and gets embedded in it. The kinetic energy of the bullet + block system is:**
(A) $\frac{1}{2}(M+m)\,v^2$ (C) $\frac{1}{2}\left(\frac{mMv^2}{M+m}\right)$
(B) $\frac{1}{2}mv^2$ (D) $\frac{1}{2}\left(\frac{m^2v^2}{M+m}\right)$

64. **The work done by a force on a body depends upon:**
(A) The initial velocity of body
(B) The distance covered by the body
(C) The mass of body
(D) The angle between the displacement vector and force vector

65. **A person "X" of 75 kg walks up a staircase in 15 s. Another person "Y" of mass 60 kg walks up the same staircase in 12s. The ratio of the power generated by "X" to that by "Y" is:**
(A) 4/5 (C) 5/6
(B) 5/4 (D) 1

66. **Neglecting air resistance, a 1.0 kg projectile has an escape velocity of about 11 km/s at the surface of Earth. The corresponding escape velocity for a 2.0 kg projectile is:**
(A) 3.5 km/s (C) 5.5 km/s
(B) 11 km/s (D) 10 km/s

67. **A body with a mass 100 g has a velocity $\vec{v} = (2\hat{i} + 4\hat{j})$ m/s at a certain instant of time. Its kinetic energy is:**
(A) 0.5 J (C) 2.0 J
(B) 1.0 J (D) 3 J

68. **Which of the following energy can never be negative?**
(A) P.E (C) Nuclear energy
(B) K.E (D) All of these

69. **The consumption of energy by 60 watt bulb in 2 s is:**
(A) 10 J (C) 60 J
(B) 30 J (D) 120 J

70. **A body of mass 5 kg is in motion and has a momentum 10 kgm/s. A force of 0.5 N acts on it along the direction of motion for 10 s. The increase in the kinetic energy is:**
(A) 2.5 J (C) 10 J
(B) 5 J (D) 12.5 J

71. **A ball whose kinetic energy is "E", is thrown at an angle of 45° with the horizontal, its kinetic energy at the highest point of its trajectory will be:**
(A) E (C) $E/\sqrt{2}$
(B) E/2 (D) zero

72. **A force "F" acts a body at an angle of 60° to the horizontal and moves it 10 m. The effective component of the force which performs work is:**
(A) 0.5 F (C) Fcos30°
(B) 0.866F (D) 0.707 F

73. **The energy used by a car from petrol in its lifetime is:**
(A) 0.1×10^{12} J (C) 0.2×10^{12} J
(B) 1×10^{12} J (D) 2×10^{12} J

74. **Proton, electron, neutron and α-particle have same momentum. Which of them have highest K.E?**
(A) Proton (C) Neutron
(B) Electron (D) α-particle

75. **Work is independent of:**
(A) Force (C) Time
(B) Displacement (D) All of these

76. **A 40 newton object is released from a height of 10 m. Just before it hits the ground, its kinetic energy, in joules is (ignoring air friction):**
(A) 400 J (C) 2800 J
(B) 3920 J (D) 4000 J

77. **A man of mass 50 kg jumps to a height of 1 m. His potential energy at the highest point is ($g = 10\ m/s^2$):**
(A) 50 J (C) 500J
(B) 60 J (D) 600 J

78. **An object of mass m was at height "h" falls through a vertical distance "x", the its K.E is:**
(A) mgx (C) mg(h – x)
(B) mgh (D) mg(x – h)

79. **The work energy expression is written as (in horizontal motion):**
(A) W = ΔK.E (C) both (A) and (B)
(B) W = ΔP.E (D) All of these

80. **In 10 second, elevator picks a weight of 1000 N over a distance of 10 m at constant velocity, its power is:**
(A) 10 Watt (C) 1000 Watt
(B) 100 Watt (D) 10,000 Watt

81. **If the momentum of a body is doubled , it kinetic energy becomes:**
(A) double (C) 8 times
(B) 4 times (D) ½ times

82. **An object of 5 kg is pulled horizontally by a force of 50 N through a displacement of 10m, the work done by gravity is:**
(A) 250 J (C) Zero
(B) 500 J (D) 5 kJ

83. **The work done will be zero when the angle between force $\vec{F}$ and displacement $\vec{d}$ is:**
(A) 45° (C) 60°
(B) 90° (D) 150°

84. **The dimensions of the work is :**
(A) $[MLT^{-1}]$ (C) $[MLT^{-2}]$
(B) $[ML^2T^{-2}]$ (D) [MLT]

85. **When the force is parallel to the direction of motion of the body, then work done on the body is:**
(A) zero (C) minimum
(B) maximum (D) infinity

86. **Which of the following type of force cannot do work on which it acts?**
(A) frictional force (C) gravitational force
(B) centripetal force (D) restoring force

87. **kWm^{-2} is the unit of:**
(A) Power (C) intensity
(B) energy (D) energy per unit area

88. **If a body of mass 2 kg is raised vertically through 2m, then the work will be:**
(A) 38.2 J (C) 392.1 J
(B) 39.2 J (D) 40 J

89. **The dimensions of the power are:**
(A) $[ML^{-1}T^{-2}]$ (C) $[ML^{-2}T^{-2}]$
(B) $[ML^{2}T^{-3}]$ (D) $[ML^{-2}T^{-1}]$

90. **The average power and instantaneous power become equal if work is done at:**
(A) any rate (C) variable rate
(B) uniform rate (D) high rate

91. **The power is one kilo watt if work is done at the rate of:**
(A) 1000 Js^{-1} (C) 100 Js^{-1}
(B) 1000 J min^{-1} (D) 1000 J h^{-1}

92. **Power can be defined as the dot product of:**
(A) Force and displacement
(B) force and time
(C) force and velocity
(D) force and mass

93. **kilowatt hour is the unit of:**
(A) power (C) momentum
(B) Force (D) energy

94. **If the velocity is doubled then K.E will be:**
(A) also doubled (C) remains constant
(B) four times (D) half

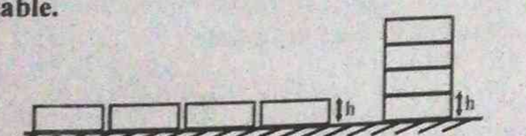
95. **The gravitational potential energy on the surface of the Earth is equal to:**
(A) mgh (C) 2mgh
(B) $\frac{1}{2}$ mgh (D) zero

96. **At a certain height an object has P.E = mgh. What will be its K.E just before hitting the ground:**
(A) mgh (C) 2mgh
(B) $\frac{1}{2}mv^2$ (D) zero

97. **Escape velocity from the surface of the Earth is given by:**
(A) $\sqrt{gR}$ (C) $\sqrt{2gR}$
(B) $2\sqrt{gR}$ (D) 2gR

98. **Which is the biggest unit of energy:**
(A) erg (C) watt hour
(B) joule (D) kilowatt hour

99. **Initially, four identical uniform blocks, each of mass "m" and thickness "h", are spread on a table.**



How much work is done on the blocks in stacking them on top of one another?
(A) 2mgh (C) 4mgh
(B) 3mgh (D) 6mgh

100. **When the velocity of the body is doubled and the mass is halved the K.E will be:**
(A) unchanged (C) halved
(B) doubled (D) four times

101. **A projectile is fired straight upward from Earth's surface with a speed that is half the escape speed. If "R" is the radius of Earth, the highest altitude reached, measured from the surface, is:**
(A) R/4 (C) R/3
(B) R/2 (D) R

102. **A mass of 10 g moving with velocity of 100 cm/s strikes a pendulum bob of mass 10 g. The two masses stick together. The maximum height reached by the system now is ($g = 10\ m/s^2$):**
(A) zero (C) 5 cm
(B) 2.5 cm (D) 1.25 cm

103. **A car moving with a speed of 50 km/h can be stopped by brakes after at least 6 m. If the same car is moving at a speed of 100 km/h the minimum stopping distance is:**
(A) 6 m (C) 18 m
(B) 12 m (D) 24 m

104. **As we move up a body, above the surface of Earth, the change in potential energy will always be:**
(A) negative (C) positive
(B) zero (D) infinity

105. **A body is moved along a straight line by a machine delivering a constant power. The distance moved by the body in time "t" is proportional to:**
(A) $t^{1/2}$ (C) $t^{3/2}$
(B) $t^{3/4}$ (D) $t^{1/4}$

106. **The ratio of dimensions of K.E. and power is:**
(A) 1:1 (C) T:1
(B) 1:T (D) M:T

107. **A ball of mass 2 kg and another of mass 4 kg are dropped together from a 60m tall building. After a fall of 30 m each towards Earth, their respective kinetic energies will be in the ratio of:**
(A) 1 : 4 (C) $1:\sqrt{2}$
(B) 1 : 2 (D) $\sqrt{2}:1$

108. **K.E is defined as dot product of:**
(A) momentum and force
(B) average momentum and velocity
(C) force and velocity
(D) all of these

109. **Absolute gravitational P.E. of an object at infinite height w.r.t Earth is taken as:**
(A) negative (C) zero
(B) minimum (D) Positive

110. **Work done by the frictional force is always:**
(A) positive (C) negative
(B) zero (D) remains same

111. A particle of mass "m_1" is moving with a velocity "v_1" and another particle of mass "m_2" is moving with a velocity "v_2". Both of them have the same momentum but their different kinetic energies are "E_1" and "E_2" respectively. If $m_1 > m_2$ then:
(A) $\frac{E_1}{E_2} = \frac{m_1}{m_2}$ (C) $E_1 = E_2$
(B) $E_1 > E_2$ (D) $E_1 < E_2$

112. A stone is thrown up from the surface of the Earth when it reaches at maximum height, its K.E. is equal to:
(A) mgh (C) $\frac{1}{2}mv^2$
(B) zero (D) 2mgh

113. Which of the following pairs does not have identical dimensions?
(A) momentum and impulse
(B) mass and moment of inertia
(C) energy and work
(D) torque and energy

114. A body of mass 2kg moving having momentum and velocity 8 Ns and $4ms^{-1}$ respectively. Its K.E. equal to:
(A) 16 J (C) 8 J
(B) 32 J (D) 2 J

115. A pump motor is used to deliver water at a certain rate from a given pipe. To obtain thrice as much as water from the same pipe in the same time, power of the motor has been increased:
(A) 3 times (C) 27 times
(B) 9 times (D) 81 times

116. Work done in moving a body along a closed path in a conservative field is:
(A) Fd (C) −mgh
(B) zero (D) mgh

117. A 2m tall man standing at the top of 30m tall tower raises a 1kg mass 0.5 m above his head. The P.E. of the raise mass will be (taking head as reference point): ($g = 10m/s^2$)
(A) 5 J (C) 25 J
(B) 320 J (D) All of these

118. If by some means, the diameter of Earth increases to 4 times. The escape velocity will become/remains:
(A) same (C) double
(B) half (D) one-fourth

119. A bomb of mass 12 kg at rest explodes into two pieces of masses 4 kg and 8 kg, the velocity of mass 8kg is 5 m/s. the kinetic energy of mass 4 kg is:
(A) 100 J (C) 200 J
(B) 150 J (D) 192 J

120. If mass of moving body is doubled its K.E. becomes:
(A) 2 times (C) 4 times
(B) 5 times (D) 16 times

121. Escape velocity of a body of mass 1000 kg is 1.1 km s^{-1}. If the mass of the body is doubled then its escape velocity will be:
(A) 5.5 kms^{-1} (C) 11 kms^{-1}
(B) 22 kms^{-1} (D) 44 kms^{-1}

122. Escape velocity on the surface of Earth is 11.2 kms^{-1}, the escape velocity on the surface of another planet of same mass as that of Earth but of ¼ times of the radius of Earth is:
(A) 5.6 kms^{-1} (C) 11.2 kms^{-1}
(B) 22.4 kms^{-1} (D) 44.8 kms^{-1}

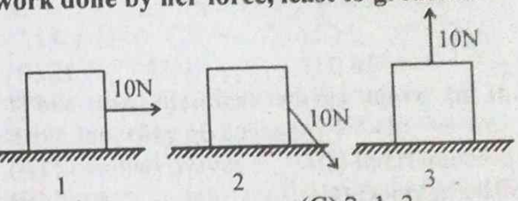
123. If momentum of body decreased by 20%, then the percentage decrease in kinetic energy is:
(A) 19 % (C) 36 %
(B) 21 % (D) 42 %

124. 3 joules of work is done in 3 seconds, then power is:
(A) 6 watt (C) 3 watt
(B) 18 watt (D) 1 watt

125. Potential energy per unit volume is given by:
(A) mgh (C) gh
(B) $\frac{mgh}{\rho}$ (D) ρgh

126. The K.E. of bullet of mass 500g moving at a speed of 200 ms^{-1} is:
(A) 250 J (C) 125 J
(B) 2500 J (D) 10000 J

127. A crate moves 10m to the right on a horizontal surface as a woman pulls on it with a 10 N force. Rank the situations shown below according to the work done by her force, least to greatest.



(A) 3, 2, 1 (C) 2, 1, 3
(B) 2, 3, 1 (D) 1, 3, 2

128. The work done by gravity during the descent of a projectile:
(A) is positive
(B) is negative
(C) is zero
(D) depends for its sign on the direction of the y axis

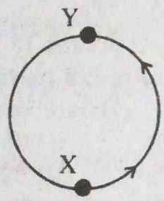
129. kinetic energy of a body on Earth moving with speed "v" to that of the same body moving with speed "v" on the moon is:
(A) 6:1 (C) 36:1
(B) 1:1 (D) 1:6

130. The amount of work required to stop a moving object is equal to:
(A) the velocity of the object
(B) the kinetic energy of the object
(C) the mass of the object times its acceleration
(D) the mass of the object times its velocity

131. 5.0 kg cart is moving horizontally at 6.0m/s. In order to change its speed to 10.0m/s, the net work done on the cart must be:
(A) 40 J (C) 90 J
(B) 160 J (D) 400 J

132. 4 kg cart starts up an incline with a speed of 3m/s and comes to rest 2m up the incline. The total work done on the car is:
(A) 6 J (C) 8 J
(B) 12 J (D) 18 J

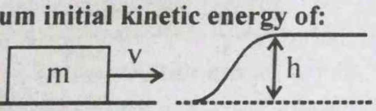
133. A man moves the 10 g object shown in a vertical plane from position "X" to position "Y" along a circular track of radius 20 m. The process takes 0.75 min. The work done by the man is about: ($g = 10 m/s^2$)



(A) 1 J (C) 2 J
(B) 4 J (D) 6 J

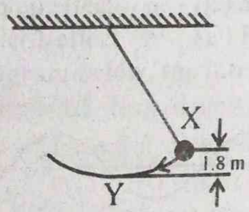
134. Which one of the following quantities CANNOT be used as a unit of potential energy?
(A) watt second (C) $g\ cm/s^2$
(B) $kg\ m^2/s^2$ (D) ft lb

135. For a block of mass "m" to slide without friction up the rise of height "h" shown, it must have a minimum initial kinetic energy of:



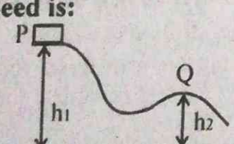
(A) mgh (C) zero
(B) $\frac{mgh}{2}$ (D) 2mgh

136. A simple pendulum consists of a 2.0 kg mass attached to a string. It is released from rest at "X" as shown. Its speed at the lowest point "Y" is about:



(A) 0.90 m/s (C) 36 m/s
(B) 3.6 m/s (D) 6.0 m/s

137. A block is released from rest at point "P" and slides along the frictionless track shown. At point "Q", its speed is:



Ground level

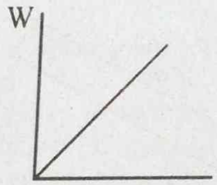
(A) $2g\sqrt{h_1 - h_2}$ (C) $2g(h_1 - h_2)$
(B) $2gm(h_1 - h_2)$ (D) $\sqrt{2g(h_1 - h_2)}$

138. A car of mass "m" has an engine which can deliver power "P". what is the minimum time in which the car can be accelerated from rest to a speed "v":
(A) $\frac{mv}{P}$ (C) $\frac{P}{mv}$
(B) $\frac{mv^2}{2P}$ (D) $\frac{2P}{mv^2}$

139. An electric motor is required to haul a cage of mass 400 kg up a mine shaft through a vertical height of 1200 m in 2 minutes. What will be the electrical power required if the overall efficiency is 80%? ($g = 10 ms^{-2}$)
(A) 3.2 kW (C) 5 kW
(B) 32 kW (D) 50 kW

UNIT 03 WORK, ENERGY AND POWER (SOLUTIONS)

01. (B)



Slope of W-t graph $= \frac{W}{t} =$ Power

02. (B)

By work energy principle:
"Work done on a body equals the change in its kinetic energy and change in potential energy of the body."
Work done = ΔK.E. + ΔP.E.

03. (C)

$$v_{esc} = \sqrt{\frac{2GM}{R}} = \sqrt{2gR}$$

From these relations the escape velocity is independent of mass of object and the angle at which it is thrown.

04. (A)

$$P.E = W_{P\to Q} + W_{Q\to R}$$
$$P.E = mgh\cos 180^\circ + mgh\cos 90^\circ$$
$$= -mgh + 0 = -mgh = -(4)(30) = -120J$$

–ve sign indicates that the work is being done against the force of gravity.

05. (D)

$$P = mv \Rightarrow P \propto v$$
$$K.E = \frac{1}{2}mv^2 \Rightarrow K.E. \propto v^2$$

06. (D)

$$1 MWh = 10^6 \times 3600 \text{ watt s}$$
$$1 MWh = 36 \times 10^8 J$$

07. (A)

Frictional force is a non conservative force.

08. (C)

$$v_{esc} = \sqrt{\frac{2GM}{R}} \quad \text{and} \quad v_o = \sqrt{\frac{GM}{R}}$$

$$\frac{v_{esc}}{v_o} = \frac{\sqrt{\frac{2GM}{R}}}{\sqrt{\frac{GM}{R}}} = \sqrt{2} \Rightarrow v_{esc} = \sqrt{2}v_o$$

09. (C)

When an arrow is thrown from its bow, the elastic P.E. of the bow is transferred to arrow as its K.E.

10. (C)

$W_{man} = mgh = (40)(10)(1) = 400\ J$

$P = \frac{W_{man}}{t} = \frac{400}{10} = 40$ watt

$W_{child} = mgh = (10)(10)(1) = 100\ J$

$P = \frac{W_{child}}{t} = \frac{100}{1} = 100$ watt

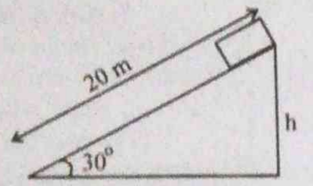
11. (D)

$W_{horizontal} = mgh\cos 90° = 0$

$W_{vertical} = mgh = (1)(9.8)(10) = 98\ J$

$W_{total} = W_{horizontal} + W_{vertical} = 0 + 98 = 98\ J$

12. (D)



$\frac{h}{20} = \sin 30° \Rightarrow h = 20 \sin 30° = 20(0.5) = 10$ m

By law of conservation of energy

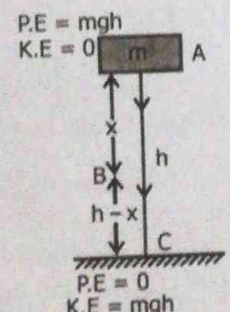
Gain in K.E = loss in Gravitational P.E

$\frac{1}{2}mv^2 = mgh$

$v^2 = 2gh$

$v = \sqrt{2gh} = \sqrt{2(10)(10)} = 10\sqrt{2} = 10\ (1.4) = 14$ m/s

13. (C)



$E_A = E_B = E_C = mgh$ (by conservation of energy)

14. (B)

$h = (15)(40)$ cm $= 600$ cm $= 6$m

$P = \frac{mgh}{t} = \frac{(500)(6)}{5} = 600$ watt

$(W = mg = 500N)$

15. (A)

$P = \frac{(2400)(10)(74.6)}{300}$ watt $= \frac{(2400)(10)(74.6)}{(300)(746)}$ hp

$= 8$ hp (1hp = 746 watt)

16. (A)

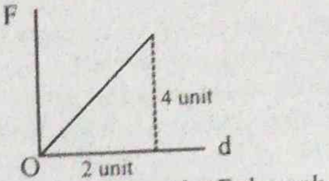
$W = \vec{F_c}.\vec{d}$

$W = F_c d\cos\theta = F_c d \cos 90° = Fd\ (0) = 0$

Due to centripetal force the object will move in a circular path. In the circular path, the centripetal force "$\vec{F_c}$" is perpendicular to velocity "$\vec{v}$".

As the displacement "$\vec{d}$" is parallel to the velocity "$\vec{v}$". So the angle between the displacement "$\vec{d}$" and the centripetal force "$\vec{F_c}$" is 90°.

17. (B)



Work done = area under F-d graph

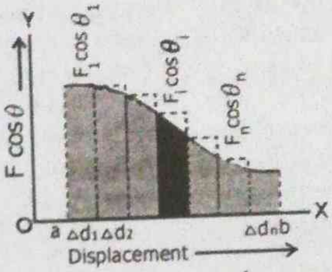
$= \frac{1}{2}(2)(4) = 4$ units

18. (D)

Body covers 5 m distance under the influence of 4 N force. So,

$W = Fd = (4)(5) = 20\ J$

19. (A)



To get more accurate result, we divide the total displacement into a very large number of intervals such that $\Delta d \rightarrow 0$.

$W_{total} = \lim_{\Delta d \rightarrow 0} \sum_{i=1}^{n} (F_i \Delta d_i \cos\theta_i)$

So, the work done by a variable force in moving a particle between two points is equal to the area under "F cosθ" and "d" graph.

20. (C)

i. The field in which work done on a body does not depend on the path followed by the body is called conservative field.

ii. The field in which work done in a closed path is zero is called conservative field.

21. (C)

$K.E. = \frac{1}{2}mv^2 = \frac{m^2v^2}{2m} = \frac{p^2}{2m} \Rightarrow K.E \propto \frac{1}{m}$

(For same momentum)

$\frac{K.E_A}{K.E_B} = \frac{m_B}{m_A} = \frac{m_B}{m_B/2} = 2 \Rightarrow K.E_A = 2K.E_B$

$(m_A = m_B/2)$

22. (A)

$W = \vec{F_c}.\vec{d}$

$W = F_c d\cos\theta = F_c d \cos 90° = Fd\ (0) = 0$

Due to centripetal force the stone will move in a circular path. In the circular path, the centripetal force "$\vec{F_c}$" is perpendicular to velocity "$\vec{v}$".

As the displacement "$\vec{d}$" is parallel to the velocity

"$\vec{v}$". So the angle between the displacement "$\vec{d}$" and the centripetal force "$\vec{F}_c$" is 90°.

23. (D)

The work will be positive if $\theta < 90^\circ$ and its value will be maximum if the displacement is in the direction of force.

$W = Fd\cos\theta$ (positive)

24. (B)

Gain in K.E = Loss in Gravitational P.E

$K.E = mg(h_1 - h_2)$

$= (1)(9.8)(50 - 40) = 9.8(10) = 98\ J$

25. (B)

$K.E = \frac{1}{2}Mv^2$

The K.E will be maximum when the product of "M" and "v^2" is maximum. In (B) the product have maximum value.

26. (D)

i. The scalar product of force and displacement is called work".

$W = \vec{F}.\vec{d}$

ii. Work = (component of force in the direction of displacement)×(magnitude of displacement)

$W = (F\cos\theta)(d)$

27. (B)

1 hp = 746 watt = 746000 mwatt

28.(D)

By work energy principle

$Work = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 = \frac{1}{2}m(v_f^2 - v_i^2)$

Work done will be positive when magnitude of $v_f > v_i$.

29. (B)

Work done on a body equals the change in its kinetic energy.

Work = ΔK.E = change in K.E.

30. (D)

By work energy principle

$\frac{W_1}{W_2} = \frac{K.E_1}{K.E_2} \Rightarrow \frac{Fd_1}{Fd_2} = \frac{K.E_1}{K.E_2}$

$\frac{d_1}{d_2} = 1$ (for same force and K.E)

31. (C)

$P.E = mgh$

$500 = (2)(10)h \Rightarrow h = \frac{500}{20} = 25\ m$

32. (C)

$P.E = mgh$

$P.E = (15)(10)(10) = 1500\ J$

33. (D)

When a body is placed at certain height with respect to Earth, then its speed, velocity and momentum is zero but it has gravitational potential energy.

34. (C)

$\rho = \frac{m}{V} \Rightarrow m = \rho V = (1000)(1\times1\times1) = 1000\ kg$

$W = P.E. = mgh = (1000)(10)(1) = 10000\ J$

35. (A)

$W = \vec{F}.\vec{S}$

$0 = (6\hat{i} + 2\hat{j} - 3\hat{k}).(2\hat{i} - 3\hat{j} + x\hat{k})$

$0 = 12 - 6 - 3x$

$3x = 6$

$x = 2$

36. (A)

$K.E. = \frac{1}{2}mv^2 = \frac{m^2v^2}{2m} = \frac{P^2}{2m} = \frac{2^2}{2(2)} = 1J$

37. (B)

$K.E. = \frac{1}{2}mv^2 = \frac{m^2v^2}{2m} = \frac{P^2}{2m}$

$P^2 = 2mK.E.$

$P = \sqrt{2mK.E.}$

$P \propto \sqrt{m}$

$\frac{P_1}{P_2} = \sqrt{\frac{m_1}{m_2}} = \sqrt{\frac{4}{1}} = 2:1$

38. (C)

$Fd = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 = \frac{1}{2}m(v_f^2 - v_i^2)$

$Fd = -\frac{1}{2}mv_i^2$ $(v_f = 0)$

$d = -\frac{mvi^2}{2F}$

for same car

$d \propto v_i^2$

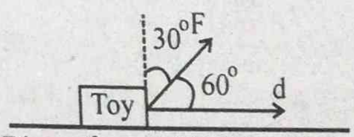
$\frac{d_2}{d_1} = \frac{v_2^2}{v_1^2} = \frac{80^2}{40^2} = 4 \Rightarrow d_2 = 4d_1 = 4(2) = 8m$

39. (C)

$W = \vec{F}.\vec{S}$

$W = (-2\hat{i} + 15\hat{j} + 6\hat{k}).(10\hat{j}) = (15)(10) = 150\ J$

40. (B)



$W = Fd\cos60^\circ = (10)(2)(0.5) = 10\ J$

41. (C)

$P = Fv = mgv = (100)(10)(5) = 5000\ watt = 5\ kW$

42. (C)

$P = \frac{P.E.}{t} = \frac{mgh}{t} = \frac{(60)(10)(10)}{20} = 300\ watt$

43. (A)

$W = F_g d\cos180^\circ = -mgh = -(5)(10)(1.5) = -75\ J$

44. (C)

$Work\ done = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$

$= \frac{1}{2}(50)(20^2 - 0^2) = 25(400)\ 10000\ J$

45. (C)

Work done (from d=0 to d=1) = Area of triangle

$= \frac{1}{2}(1)(4) = 2$ J

46. (A)

Work done by gravitational force, W = mgh

$= (\rho V)gh = \left(\frac{4}{3}\pi r^3\right)\rho gh \Rightarrow W \propto r^3$

47. (C)

After the impact the 25% of energy is lost while 75% of its initial energy is left behind.

$P.E_2 = 0.75P.E_1$

$mgh_2 = 0.75mgh_1$

$h_2 = 0.75h_1 = 0.75(12) = 9$ m

48. (B)

By law of conservation of energy

$\frac{1}{2}mv^2 = mgh$

$v^2 = 2gh$

$v = \sqrt{2gh} \Rightarrow v \propto \sqrt{h}$

$\frac{v_1}{v_2} = \sqrt{\frac{h_1}{h_2}} = \sqrt{\frac{5}{1.8}} = \sqrt{\frac{100}{36}} = \frac{10}{6} = \frac{5}{3}$

$v_1 = \frac{3}{5}v_2$

loss in velocity on bouncing $= 1 - \frac{3}{5} = \frac{2}{5}$

49. (D)

By work energy principle

Work = K.E

$Fd\cos\theta = K.E$

$\cos\theta = \frac{K.E}{Fd} = \frac{40}{(20)(4)} = \frac{1}{2}$

$\theta = \cos^{-1}(1/2) = 60°$

50. (D)

$500 \text{ watt} = \frac{500J}{s} = \frac{500\times 60J}{min} = 30000 \text{ J min}^{-1} = 30$ kJ

51. (D)

$K.E_1 = \frac{1}{2}mv^2 = \frac{m^2v^2}{2m} = \frac{P^2}{2m}$

$K.E_2 = \frac{\left(P + \frac{10P}{100}\right)^2}{2m} = (1.1)^2\frac{P^2}{2m} = 1.2K.E_1$

$\Delta K.E. = K.E_2 - K.E_1 = 1.2\,K.E_1 - K.E_1 = 0.2\,K.E_1$

%age $\Delta K.E = \frac{\Delta K.E.}{K.E_1} \times 100\% = 0.20\times 100\% = 20\%$

52. (A)

$P = Fv = mav = m\frac{v}{t}v = \frac{mv^2}{t}$

53. (A)

According to work energy principle

Acquired K.E = Work done = Fd = (4)(2) = 8 J

54. (D)

By conservation of linear momentum

Total initial momentum = Total final momentum

$0 = m_1v_1 + m_2v_2$

$0 = (6)v_1 + (4)(12)$

$v_1 = -\frac{48}{6} = -8$ m/s

$K.E. = \frac{1}{2}m_1v_1^2 = \frac{1}{2}(6)(-8)^2 = 192$ J

55. (C)

$K.E. = \frac{1}{2}mv^2 = \frac{m^2v^2}{2m} = \frac{P^2}{2m}$

For same momentum

$K.E. \propto \frac{1}{m}$

$\frac{K.E_1}{K.E_2} = \frac{m_2}{m_1} = \frac{2}{1} = 2:1$

56. (D)

$P = \frac{mgh}{t} = \frac{(250)(10)(2)}{2.5} = 500(4) = 2000$ watt

57. (C)

In freely falling motion, objects of different mass move with same gravitational acceleration (g = 9.8 m/s).

58. (D)

$\Delta K.E = \frac{1}{2}m(v_f^2 - v_i^2)$

$= \frac{1}{2}(1)(2^2 - 6^2) = 0.5(-32) = -16J$

(–ve sign indicates that K.E will reduce)

59. (C)

By law of conservation of energy

Gain in K.E = loss in P.E

$\frac{1}{2}mv^2 = \frac{mgh}{2}$

$v^2 = gh$

$v = \sqrt{gh}$

60. (A)

$P = \frac{W}{t}$

$W = Pt = (1000\text{ W})(1s) = 10^3$ J (Ws = J)

61. (B)

K.E = P

$\frac{1}{2}mv^2 = mv$

v = 2 m/s

$K.E = \frac{1}{2}m(2)^2 = 2m$

P = mv = m(2) = 2m

62. (D)

$P = \frac{mgh}{t} = \left(\frac{m}{t}\right)gh$

$\frac{m}{t} = \frac{P}{gh} = \frac{10^6}{(10)(20)} = 5000$ kg/s

63. (D)

By law of conservation of linear momentum

Total initial momentum = Total final momentum

mv = mv' + Mv'

mv = (m + M)v'

$v' = \frac{mv}{M+m}$

$K.E. = \frac{1}{2}(M+m)\left(\frac{mv}{M+m}\right)^2$

$$K.E. = \frac{1}{2}\left(\frac{m^2v^2}{M+m}\right)$$

64. (D)

Work = (component of force in the direction of displacement)×(magnitude of displacement)

$W = (F\cos\theta)(d)$

65. (D)

$$\frac{P_X}{P_Y} = \frac{\frac{m_X gh}{t_x}}{\frac{m_Y gh}{t_Y}} = \frac{m_X}{m_Y} \times \frac{t_Y}{t_X} = \frac{75}{60} \times \frac{12}{15} = 1$$

66. (B)

$$v_{esc} = \sqrt{\frac{2GM}{R}} = \sqrt{2gR}$$

From these relations the escape velocity is independent of mass of object.

67. (B)

$$K.E = \frac{1}{2}m\vec{v}.\vec{v} = \frac{1}{2}(0.1)(2\hat{i} + 4\hat{j}).(2\hat{i} + 4\hat{j})$$

$$= \frac{1}{2}(0.1)(4+16) = \frac{1}{2}(0.1)(20) = 1 \text{ J}$$

68. (D)

Energy is a scalar quantity. So, its magnitude can never be negative.

69. (D)

Consumption of Energy (W) = Pt = (60)(2) = 120 J

70. (D)

$$P = mv \Rightarrow v = \frac{P}{m} = \frac{10}{5} = 2 \text{ m/s}$$

$$a = \frac{F}{m} = \frac{0.5}{5} = 0.1 \text{ m/s}^2$$

$$S = vt + \frac{1}{2}at^2 = (2)(10) + \frac{1}{2}(0.1)(10)^2$$

$$= 20 + \frac{1}{2}(0.1)(100) = 20 + 5 = 25\text{m}$$

By work energy principle

$\Delta K.E$ = work done

$\Delta K.E = FS = (0.5)(25) = 12.5$ J

71. (B)

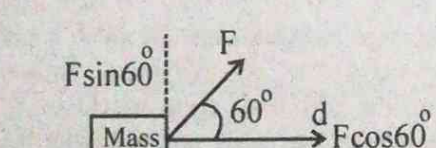
The velocity at highest point is

$v = v_x = v\cos\theta$

$$K.E = \frac{1}{2}mv_x^2 = \frac{1}{2}mv^2\cos^2\theta = E(\cos 45^\circ)^2$$

$= E(1/2) = E/2$ $\quad (E = ½ mv^2)$

72. (A)



The effective component of force is that which is in the direction of displacement.

Effective component = $F\cos 60^\circ = 0.5$ F

73. (B)

It takes about 9×10^9J to make a car and the car then uses about 1×10^{12}J of energy from petrol in its life time.

74. (B)

$$K.E. = \frac{1}{2}mv^2 = \frac{m^2v^2}{2m} = \frac{P^2}{2m}$$

For same momentum

$$K.E. \propto \frac{1}{m}$$

$m_e < m_p < m_n < m_\alpha$

$K.E_e > K.E_p > K.E_n > K.E_\alpha$

75. (C)

$W = Fd\cos\theta$

So, Work is independent of time.

76. (A)

By law of conservation of energy

Gain in K.E = Loss in P.E

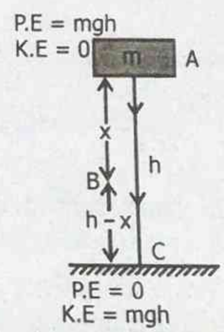
K.E = mgh = (40)(10) = 400 J

(F=mg)

77. (C)

P.E = mgh = (50)(10)(1) = 500 J

78. (C)



Gain in K.E = Loss in P.E

K.E = mg (h − x)

79. (A)

By work energy prinpciple

Work done = $\Delta K.E + \Delta P.E$

In case of horizontal motion $\Delta P.E = 0$

Work done = $\Delta K.E$

80. (C)

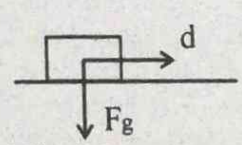
$$P = \frac{mgh}{t} = \frac{(1000)(10)}{10} = 1000 \text{ W}$$

81. (B)

$$K.E. = \frac{1}{2}mv^2 = \frac{m^2v^2}{2m} = \frac{P^2}{2m}$$

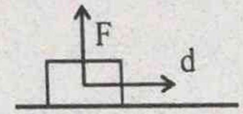
$K.E. \propto P^2$

82. (C)



$W = F_g d\cos 90^\circ = 0$ J

83. (B)



$W = Fd\cos\theta$

If $\theta = 90^\circ$

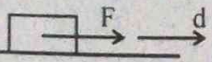
$W = Fd\cos 90^\circ = 0$ J

84. (B)

$W = Fd$

$[W] = [MLT^{-2}][L] = [ML^2T^{-2}]$

85. (B)



$W = Fd\cos\theta$
If $\theta = 0^o$
$W = Fd\cos 0^o = Fd$ (maximum)

86. (B)

$W = \vec{F_c}.\vec{d}$
$W = F_c d\cos\theta = F_c d\cos 90^o = Fd(0) = 0$
Due to centripetal force the object will move in a circular path. In the circular path, the centripetal force "$\vec{F_c}$" is perpendicular to displacement "$\vec{d}$".

87. (C)

$$\text{Intensity} = \frac{\text{energy}}{\text{time} \times \text{area}} = \frac{J}{s \times m^2} = Wm^{-2}$$

88. (B)

$= P.E. = mgh = (2)(9.8)(2) = 39.2\ J$

89. (B)

$$P = \frac{W}{t}$$

$$[P] = \frac{[W]}{[t]} = \frac{[ML^2T^{-2}]}{[T]} = [ML^2T^{-3}]$$

90. (B)

If a body do equal work in equal interval of time, then its work done is said to be in uniform rate. So,
$$P_{avg} = P_{Ins}$$

91. (A)

Work done by a body in one second is known as power.
$P = 1kW = 1000\ W = 1000\ Js^{-1}$
$= 1000$ J work in one second

92. (C)

$$P = \frac{\Delta W}{\Delta t} = \frac{\vec{F}.\Delta\vec{d}}{\Delta t} = \vec{F}.\frac{\Delta\vec{d}}{\Delta t} = \vec{F}.\vec{v}$$

93. (D)

One kilowatt hour is the work done (energy) in one hour by an agency whose power is one kilowatt.
$1kWh = (1000\ \text{watt}) \times (3600\ s)$
$1kWh = 3600000\ \text{watt s} = 3.6 \times 10^6\ J = 3.6\ MJ$

94. (B)

$$K.E = \frac{1}{2}mv^2$$
$K.E \propto v^2$

95. (D)

$P.E = mgh$
If reference point on the surface of Earth
$h = 0$
$P.E.\ mg(0) = 0$

96. (A)

By law of conservation of energy
Gain in K.E = Loss in P.E
Gain in K.E = mgh

97. (C)

$$v_{esc} = \sqrt{\frac{2GM}{R}} = \sqrt{2gR}$$

The value of v_{esc} for Earth comes out to be approximately $11\ kms^{-1}$.

98. (D)

$1kWh = 3.6 \times 10^6\ J$
$1erg = 10^{-7}\ J$
$1Wh = 3.6 \times 10^3\ J$
$1kWh > 1Wh > 1J > 1erg$

99. (D)

$W = 0 + mgh + mg(2h) + mg(3h) = 6mgh$

100. (B)

$$K.E = \frac{1}{2}mv^2$$

$$(K.E)' = \frac{1}{2}\left(\frac{m}{2}\right)(2v)^2 = \frac{1}{2}\left(\frac{m}{2}\right)4v^2 = 2\left(\frac{1}{2}mv^2\right) = 2\ (K.E)$$

101. (A)

Gain in P.E = Loss in K.E

$$mgh = \frac{1}{2}mv^2$$

$$gh = \frac{1}{2}v^2$$

$$gh = \frac{1}{2}\left(\frac{v_{esc}}{2}\right)^2 = \frac{1}{2}\left(\frac{v_{esc}^2}{4}\right) = \frac{1}{2}\left(\frac{2gR}{4}\right)$$

$(v_{esc} = \sqrt{2gR})$

$$h = \frac{R}{4}$$

102. (B)

Gain in P.E = Loss in K.E

$$(2m)gh = \frac{1}{2}mv^2 \qquad (m + m = 2m)$$

$$h = \frac{v^2}{4g} = \frac{1^2}{4(10)} = 0.025\ m = 2.5\ cm$$

103. (D)

$$Fd = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 = \frac{1}{2}m(v_f^2 - v_i^2)$$

$$Fd = -\frac{1}{2}mv_i^2 \qquad (v_f = 0)$$

$$d = -\frac{mvi^2}{2F}$$

for same car
$d \propto v_i^2$

$$\frac{d_2}{d_1} = \frac{v_2^2}{v_1^2} = \frac{100^2}{50^2} = 4 \Rightarrow d_2 = 4d_1 = 4(6) = 24m$$

104. (A)

$$U_g = -\frac{GMm}{R}$$

– ve sign indicates that the earth's gravitational field for mass "m" is attractive. When the distance from the centre of earth increases the gravitational force does –ve work and potential energy increases. (becomes less – ve).

105. (C)

$$P = Fv = mav = (m)\left(\frac{v}{t}\right)(v) = \frac{mv^2}{t} = \frac{m}{t}\left(\frac{d}{t}\right)^2 = \frac{md^2}{t^3}$$

$$d^2 = \frac{Pt^3}{m}$$

$d^2 \propto t^3 \Rightarrow d \propto t^{3/2}$

106. (C)

$$\frac{[K.E]}{[P]} = \frac{[ML^2T^{-2}]}{[ML^2T^{-3}]} = [T] : 1$$

107. (B)

By law of conservation of energy

Gain in K.E = Loss in P.E

K.E = mgh

$$\frac{(K.E)_1}{(K.E)_2} = \frac{m_1 g(h_1 - h_2)}{m_2 g(h_1 - h_2)} = \frac{m_1}{m_2} = \frac{2}{4} = \frac{1}{2} = 1:2$$

108. (B)

$$K.E = \frac{1}{2}mv^2 = \frac{1}{2}m\vec{v}.\vec{v} = \left(\frac{0 + m\vec{v}}{2}\right).\vec{v} = \vec{P}_{av}.\vec{v}$$

109. (C)

$$U_g = -\frac{GMm}{R}$$

At infinite height from center of Earth

$R = \infty$

$$U_g = -\frac{GMm}{\infty} = 0$$

110. (C)

Friction force always in opposite to the direction of motion. So, angle between frictional force and displacement is 180°.

$W = fd\cos 180^\circ = -fd$

111. (D)

$$E = \frac{1}{2}mv^2 = \frac{m^2v^2}{2m} = \frac{P^2}{2m}$$

For same momentum

$$E \propto \frac{1}{m}$$

As

$m_1 > m_2$

so, $E_1 < E_2$

112. (B)

At maximum height the velocity is zero. So, its kinetic energy will be zero.

113. (B)

Dimension of mass = [M]

Dimension of moment of inertia $= [I] = [m][r^2] = [ML^2]$

114. (A)

$$K.E = \frac{1}{2}mv^2 = \frac{1}{2}(mv)(v) = \frac{1}{2}Pv = \frac{1}{2}(8)(4) = 16\text{ J}$$

115. (A)

$$P = \frac{mgh}{t}$$

$P \propto m$ (for same height and time)

$$P' = \frac{3mgh}{t} = 3P \quad (m' = 3m)$$

116. (B)

"The field in which work done on a body does not depend on the path followed by the body is called conservative field".

OR

"The field in which work done in a closed path is zero is called conservative field".

117. (A)

$P.E = mgh = (1)(10)(0.5) = 5\text{ J}$

118. (B)

$$v_{esc} = \sqrt{2gR}$$

$$g = \frac{GM}{R^2}$$

When diameter of Earth increases to 4 times, then radius also increases to 4 times. (R' = 4R)

$$g' = \frac{GM}{(4R)^2} = \frac{GM}{16R^2} = \frac{g}{16}$$

$$v'_{esc} = \sqrt{2(g/16)(4R)} = \sqrt{\frac{2gR}{4}} = \frac{\sqrt{2gR}}{2} = \frac{v_{esc}}{2}$$

119. (C)

By conservation of linear momentum

Total initial momentum = Total final momentum

$0 = m_1v_1 + m_2v_2$

$0 = (4)v_1 + (8)(5)$

$$v_1 = -\frac{(8)(5)}{4} = -10\text{ m/s}$$

$$K.E. = \frac{1}{2}m_1v_1^2 = \frac{1}{2}(4)(-10)^2 = 200\text{ J}$$

120. (A)

$$K.E = \frac{1}{2}mv^2$$

$K.E \propto m$

121. (C)

$$v_{esc} = \sqrt{2gR}$$

It is independent to mass of a body.

122. (B)

$$v_{esc} = \sqrt{2gR}$$

$$g = \frac{GM}{R^2}$$

When radius of planet decreases to 4 times the radius of Earth. (R' = R/4)

$$g' = \frac{GM}{(R/4)^2} = \frac{16GM}{R^2} = 16g$$

$$v'_{esc} = \sqrt{2(16g)(R/4)} = \sqrt{2(4g)(R)} = 2\sqrt{2gR} = 2v_{esc}$$

$= 2(11.2) = 22.4$ km/s

123. (C)

$$K.E_1 = \frac{1}{2}mv^2 = \frac{m^2v^2}{2m} = \frac{P^2}{2m}$$

$$K.E_2 = \frac{\left(P - \frac{20P}{100}\right)^2}{2m} = (0.8)^2\frac{P^2}{2m} = 0.64K.E_1$$

Decrease in K.E. $= K.E_1 - K.E_2$

$= K.E_1 - 0.64K.E_1 = 0.36\,K.E_1$

$$\%\text{age decrease in K.E} = \frac{\text{decrease in K.E.}}{K.E_1} \times 100\%$$

$= 0.36 \times 100\% = 36\%$

124. (D)

$$P = \frac{W}{t} = \frac{3}{3} = 1\text{ W}$$

125. (D)

$$\frac{P.E}{V} = \frac{mgh}{V} = \rho gh$$

126. (D)

$K.E = \frac{1}{2}mv^2$

$= \frac{1}{2}(0.5)(200)^2 = \frac{1}{2}(0.5)(40000)$

$= \frac{1}{2}(20000) = 10000$ J

127. (A)

1. Force and displacement are parallel to each other. So, $\theta = 0^\circ$, $\cos 0^\circ = 1$
   $W_1 = Fd$
2. Force and displacement are making some angle "θ"
   $W_2 = Fd\cos\theta$
3. Force and displacement are perpendicular to each other. So, $\theta = 90^\circ$, $\cos 90^\circ = 0$
   $W_3 = 0$

$W_3 < W_2 < W_1$

128. (A)

During descent (downward motion) force of gravity and displacement are in the same direction.

So, $\theta = 0^\circ$, $\cos 0^\circ = 1$

$W = F_g d$ (+ve)

129. (B)

$\frac{(K.E)_E}{(K.E)_M} = \frac{\frac{1}{2}mv^2}{\frac{1}{2}mv^2} = 1:1$ (For same mass and speed)

130. (B)

By work energy prinpciple

Work done = ΔK.E

131. (B)

By work energy principle

Work $= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 = \frac{1}{2}m(v_f^2 - v_i^2)$

$= \frac{1}{2}(5)(10^2 - 6^2) = \frac{1}{2}(5)(64) = 160$ J

132. (D)

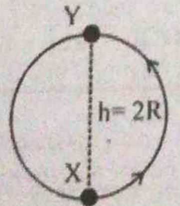
By work energy principle

Work $= \frac{1}{2}m(v_f^2 - v_i^2)$

$= \frac{1}{2}(4)(0^2 - 3^2) = (2)(-9) = -18$ J

–ve sign indicates that the loss in K.E which is converted into P.E.

133. (B)



From "X" to "Y" the displacement = 2(radius)

= 2(20m) = 40m

$W = mgh = (0.01)(10)(40) = 4$ J

134. (C)

All are the unit of energy except "gcms^{-2}". It is the unit of force in CGS system.

135. (A)

In upward motion

Loss in K.E = Gain in P.E

Initial K.E = mgh

136. (D)

Gain in K.E = Loss in P.E

$\frac{1}{2}mv^2 = mgh$

$v^2 = 2gh \Rightarrow v = \sqrt{2gh} = \sqrt{2(10)(1.8)} = \sqrt{36} = 6$ m/s

137. (D)

Gain in K.E = Loss in P.E

$\frac{1}{2}mv^2 = mg(h_1 - h_2)$

$v^2 = 2g(h_1 - h_2)$

$v = \sqrt{2g(h_1 - h_2)}$

138. (B)

Gain in K.E = Work done

$\frac{1}{2}mv^2 = W$

$\frac{1}{2}mv^2 = Pt \Rightarrow t = \frac{mv^2}{2P}$ (W = Pt)

139. (D)

Energy of motor = Gain in gravitational P.E

80%W = mgh

0.8(Pt) = mgh

0.8P(120) = (400)(10)(1200)

$P = \frac{(400)(10)(1200)}{(0.8)(120)}$

$= \frac{40000}{0.8} = 50000$ J = 50 kJ

UHS PAST MDCAT (2008-2019)

1. **100 joules work has been done by an agency in 10 seconds. What is power of agency? (UHS 2008)**

(A) 1000 watts
(B) 100 watts
(C) 10 watts
(D) 0.10 watts

(C)

$P = \frac{W}{t} = \frac{100}{10} = 10$ watts

2. **Work done on a body equal to change in its _____ energy? (UHS 2008)**

(A) Total
(B) Potential
(C) Kinetic
(D) All of these

(D)

By work energy principle

Work done = ΔK.E + ΔP.E = total energy

3. **The escape velocity corresponds to _____ energy gained by body, which carries it to an infinite distance from the surface of Earth? (UHS 2008)**

(A) Total
(B) Potential
(C) Initial kinetic
(D) None of these

(C)

If we want to lift a body of mass "m" from the surface of earth to infinity, the kinetic energy must be supplied to the body which is equal to increase in its P.E.

Initial K.E = Increase in P.E

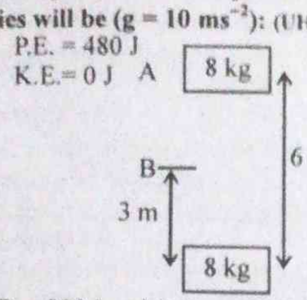
4. If a certain force acts on an object and changes its kinetic energy from 65 J to 130 J, then work done by the force will be? (UHS 2009)

(A) 92.5 J (C) 65 J
(B) 97.5 J (D) 130 J

(C)

Work done $= (K.E)_f - (K.E)_i = 130 - 65 = 65$ J

5. A body of mass 6 kg falls under action of gravity. At initial position "A" its P.E. is 480 J and K.E. is 0 J. During its downward journey at point "B" its energies will be ($g = 10\ ms^{-2}$): (UHS 2009)



(A) P.E. = 300 J and K.E. = 180 J
(B) P.E. = 180 J and K.E. = 300 J
(C) P.E. = 240 J and K.E. = 240 J
(D) P.E. = 250 J and K.E. = 230 J

(C)

At point "B"
P.E = mgh = (8)(3)(10) = 240 J
K.E = 480 − 240 = 240 J

6. If velocity is doubled, then: (UHS 2010)

(A) momentum increases 4 times and K.E. increases 2 times
(B) momentum and K.E. remain same
(C) momentum increases 2 times and K.E. remains constant
(D) momentum increases 2 times and K.E. increases 4 times

(D)

$P = mv \Rightarrow P \propto v$

$K.E = \frac{1}{2} mv^2 \Rightarrow K.E \propto v^2$

7. The consumption of energy by 60 watt bulb in 2 seconds is: (UHS 2010)

(A) 20 J (C) 30 J
(B) 120 J (D) 0.02 J

(B)

$P = \frac{W}{t} \Rightarrow W = Pt = (60)(2) = 120$ J

8. Which of the following is non-conservative force? (UHS 2010)

(A) Gravitational force (C) Elastic spring force
(B) Frictional force (D) Electric force

(B)

Frictional force is a non–conservative force. Work done against the frictional force depends upon the path followed.

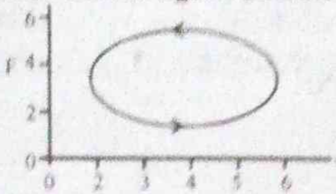
9. Value of escape velocity for the surface of the Earth is 11 km/s, its value for surface of Moon is: (UHS 2010)

(A) 11 km/s (C) 2.4 km/s
(B) 10.4 km/s (D) 4.3 km/s

(C)

The value of escape velocity for the surface of Moon is 2.4 km/s

10. Total work done in figure: (UHS 2017)



(A) 24 Nm (C) 8 Nm
(B) 16 Nm (D) Zero Nm

(D)

$W = \vec{F}.\vec{d}$

In closed path the displacement is zero. So,

$W = 0$

11. Work done will be zero if angle between Force and displacement is: (UHS 2017)

(A) 0° (C) 270°
(B) 60° (D) 360°

(C)

$W = \vec{F}.\vec{d} = Fd\cos\theta$

$W = \vec{F}.\vec{d} = Fd\cos 270° = 0$ ($\cos 270° = 0$)

12. If mass 'm' is dropped from height "h" vertically, "f" is the force of friction during downward motion and "v" is the velocity at bottom, following equation will be hold: (UHS 2017)

(A) $\frac{1}{2}mv^2 = mgh + fh$ (C) $fh = mgh + \frac{1}{2}mv^2$
(B) $mgh = \frac{1}{2}mv^2 - fh$ (D) $mgh = \frac{1}{2}mv^2 + fh$

(D)

If the frictional force is present during the downward motion, a part of P.E. is used in doing work against frictional force and is equal to "f h". The remaining P.E (mgh − f h) is converted into the K.E.

$$mgh - fh = \frac{1}{2}mv^2$$

$$mgh = \frac{1}{2}mv^2 + fh$$

13. The rate at which work is being done is called: (UHS 2018)

(A) Power (C) Density
(B) Energy (D) Force

(A)

The time rate at which work is being done is called power.

$$P = \frac{W}{t}$$

14. **Energy consumed by 60 watt bulb in 2 minutes is equal to: (UHS 2018)**
(A) 120 joules (C) 720 joules
(B) 72000 joules (D) 7.2 kJ

(D)

$$P = \frac{W}{t} \Rightarrow W = Pt = (60)(120) = 7200\ J$$

15. **A stone of mass 2.0 kg is dropped from a rest position 5.0 m above the ground. What is its velocity at a height of 3.0 m above the ground: (UHS 2018)**
(A) 16.0 m/s (C) 6.3 m/s
(B) 12.5 m/s (D) 9.3 m/s

(C)

Gain in K.E = Loss in P.E

$$\frac{1}{2}m(v_2^2 - v_1^2) = mg(h_1 - h_2)$$

$$v_2^2 - 0 = 2g(h_1 - h_2) \Rightarrow v = \sqrt{2g(h_1 - h_2)}$$

$$v = \sqrt{2(10)(2)} = 6.3\ m/s$$

16. **Which of the following is statement shows that no work is done: (UHS 2019)**
(A) Pushing a car to start it moving
(B) Writing an essay on a page
(C) Lifting the weight
(D) The Moon orbiting the Earth

(D)

$$W = \vec{F}.\vec{d}$$

In closed path (circular motion) the displacement is zero. So,

$$W = 0$$

17. **An automobile is moving forwards with uniform velocity due to the force exerted by its engine. If that force is double with the velocity remaining constant that happens to its total power? (UHS 2019)**
(A) it does not change (C) It is halved
(B) It is squared (D) It is doubled

(D)

$$P = \vec{F}.\vec{v} = Fv\cos\theta \Rightarrow P \propto v$$

UNIT 04 CIRCULAR MOTION

01. An electric motor of 12 horse power generates an angular velocity of 22 rad/s. What will be the frequency of rotation?

(A) $\frac{20}{\pi}$ (C) $\frac{10}{\pi}$

(B) 7/2 (D) 7/44

02. The ratio of angular speeds of seconds hand and hour hand of a watch is:

(A) 1 : 720 (C) 1 : 60

(B) 60 : 1 (D) 720 : 1

03. A body moves with constant angular velocity on a circle. Magnitude of angular acceleration is:

(A) $r\omega^2$ (C) zero

(B) constant (D) $r\omega$

04. A wheel having a diameter of 3 m starts from rest and accelerates uniformly to an angular velocity of 210 r.p.m. in 5 seconds. Angular acceleration of the wheel is:

(A) 4.4 rad s^{-2} (C) 2.2 rad s^{-2}

(B) 3.3 rad s^{-2} (D) 1.1 rad s^{-2}

05. If a particle moves in a circle describing equal angles in equal intervals of time, the velocity vector:

(A) remains constant.

(B) changes in magnitude only.

(C) changes in direction only

(D) changes both in magnitude and direction

06. Which of the following is an axial vector?

(A) Torque (C) Angular Velocity

(B) Angular Displacement (D) All of these

07. A particle of mass 1 kg is revolved in a horizontal circle of radius 1 m with the help of a string. If the maximum tension the string can withstand is $16\pi^2$ N, then the maximum frequency with which the particle can revolve is:

(A) 3 Hz (C) 4 Hz

(B) 2 Hz (D) 5 Hz

08. Angle between radius vector and centripetal acceleration is:

(A) 0° (C) 180°

(B) 90° (D) 45°

09. The angular displacement in circular motion is:

(A) dimensional quantity

(B) dimensionless quantity.

(C) unit less and dimensionless quantity

(D) unit less quantity.

10. A flywheel rotates at a constant speed of 3000 r.p.m. The angle described by the shaft in one second is:

(A) 3π rad (C) 100π rad

(B) 30π rad (D) 3000π rad

11. What is the angular speed of the seconds hand of a watch?

(A) 60 rad/s (C) $\pi/30$ rad/s

(B) π rad/s (D) 2 rad/s

12. A body of mass 100 g is revolving in a horizontal circle. If its frequency of rotation is 3.5 r.p.s. and radius of circular path is 0.5 m, the angular speed of the body is:

(A) 18 rad/s (C) 22 rad/s

(B) 20 rad/s (D) 24 rad/s

13. A wheel has circumference C. If it makes " f " r.p.s., the linear speed of a point on the circumference is:

(A) $2\pi fC$ (C) $fC/2\pi$

(B) fC (D) fC/60

14. A body is whirled in a horizontal circle of radius 20 cm. It has angular velocity of 10 rad/s. What is its linear velocity at any point on circular path?

(A) 10 m/s (C) 20 m/s

(B) 2 m/s (D) 2 m/s

15. A particle moves along a circular orbit with constant angular velocity. This necessarily means:

(A) its motion is confined to a single plane

(B) its motion is not confined to a single plane

(C) nothing can be said regarding the plane of motion.

(D) its motion is one–dimensional

16. A mass of 5 kg is tied to a string of length 1.0 m and is rotated in vertical circle with a uniform speed of 4 m/s. The tension in the string will be 130 N when the mass is at ($g = 10\ m/s^2$)

(A) highest point (C) bottom

(B) mid way (D) cannot be justified

17. A cane filled with water is revolved in a vertical circle of radius 4 m and water does not fall down. The time period of revolution will be:

(A) 2 s (C) 6 s

(B) 4 s (D) 8 s

18. A body travelling in a circular path at constant speed:

(A) Has a constant velocity

(B) is not accelerated

(C) has an inward acceleration

(D) has transverse acceleration

19. A satellite is revolving around the Earth in a circular orbit of radius R. Its period of revolution varies as:

(A) R^2 (C) R

(B) $R^{3/2}$ (D) $R^{1/2}$

20. Two satellites of mass "M" and "3M" are revolving around the Earth in circular orbits of radii "3R" and "R" respectively. What is the ratio of their speeds?

(A) 3:1 (C) $1:\sqrt{3}$

(B) $\sqrt{3}:1$ (D) 1:1

21. On Earth, weight of an object is maximum at:

(A) Equator (C) Center of Earth

(B) Poles (D) At the surface of Earth

22. Which of the following is not directed along the axis of rotation?

(A) angular displacement

(B) centripetal acceleration

(C) angular momentum
(D) Angular acceleration

23. The direction of ______ can be found by right hand rule.
(A) angular displacement (C) angular acceleration
(B) angular velocity (D) all of these

24. A pedestal fan is rotating anticlockwise. When the electric power is cut off, its speed steadily decreases to zero. Its angular acceleration will be directed:
(A) upward (C) away from us
(B) downward (D) towards us

25. The angular velocity of the minute's hand of the watch is:
(A) 2π rads^{-1} (C) $\pi/30$ rads^{-1}
(B) $\pi/1800$ rads^{-1} (D) 3600π rads^{-1}

26. The angular velocity of a body moving along a circular path can be manipulated as a scalar if:
(A) angular speed is slow
(B) axis of rotation is fixed
(C) mass of body is very light
(D) Both "A" and "B"

27. The time rate of change of angular displacement is called:
(A) linear velocity (C) linear speed
(B) angular velocity (D) angular speed

28. In which case angular work is being done:
(A) if angular velocity is increased
(B) if angular velocity is decreased
(C) if radius is decreased
(D) Both "A" and "B"

29. Angular velocity has same dimensions as that of:
(A) angular displacement (C) frequency
(B) linear acceleration (D) linear velocity

30. Equations of angular motion are useful only when the axis of rotation is:
(A) constantly varying (C) along the x–axis
(B) fixed (D) not stable

31. For very small values of $\Delta\theta$, the angular displacement is:
(A) base quantity (C) vector quantity
(B) supplementary quantity (D) scalar quantity

32. A particle moves in a circle of radius "r". After half revolution, its displacement and distance are:
(A) "πr" and "2r" respectively
(B) equal to each other
(C) "0" and "πr" respectively
(D) "2r" and "πr" respectively

33. A flywheel at rest is to reach an angular velocity of 36 rads^{-1} in 6 second, with a constant angular acceleration. The total angle turned through during this interval is:
(A) 216 rad (C) 144 rad
(B) 108 rad (D) 72 rad

34. Identify the increasing order of the angular velocities of the following:
(I) Earth rotating about its own axis
(II) hour's hand of a clock
(III) second's hand of a clock
(A) I, II, III (C) II, III, I
(B) III, I, II (D) III, II, I

35. The angle between angular acceleration and centripetal acceleration is:
(A) 0^0 (C) 180^0
(B) 90^0 (D) 360^o

36. A body of mass 2kg is moving in a circle of radius 3m with velocity 6ms^{-1}. Its centripetal acceleration is:
(A) 24 ms^{-2} (C) 12 ms^{-2}
(B) 36 ms^{-2} (D) 18 ms^{-2}

37. An electric fan rotating with 3 revs^{-1} is switched off. It comes to rest in 2 seconds having a constant deceleration of 1 revs^{-2}. How many revolutions did it turn before coming to rest?
(A) 6 revolutions (C) 2 revolutions
(B) 8 revolutions (D) 10 revolutions

38. Conventionally the angular velocity is directed at an angle of:
(A) 90^o to the axis of rotation
(B) 30^o to the axis of rotation
(C) 0^o to the axis of rotation
(D) Along the radius

39. The satellites are held in orbits:
(A) by rockets
(B) due to gravitational pull of Earth
(C) due to their high mass
(D) due to inertia

40. The acceleration of a low flying Earth satellite is:
(A) 1.62 m/s^2 (B) 9.8 m/s^2
(C) very high (D) zero

41. The frequency of rotation of a spaceship about its own axis to create artificial gravity like that on Earth is:
(A) $f = 2\pi\sqrt{\frac{g}{R}}$ (C) $f = \frac{1}{\pi}\sqrt{\frac{R}{g}}$
(B) $f = \frac{1}{2\pi}\sqrt{\frac{R}{g}}$ (D) $f = \frac{1}{2\pi}\sqrt{\frac{g}{R}}$

42. The minimum number of communication satellites required to cover the whole Earth is:
(A) 2 (C) 4
(B) 3 (D) 5

43. What should the orbital radius of geostationary satellite be so that it could stay over the same point on the Earth surface?
(A) 4.23×10^4 m (C) 4.23×10^6 m
(B) 4.23×10^5 m (D) 4.23×10^7m

44. The required orbital velocity of an orbiting satellite ______ as its height increases :
(A) increases (C) remains constant
(B) decreases (D) any of these

45. The artificial gravity is created in an orbiting space ship by:
(A) placing powerful magnets inside it
(B) applying strong electric field
(C) increasing its orbital speed
(D) spinning it about its own axis

46. **An object of mass 1 g is whirled in a horizontal circle of radius 0.5m at a constant speed of 2m/s. The work done on the object during one revolution is:**
(A) 0 (C) 1 J
(B) 2 J (D) 4 J

47. **A child is revolving a tiny 10g stone, tied at one end of a string, in a vertical loop of 2m diameter. If the stone completes 100 revolutions in 1 second, the work done on it will be:**
(A) zero (C) 4.9 J
(B) 19.8 J (D) 9.8 J

48. **The angle between the minute and hour hands of a watch at 4'O clock is:**
(A) $3\pi/2$ radians (C) $2\pi/3$ radians
(B) $\pi/2$ radians (D) $5\pi/2$ radians

49. **For satellite telecommunication _____ signals are used.**
(A) micro waves (C) infrared waves
(B) radio waves (D) light waves

50. **Angular velocity of a body is 4 rev/min. Its angular velocity in rad/s will be:**
(A) 2π rad/s (C) π rad/s
(B) $2\pi/15$ rad/s (D) 4π rad/s

51. **An athlete completes one round ($\theta = 2\pi$ radian) of a circular track of 40m radius in 40 sec. How much linear displacement will he cover in 2 minutes and 20 seconds?**
(A) 240π meters (C) 80π meters
(B) 2π meters (D) 80 meters

52. **When a body moves in a circle, the angle between its linear velocity $\vec{v}$ and angular velocity $\overline{\omega}$ is:**
(A) 180° (C) 90°
(B) 0° (D) 45°

53. **A body rotating at 10 rad/s in a circle of radius 2m has the tangential velocity:**
(A) 5 ms^{-1} (C) 100 ms^{-1}
(B) 20 ms^{-1} (D) 0.5 ms^{-1}

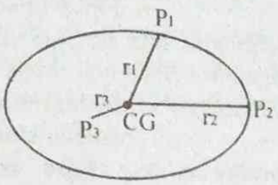
54. **A body is moving in a circle under centripetal force "F_c". If its linear velocity and radius both are made twice, the centripetal force will be:**
(A) F_c (C) $F_c/2$
(B) $2F_c$ (D) $4F_c$

55. **Two isosceles triangles are similar, if the angle between their:**
(A) unequal arms are equal
(B) equal arms are equal
(C) unequal arms are unequal
(D) equal arms are unequal

56. **When a body is whirled in a horizontal circle by means of a string, the centripetal force is supplied by:**
(A) mass of a body
(B) tension in the string
(C) velocity of a body
(D)centripetal acceleration

57. **The time period of geo synchronous satellite is:**
(A) 84 minutes (C) 24 minutes
(B) 86400 s (D) 365 days

58. **Taking the Earth elliptical as shown in the figure.**



If $r_2 > r_1 > r_3$, then weight of a body will be greatest at:
(A) P_1 (C) P_3
(B) P_2 (D) equal at P_1 and P_2

59. **For a body moving in a circle, its linear _______ is equal to radius times angular _______.**
(A) displacement (C) acceleration
(B) velocity (D) all of these

60. **What is wrong about centripetal and centrifugal forces?**
(A) they act on the same body
(B) their magnitudes are same
(C) their directions are opposite
(D) Both perform work done

61. **Doubling which of the following quantities will increase the centripetal force eight times?**
(i) mass (ii) radius (iii) velocity
(A) (i) and (ii) only (C) (i) and (iii) only
(B) (ii) and (iii) only (D) (i), (ii) and (iii)

62. **A 1000kg car is turning around a corner at 10 ms^{-1} as the radius of circle is 10m. Find the centripetal force:**
(A) 2×10^3 N (C) 2×10^4 N
(B) 1×10^4 N (D) 0.5×10^4 N

63. **The angle between the centripetal force and tangential velocity is:**
(A) 0° (C) 180°
(B) 90° (D) 60°

64. **The ratio of the angular speed of minute hand of a clock to the second hand of clock for one complete rotation is:**
(A) 1 : 15 (C) 1 : 60
(B) 15 : 1 (D) 60 : 1

65. **If mass, velocity and radius becomes double then the centripetal force will be:**
(A) Two times (C) Eight times
(B) Four times (D) ¼ times

66. **If body moving with angular speed of 2π rad/s and radius is 1m the centripetal acceleration becomes:**
(A) 4π ms^{-2} (C) 2π ms^{-2}
(B) $4\pi^2$ ms^{-2} (D) $2\pi^2$ ms^{-2}

67. **The ratio of frequency to angular frequency is:**
(A) $\frac{1}{\pi}$ (C) $\frac{1}{2\pi}$
(B) π (D) 2π

68. **The direction of centrifugal force is directed ____ the center.**
(A) towards
(B) away
(C) at

(D) Perpendicular to the plane

69. **An object of mass "m" and another object of mass "2m" are each forced to move along a circle of radius 1.0m at a constant speed of 1.0m/s. The magnitudes of their accelerations are:**
(A) equal (C) in the ratio of $\sqrt{2}:1$
(B) in the ratio of 2 : 1 (D) in the ratio of 4 : 1

70. **An object moves in a circle. If the mass is tripled, the speed halved, and the radius unchanged, then the magnitude of the centripetal force must be multiplied by a factor of:**
(A) 3/2 (C) 3/4
(B) 9/4 (D) 6

71. **The driver of a 1000 kg car tries to turn through a circle of radius 100m on an unbanked curve at a speed of 10 m/s. The actual frictional force between the tyres and slippery road has a magnitude of 900 N. The car:**
(A) slides into the inside of the curve
(B) slides off to the outside of the curve
(C) makes the turn
(D) makes the turn only if it goes faster

72. **One end of a 1.0 m string is fixed, the other end is attached to a 2.0 kg stone. The stone swings in a vertical circle, passing the top point at 4.0m/s. The tension force of the string (in newtons) at this point is about:**
(A) 0 (C) 12
(B) 20 (D) 32

73. **A flywheel rotating at 12 rev/s is brought to rest in 6 s. The magnitude of the average angular acceleration in rad/s^2 of the wheel during this process is:**
(A) $1/\pi$ (C) 2
(B) 4 (D) 4π

74. **A wheel initially has an angular velocity of 18 rad/s but it is slowing at a rate of 2.0 rad/s^2. By the time it stops it will have turned through:**
(A) 81 rad (C) 160 rad
(B) 245 rad (D) 330 rad

75. **In case of planets the necessary acceleration is provided by:**
(A) Gravitational force (C) Frictional force
(B) Coulomb force (D) Centripetal force

76. **If a car moves with a uniform speed of 400 cms^{-1} in a circle of radius 0.4m. Its angular speed is:**
(A) 4 rads^{-1} (C) 5 rads^{-1}
(B) 10 rad s^{-1} (D) 2.8 rad s^{-1}

77. **When a wheel, 1 m in diameter makes 30 rev min^{-1}, the linear speed of point on its rim in ms^{-1} is:**
(A) 2π (C) $\pi/2$
(B) π (D) 20π

78. **A cyclist cycling around a circular racing track, skids because:**
(A) the centripetal force upon him is less than limiting friction
(B) the centripetal force upon him is greater than limiting friction
(C) the centripetal force upon him is equal to the limiting friction
(D) the friction between the tyres of the cycle and road vanishes

79. **In angular motion, Newton's second law of motion is:**
(A) F = ma (C) $F = \Delta P/\Delta t$
(B) $\tau = I\alpha$ (D) all of above

80. **If we whirl a stone at the end of a string in the vertical circle, it is likely to break when the stone is:**
(A) at the highest point
(B) at any point during motion
(C) at the lowest point
(D) at the point where gravity is not acting

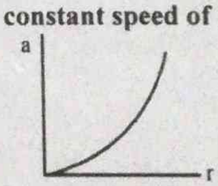
81. **A planet is in circular orbit around the Sun. Its distance from the Sun is four times the average distance of Earth from the Sun. The period of this planet, in Earth years, is:**
(A) 4 (C) 8
(B) 16 (D) 64

82. **How many days would be in a year if the distance between the Earth and the sun were reduced to half of its present value (assuming circular orbit)?**
(A) 365 days (C) 730 days
(B) 329 days (D) 129 days

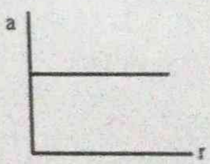
83. **Uniform circular motion is the direct consequence of:**
(A) a force that is always tangent to the path
(B) an acceleration tangent to the path
(C) a force of constant magnitude that is always directed away from the same fixed point
(D) a force of constant magnitude that is always directed toward the same fixed point

84. **The magnitude of the force required to cause a 0.04 kg object to move at 0.6m/s in a circle of radius 1.0 m is:**
(A) 2.4×10^{-2} N (C) 1.4×10^{-2} N
(B) $1.4\pi \times 10^{-2}$ N (D) $2.4\pi^2 \times 10^{-2}$ N

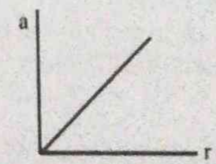
85. **Which of the following graphs is correct for a particle moving in a circle of radius "r" at a constant speed of 10m/s?**



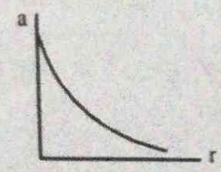
(A)



(C)



(B)



(D)

86. **An object moves around a circle. If the radius is doubled keeping the speed the same then the magnitude of the centripetal force must be:**
(A) twice (C) half
(B) four times (D) one fourth

87. **If a satellite moves above Earth's atmosphere in a circular orbit with constant speed, then:**
(A) its acceleration and velocity are always in the same direction
(B) its acceleration is toward the Earth
(C) its velocity is constant
(D) it will fall back to Earth when its fuel is used up

88. **If a certain car, going with speed v_1, rounds a level curve with a radius R_1, it is just on the verge of skidding. If its speed is now doubled, the radius of the tightest curve on the same road that it can round without skidding is:**
(A) $2R_1$ (C) $4R_1$
(B) $R_1/2$ (D) $R_1/4$

89. **A person riding a Ferris wheel is strapped into her seat by a seat belt. The wheel is spun so that the centripetal acceleration is g. Select the correct combination of forces that act on her when she is at the top. In the table F_g = force of gravity, down; F_b = seat belt force, down; and F_s = seat force, up.**

	F_g	F_b	F_s
(A)	0	mg	0
(B)	mg	0	0
(C)	0	0	mg
(D)	mg	mg	0

90. **If a wheel turns with constant angular speed then:**
(A) each point on its rim moves with constant velocity
(B) each point on its rim moves with constant acceleration
(C) the wheel turns through equal angles in equal times
(D) the angle through which the wheel turns in each second increases as time goes on

91. **The angular velocity of a rotating wheel increases by 2 rev/s every minute. The angular acceleration in rad/s^2 of this wheel is:**
(A) $4\pi^2$ (C) 2π
(B) 1/30 (D) $\pi/15$

92. **A particle is under the action of force of constant magnitude. The direction of the force is such that it is always normal to the velocity of the particle. If the motion of the particle is confined to a plane, then:**
(A) The particle has a linear motion
(B) The particle has a circular motion
(C) The acceleration of the particle is constant
(D) The velocity of the particle constant

93. **If the angular velocity vector of a spinning body points out of the page then, when viewed from above the page, the body is spinning:**
(A) clockwise about an axis that is perpendicular to the page
(B) counterclockwise about an axis that is perpendicular to the page
(C) about an axis that is parallel to the page
(D) about an axis that is changing orientation

94. **A child, riding on a large merry-go-round, travels a distance of 3000m in a circle of diameter 40 m. The total angle through which she revolves is:**
(A) 50 rad (C) 75 rad
(B) 150 rad (D) 314 rad

95. **A particle moves in a circular path of radius 0.10m with a constant angular speed of 5 rev/s. The acceleration of the particle is:**
(A) 10π m/s^2 (C) 0.50m/s^2
(B) 500π m/s^2 (D) $10\pi^2$ m/s^2

96. **For a wheel spinning on an axis through its center, the ratio of the tangential acceleration of a point on the rim to the tangential acceleration of a point halfway between the center and the rim is:**
(A) 1 (C) 2
(B) ½ (D) 4

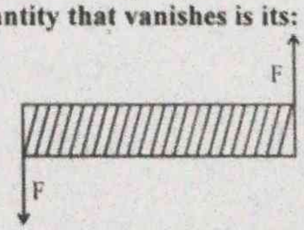
97. **Two wheels are identical but wheel "B" is spinning with twice the angular speed of wheel "A". The ratio of the magnitude of the radial acceleration of a point on the rim of "B" to the magnitude of the radial acceleration of a point on the rim of "A" is:**
(A) 1 (C) 2
(B) ½ (D) 4

98. **A disk is free to rotate on a fixed axis. A force of given magnitude F, in the plane of the disk, is to be applied. Of the following alternatives the greatest angular acceleration is obtained if the force is:**
(A) applied tangentially halfway between the axis and the rim
(B) applied tangentially at the rim
(C) applied radially halfway between the axis and the rim
(D) applied radially at the rim

99. **A thin circular hoop of mass 1.0 kg and radius 2.0 m is rotating about an axis through its center and perpendicular to its plane. It is slowing down at the rate of 7.0 rad/s^2. The net torque acting on it is:**
(A) 7.0 N m (C) 14.0 N m
(B) 28.0 N m (D) 44.0 N m

100. **Two wheels roll side-by-side without sliding, at the same speed. The radius of wheel 2 is twice the radius of wheel 1. The angular velocity of wheel 2 is:**
(A) twice the angular velocity of wheel 1
(B) the same as the angular velocity of wheel 1
(C) half the angular velocity of wheel 1
(D) more than twice the angular velocity of wheel 1

101. **A rod rests on frictionless ice. Forces that are equal in magnitude and opposite in direction are then simultaneously applied to its ends as shown. The quantity that vanishes is its:**



(A) angular momentum (C) angular acceleration
(B) total linear momentum (D) kinetic energy

102. When arc length and radius of the circle become equal then the angle subtended at the centre of the circle will be:
(A) 1 rad (C) 53.7°
(B) π rad (D) All of these

103. The ratio of circumference of a circle to its diameter is equal to:
(A) 2π rad (C) π rad
(B) π /2 rad (D) 1 sr

104. The weight of the body at the center of Earth is:
(A) slightly less (C) slightly greater
(B) zero (D) maximum

105. One geostationary satellite covers a longitude of:
(A) 270° (C) 120°
(B) 90° (D) 360°

106. The minimum velocity required to put a satellite into orbit is:
(A) 5.9 kms^{-1} (C) 6.9 km s^{-1}
(B) 7.9 kms^{-1} (D) 7.3 km s^{-1}

107. A satellite moving around the Earth constitute:
(A) inertial frame of reference
(B) neither inertial nor non inertial
(C) non inertial frame of reference
(D) both inertial and non inertial

108 The value of "g" at a height equal to the radius of the Earth from its surface is:
(A) g (C) g / 4
(B) g / 9 (D) g / 2

109. As we move below the surface of Earth the value of "g":
(A) Increases (C) decreases
(B) Remains constant (D) none of these

110. The height of geostationary satellite above the equator is:
(A) 26000 km (C) 40000 km
(B) 36000 km (D) 30000 km

111. International Telecommunication Satellite Organization operates at microwave frequency of:
(A) 4,6,8 and 10 Hz (C) 4,6,11 and 14 GHz
(B) 4,6,8 and 12 Hz (D) 4,6,11 and 16 GHz

112. One radian is equal to:
(A) 2π rev (B) π/4 rev
(C) π/2 rev (D) 1/2π rev

113. Angular acceleration is:
(A) "r" times linear acceleration
(B) "1/r" times linear acceleration
(C) "1/r" times angular velocity
(D) "r" times angular velocity

114. The time period of the artificial satellite is given by:
(A) $\frac{2\pi R}{v}$ (C) 2πRv
(B) $\frac{2\pi v}{R}$ (D) $\frac{\pi R}{v}$

115. The largest satellite system is managed by the countries:
(A) 126 (C) 136
(B) 120 (D) 3

116. The time required for a satellite to complete one revolution "T" is related to the radius of circular orbit "r" is:
(A) $T^2 \propto r$ (C) $T \propto r^2$
(B) $T^2 \propto r^3$ (D) $T^3 \propto r^2$

117 A wheel of radius 50 cm having angular speed of 5 rad s^{-1} will have linear speed in ms^{-1}:
(A) 1.5 (C) 2.5
(B) 3.5 (D) 4

118. A body of mass 8 kg moves along a circle of radius 4m with a constant speed of $8ms^{-1}$. The centripetal force on the body is:
(A) 48 N (C) 8 N
(B) 128 N (D) 72 N

119. The centripetal acceleration is also called:
(A) Tangential acceleration
(B) Angular acceleration
(C) Radial acceleration
(D) Rotational acceleration

120. 1 rev min^{-1} is equal to:
(A) π/6 rad s^{-1} (C) π/15 rad s^{-1}
(B) π/20 rad s^{-1} (D) π/30 rad s^{-1}

121. If the radius of the Earth is doubled then the value of critical velocity becomes:
(A) $\frac{1}{\sqrt{2}}$ v (C) $\frac{1}{2}$ v
(B) $\sqrt{2}$ v (D) $\frac{1}{4}$ v

122. A wheel of radius 2 m turns through an angle of 57.3°. it lays out a tangential distance:
(A) 2 m (C) 4 m
(B) 57.3 m (D) 114.6 m

123. In angular motion the centripetal force "F_c" is:
(A) $m^2r\omega$ (C) $mr^2\omega$
(B) $mr\omega^2$ (D) $mr^2\omega^2$

124. The angular speed of flywheel making 120 revolution per minute is:
(A) 2π rad s^{-1} (C) 120 rad s^{-1}
(B) 4π rad s^{-1} (D) 1 k rad s^{-1}

125. Which is unimportant in describing the satellite's orbit?
(A) Distance of satellite from Earth's center
(B) Mass of satellite
(C) Gravitational constant "G"
(D) Mass of Earth

126. All the points on a rigid body rotating about a fixed axis do not have same:
(A) speed (C) Angular speed
(B) Angular acceleration (D) Angular displacement

127. Satellites are the objects that orbit around the:
(A) Moon (C) Sun
(B) Earth (D) Star

128. A body rotating with angular velocity of 2 rad s^{-1} and linear velocity is also 2 ms^{-1}, then radius of

circle is:

(A) 1 m (C) 0.5 m
(B) 4 m (D) 2 m

129. **Let "M" denote the mass of Earth and let "R" denote its radius. The ratio $\frac{g}{G}$ at Earth's surface is:**

(A) $\frac{R^2}{M}$ (C) $\frac{M}{R^2}$
(B) MR^2 (D) $\frac{M}{R}$

130. **The approximate value of "g" at an altitude above Earth equal to one Earth diameter is:**

(A) 9.8 m/s^2 (C) 4.9 m/s^2
(B) 2.5 m/s^2 (D) 1.1 m/s^2

131. **To measure the mass of a planet with the same radius as Earth, an astronaut drops an object from rest (relative to the planet) from an altitude of one radius above the surface. When the object hits its speed is 4 times what it would be if the same experiment were carried out for Earth. In units of Earth masses, the mass of the planet is:**

(A) 2 (C) 4
(B) 8 (D) 16

132. **Suppose you have a pendulum clock that keeps correct time on Earth (acceleration due to gravity = 9.8m/s^2). Without changing the clock, you take it to the Moon (acceleration due to gravity = 1.6m/s^2). For every hour interval (on Earth) the Moon clock will record:**

(A) $\frac{9.8}{1.6}$ hr (C) 1 hr
(B) $\sqrt{\frac{9.8}{1.6}}$ hr (D) $\sqrt{\frac{1.6}{9.8}}$ hr

133. **The mass of a hypothetical planet is 1/100 that of Earth and its radius is 1/4 that of Earth. If a person weighs 600N on Earth, what would he weigh on this planet?**

(A) 24 N (C) 48 N
(B) 96 N (D) 192 N

134. **An object at the surface of Earth (at a distance R from the center of Earth) weighs 90 N. Its weight at a distance 3R from the center of Earth is:**

(A) 10N (C) 30N
(B) 90N (D) 270N

135. **An object is raised from the surface of Earth to a height of two Earth radii above Earth. Then:**

(A) its mass increases and its weight remains constant
(B) both its mass and weight remain constant
(C) its mass remains constant and its weight decreases
(D) both its mass and its weight decrease

136. **A spring scale, calibrated in newtons, is used to weigh sugar. If it were possible to weigh sugar at the following locations, where will the buyer get the most sugar to a newton?**

(A) At the north pole (C) At the equator
(B) At the center of Earth (D) On the Moon

UNIT 04 CIRCULAR MOTION (SOLUTIONS)

01. (B)

$\omega = 2\pi f$

$f = \frac{\omega}{2\pi} = \frac{22}{2\pi} = \frac{22}{2} \times \frac{7}{22} = \frac{7}{2}$ $\quad (\pi = \frac{22}{7})$

02. (D)

$\omega_S = \frac{2\pi}{60}$

$\omega_H = \frac{2\pi}{12\times3600}$

(hour hand complete 1 revolution in 12 hours)

$\frac{\omega_S}{\omega_H} = \frac{\frac{2\pi}{60}}{\frac{2\pi}{12\times3600}} = \frac{12\times3600}{60} = 12\times60 = 720:1$

03. (C)

$\alpha = \frac{\Delta\omega}{\Delta t}$

$\omega = \text{constant} \Rightarrow \Delta\omega = 0$

$\alpha = 0$

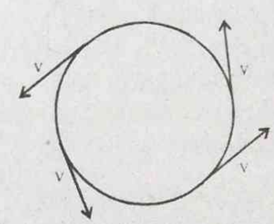
04. (A)

$\omega_f = 210 \times \frac{2\pi}{60} = 210 \times \frac{2}{60} \times \frac{22}{7} = 22 \text{ rad/s}$

$\left(\pi = \frac{22}{7}\right), \left(1\text{rpm} = \frac{2\pi}{60}\text{ rad/s}\right)$

$\alpha = \frac{\omega_f - \omega_i}{\Delta t} = \frac{22-0}{5} = \frac{22}{5} = 4.4 \text{ rads}^{-2}$

05. (C)



In circular motion the direction of velocity changes at every point and it is along the tangent.

06. (D)

Angular displacement, angular velocity, angular acceleration, angular momentum and torque all have direction along the axis of rotation. They can be determined by right hand rule.

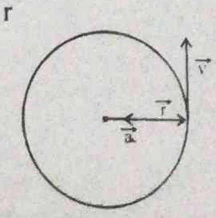
07. (B)

$F_c = mr\omega^2 = mr(2\pi f)^2 = 4\pi^2 mrf^2$

$4\pi^2 mrf^2 = 16\pi^2 \Rightarrow (1)(1)f^2 = 4 \Rightarrow f = 2 \text{ Hz}$

08. (C)

$\vec{F_c} = -m\omega^2\vec{r}$



09. (B)

Unit of angular displacement is "radian" and it has no dimension.

$$\theta = \frac{\text{arc length}}{\text{radius}} \Rightarrow [\theta] = \frac{[\ell]}{[r]} = \frac{[L]}{[L]} = [L^0]$$

10. (C)

$$3000 \text{ rpm} = 3000 \times \frac{2\pi}{60} \text{ rad/s} = 100\pi \text{ rad/s}$$

$$\left(1\text{rpm} = \frac{2\pi}{60} \text{ rad/s}\right)$$

11. (C)

$$\omega_S = \frac{2\pi}{60} \text{ rad/s} = \frac{\pi}{30} \text{ rad/s}$$

(second hand complete 1 revolution in 1 minute)

12. (C)

$$3.5 \text{ rps} = 3.5 \times 2\pi \text{ rad/s} = 22 \text{ rad/s}$$

$$(1\text{rps} = 2\pi \text{ rad/s})$$

13. (B)

$$C = 2\pi r \Rightarrow r = \frac{C}{2\pi}$$

$$\omega = f \text{ rps} = 2\pi f \text{ rad/s}$$

$$v = r\omega$$

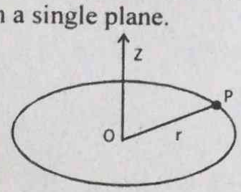
$$v = \left(\frac{C}{2\pi}\right)2\pi f = fC$$

14. (B)

$$v = r\omega = (0.2)(10) = 2 \text{ m/s}$$

15. (A)

Angular velocity is a vector quantity and its direction is along the axis of rotation and axis of rotation is perpendicular to plane of rotation. So, motion is confined in a single plane.



16. (C)

Tension at bottom:

$$T - W = F_C \Rightarrow T = W + F_C = mg + \frac{mv^2}{r} = m\left(g + \frac{v^2}{r}\right)$$

$$= 5\left(10 + \frac{4^2}{1}\right) = 5(26) = 130 \text{ N}$$

17. (B)

$$T = \frac{2\pi R}{v} = \frac{2\pi R}{\sqrt{gR}} = \frac{2\pi(4)}{\sqrt{(9.8)(4)}} = \frac{\pi(4)}{\sqrt{9.8}} \approx 4 \text{ s}$$

$$\left(\frac{\pi}{\sqrt{9.8}} \approx 1\right)$$

18. (C)

The instantaneous acceleration of an object travelling with uniform speed in a circle is directed towards the centre of circle (inward) is called centripetal acceleration.

19. (C)

$$T = \frac{2\pi R}{v} \Rightarrow T \propto R$$

20. (C)

$$v = \sqrt{\frac{GM_E}{R}}$$

$$\frac{v_1}{v_2} = \frac{\sqrt{\frac{GM_E}{R_1}}}{\sqrt{\frac{GM_E}{R_2}}} = \sqrt{\frac{R_2}{R_1}} = \sqrt{\frac{R}{3R}} = 1 : \sqrt{3}$$

21. (B)

$$g = \frac{GM}{R^2} \Rightarrow g \propto \frac{1}{R^2}$$

As

$$R_{Pole} < R_{Equator}$$

So,

$$g_{Pole} > g_{Equator}$$

22. (B)

Centripetal acceleration is directed towards the center of circle. It is not directed along the axis of rotation.

23. (D)

Angular displacement, angular velocity, angular acceleration, angular momentum and torque all have direction along the axis of rotation. They can be determined by right hand rule.

24. (C)

When the pedestal fan is switched off, then its angular velocity and acceleration are anti parallel to each other. By right hand rule the angular velocity towards us while angular acceleration away from us.

25. (B)

$$\omega_m = \frac{2\pi}{3600} \text{ rad/s} = \frac{\pi}{1800} \text{ rad/s}$$

(minute hand complete 1 revolution in 1 hour)

26. (B)

When axis of rotation is fixed then all angular vectors have the same direction. Hence they can be manipulated as scalars.

27. (B)

The time rate of change of angular displacement is called angular velocity. It is given by

$$\omega = \frac{\Delta\theta}{\Delta t}$$

28. (D)

$$\text{Angular work done} = \tau\theta = I\alpha\theta \qquad \left(\alpha = \frac{\omega_f - \omega_i}{\Delta t}\right)$$

Angular work is being done when external torque acts on the body that changes the angular velocity (either increase or decrease).

29. (C)

$$[\omega] = \frac{[\Delta\theta]}{[\Delta t]} = [T^{-1}] = [f]$$

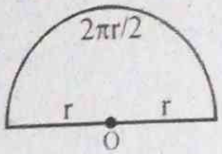
30. (B)

The angular equations holds true only in the case when axis of rotation is fixed .So, that all angular vectors have the same direction. Hence they can be manipulated as scalars.

31. (C)

For very small values of "$\Delta\theta$", the angular displacement is a vector quantity, its direction is along the axis of rotation and it is given by right hand rule.

32. (D)



Displacement = 2r
Distance = πr

33. (B)

$$\alpha = \frac{\omega_f - \omega_i}{\Delta t} = \frac{36 - 0}{6} = 6 \text{ rad/s}^2$$

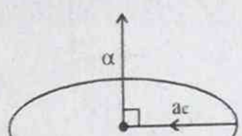
$$\theta = \omega_i t + \frac{1}{2}\alpha t^2 = 0 + \frac{1}{2}(6)(6)^2 = 108 \text{ rad}$$

34. (A)

$$\omega = \frac{\theta}{t} \Rightarrow \omega \propto \frac{1}{t}$$

(in one rotation "θ" remains same)
Earth completes one rotation in 24 hours
Hour hand completes one rotation in 12 hours
Second hand completes one rotation in 1 minute
$\omega_{Earth} < \omega_{Hour} < \omega_{Second}$

35. (B)



"a_c" is directed towards the center of circle while "α" is directed along the axis of rotation.

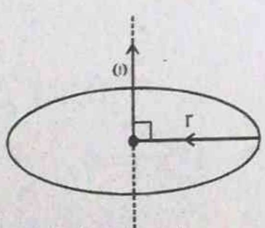
36. (C)

$$a_c = \frac{v^2}{r} = \frac{6^2}{3} = \frac{36}{3} = 12 \text{ m/s}^2$$

37. (B)

$$\theta = \omega_i t + \frac{1}{2}\alpha t^2 = (3)(2) + \frac{1}{2}(1)(2)^2 = 6 + 2 = 8 \text{ rev}$$

38. (C)



39. (B)

Satellites are the objects which are orbiting around the earth at different heights from the surface of Earth. Artificial satellites are put into their orbits by rockets and are held in orbits by the gravitational pull of the Earth.

40. (B)

The low flying earth satellites have acceleration 9.8 ms^{-2} towards the center of Earth. If they do not have any acceleration, they would fly off in a straight line tangent to the Earth. When the satellite is moving in a circle, it has an acceleration

$$a_c = \frac{v^2}{r}$$

In circular orbit around the earth, the centripetal force is supplied by gravity and we have

$$g = \frac{v^2}{R}$$

41. (D)

$$f = \frac{1}{2\pi}\sqrt{\frac{a_c}{R}}$$

for Earth like gravity

$$a_c = g$$

$$f = \frac{1}{2\pi}\sqrt{\frac{g}{R}}$$

42. (B)

A satellite communication system can be set up by placing several geostationary satellites in orbit over different points on the surface of the earth. One such satellite covers 120° covers of longitude. So whole of the Earth's surface can be covered by three properly positioned satellite.

43. (B)

$$r = \left(\frac{GM\,T^2}{4\pi^2}\right)^{1/3}$$

after putting the values, we get
$r = 4.23 \times 10^7$ m
This is the radius of geostationary orbit from the centre of the Earth. The height above the equator is 36000 km.

44. (B)

$$v_o = \sqrt{\frac{GM}{r}} = \sqrt{\frac{GM}{R + h}}$$

$$v_o \propto \frac{1}{\sqrt{R + h}}$$

45. (D)

Gravity like effect is produced in the spaceship or satellite to overcome weightlessness is called artificial gravity. This can be done by rotating the satellite or spaceship about its own axis of rotation.

46. (A)

$W = \vec{F_c} \cdot \vec{d}$
$W = F_c d \cos\theta = F_c d \cos 90° = Fd\,(0) = 0$
Due to centripetal force the object will move in a circular path. In the circular path, the centripetal force "$\vec{F_c}$" is perpendicular to velocity "$\vec{v}$". As the displacement "$\vec{d}$" is parallel to the velocity "$\vec{v}$". So the angle between the displacement "$\vec{d}$" and the centripetal force "$\vec{F_c}$" is 90°.

47. (A)

No work done in circular motion due to centripetal force.

48. (C)

The angle between hour and minute hand at 1'O clock $= \frac{2\pi}{12}$ rad

The angle between hour and minute hand at 4'O clock $= 4 \times \frac{2\pi}{12}$ rad $= \frac{2\pi}{3}$ rad

49. (A)

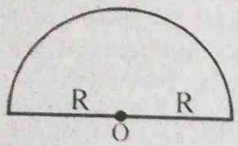
Microwaves are used for the communication because they travel in a narrow beam in a straight line and pass though the atmosphere of the Earth.

50. (B)

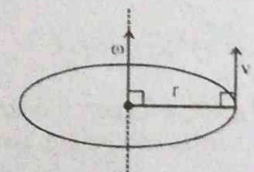
$$4 \text{ rev/min} = 4 \times \frac{2\pi}{60} = \frac{2\pi}{15} \text{ rad/s}$$

51. (D)

An athlete complete 1 round in 40 s. it means that 3 rounds complete 120s (2 minutes). So total displacement is zero in 120 s. The displacement of athlete in next 20 s (semi circle) is R+R =2R = (40)(2) = 80m.



52. (C)



Axis of rotation

53. (B)

$$v_t = r\omega = (2)(10) = 20 \text{ m/s}$$

54. (B)

$$F_c = \frac{mv^2}{r}$$

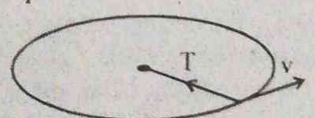
$$F_c' = \frac{m(2v)^2}{2r} = \frac{4}{2}\left(\frac{mv^2}{r}\right) = 2F_c$$

55. (B)

Two isosceles triangles are similar if the angle between their equal arms are equal.

56. (B)

$$T = F_c = \frac{mv^2}{r}$$



57. (B)

A geo-stationary orbit is that in which the period of rotation of the satellite around the Earth is exactly equal to the period of rotation of the Earth (24 hours) about its axis.

T = 24 hr = 24 × 3600 = 86400 s

58. (A)

The value of g is maximum at the surface of Earth. While on moving below the surface of Earth the value of g decreases.

$$g = \frac{GM}{r^2} \Rightarrow g \propto \frac{1}{r^2}$$

As $r_2 > r_1$ (At the surface)

$g_1 > g_2$

$W_1 > W_2$

59. (D)

$S = r\theta$

$v = r\omega$

$a = r\alpha$

60. (D)

$$W = \vec{F} . \vec{d}$$

$$W = Fd\cos\theta = Fd\cos 90^\circ = Fd(0) = 0$$

The centripetal and centrifugal forces are perpendicular to velocity. As the displacement is parallel to the velocity. So the angle between the displacement and the forces is 90°.

61. (B)

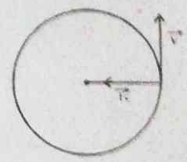
$$F_c = \frac{mv^2}{r}$$

$$F_c' = \frac{2m(2v)^2}{r} = 8\left(\frac{mv^2}{r}\right) = 8F_c$$

62. (B)

$$F_c = \frac{mv^2}{r} = \frac{(1000)(10)^2}{10} = 1 \times 10^4 \text{ N}$$

63. (B)



64. (C)

$$\omega_S = \frac{2\pi}{60}$$

$$\omega_M = \frac{2\pi}{3600}$$

(minute hand complete 1 revolution in 1 hour)

$$\frac{\omega_M}{\omega_S} = \frac{\frac{2\pi}{3600}}{\frac{2\pi}{60}} = \frac{60}{3600} = \frac{1}{60} = 1:60$$

65. (B)

$$F_c = \frac{mv^2}{r}$$

$$F_c' = \frac{2m(2v)^2}{2r} = 4\left(\frac{mv^2}{r}\right) = 4F_c$$

66. (B)

$$a_c = \frac{v^2}{r} = r\omega^2 = (1)(2\pi)^2 = 4\pi^2 \text{ m/s}^2$$

67. (C)

$$\omega = 2\pi f$$

$$\frac{f}{\omega} = \frac{1}{2\pi}$$

68. (B)

Centrifugal force is equal in magnitude and opposite to the centripetal force. So, it is away from the center of circle .

69. (A)

$$a_c = \frac{v^2}{r} = r\omega^2$$

As centripetal acceleration does not depend upon the mass of object. So, at same speed and radius both have same centripetal acceleration.

70. (C)

$$F_c = \frac{mv^2}{r}$$

$$F_c' = \frac{3m(v/2)^2}{r} = \frac{3}{4}\left(\frac{mv^2}{r}\right) = \frac{3}{4}F_c$$

71. (B)

$$F_c = \frac{mv^2}{r} = \frac{(1000)(10)^2}{100} = 1000\text{ N}$$

To move in the circular path the required centripetal force must be provided by any source. But in this case the source of centripetal force is the force friction between road and tyres. In this case frictional force does not provide necessary centripetal force. So, the car slides off to the outside of the curve.

72. (C)

$$T + W = F_C \Rightarrow T = F_C - W = \frac{mv^2}{r} - mg = m\left(\frac{v^2}{r} - g\right)$$

$$= 2\left(\frac{4^2}{1} - 10\right) = 2(6) = 12\text{ N}$$

73. (D)

$$\alpha = \frac{\omega_f - \omega_i}{\Delta t} = \frac{0 - (12 \times 2\pi)}{6} = -4\pi\text{ rads}^{-2}$$

(1rev = 2π rad)

74. (A)

$$2\alpha\theta = \omega_f^2 - \omega_i^2$$

$$2(-2)\theta = (0)^2 - (18)^2$$

$$-4\theta = -324$$

$$\theta = \frac{324}{4} = 81\text{ rad}$$

75. (A)

Planets are orbiting around the Sun due to gravitational force of Sun.

76. (B)

$$v = r\omega \Rightarrow \omega = \frac{v}{r} = \frac{4}{0.4} = 10\text{ rad/s}$$

77. (C)

$$v = r\omega = \left(\frac{1}{2}\right)\left(\frac{30\times 2\pi}{60}\right) = \frac{\pi}{2}\text{ m/s}$$

(r = d/2 = 1/2 m)

78. (B)

To move in the circular path the required centripetal force must be provided by any source. But in this case the source of centripetal force is the force friction between road and tyres. Cyclist required more centripetal force to overcome skidding.

79. (B)

The analogous of Newton's 2nd law in angular motion is

$$\tau = I\alpha$$

80. (C)

$$T - W = F_C \Rightarrow T = W + F_C = mg + \frac{mv^2}{r}$$

The probability to break the string at lowest point is maximum. Because the tension at that point is maximum.

81. (C)

$$r^3 = \frac{GM\,T^2}{4\pi^2}$$

$$T^2 = \left(\frac{4\pi^2}{GM}\right)r^3$$

$$T^2 \propto r^3$$

$$\frac{T_P^2}{T_E^2} = \left(\frac{r_P^3}{r_E^3}\right) = \left(\frac{(4r_P)^3}{r_E^3}\right) = 64$$

$$T_P^2 = 64\,T_E^2$$

$$T_P = 8\,T_E$$

82. (D)

$$r^3 = \frac{GM\,T^2}{4\pi^2}$$

$$T^2 = \left(\frac{4\pi^2}{GM}\right)r^3$$

$$T^2 \propto r^3$$

$$\frac{T_2^2}{T_1^2} = \left(\frac{r_2^3}{r_1^3}\right) = \left(\frac{(r_1/2)^3}{r_1^3}\right) = \frac{1}{8}$$

$$T_2^2 = \frac{1}{8}T_1^2$$

$$T_2 = \frac{1}{\sqrt{8}}T_1 = \frac{1}{\sqrt{8}}(365) = 129\text{ days}$$

83. (D)

The force which is needed to move a body in a circular path and it is always directed towards the centre of the circle, is called centripetal force.

84. (C)

$$F_c = \frac{mv^2}{r} = \frac{(0.04)(0.6)^2}{1} = \frac{144}{10000} = 1.4 \times 10^{-2}\text{ N}$$

85. (D)

$$a_c = \frac{v^2}{r}$$

$$a_c \propto \frac{1}{r} \qquad (v = \text{constant})$$

86. (C)

$$F_c = \frac{mv^2}{r}$$

$$F_c' = \frac{mv^2}{2r} = \frac{1}{2}\left(\frac{mv^2}{r}\right) = \frac{1}{2}F_c$$

87. (B)

Artificial satellites are put into their orbits by rockets and are held in orbits by the gravitational pull of the Earth. The low flying earth satellites have acceleration 9.8 ms^{-2} towards the center of Earth.

88. (C)

$$F_1 = F_2$$

$$\frac{mv_1^2}{R_1} = \frac{mv_2^2}{R_2}$$

$$\frac{v_1^2}{R_1} = \frac{(2v_1)^2}{R_2}$$

$$\frac{v_1^2}{R_1} = \frac{4v_1^2}{R_2}$$

$$R_2 = 4R_1$$

89. (B)

The acceleration will be "g" iff $F_{net} = W = mg$

This is only possible when $F_s = F_b$

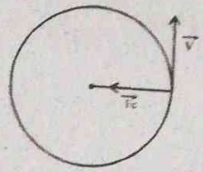
90. (C)

If a body covers equal angular displacement in equal time intervals, then it is said to be in uniform angular velocity.

91. (D)

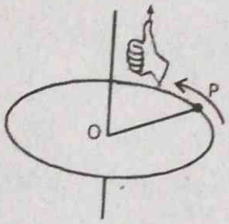
$$\alpha = \frac{\Delta\omega}{\Delta t} = \frac{2 \times 2\pi}{60} = \frac{\pi}{15} \text{ rad/s}^2$$

92. (B)



93. (B)

If we grapes the axis of rotation in our right hand such that the fingers are curled in the direction of rotation.



94. (B)

$$\theta = \frac{S}{r} = \frac{3000}{20} = 150 \text{ rad}$$

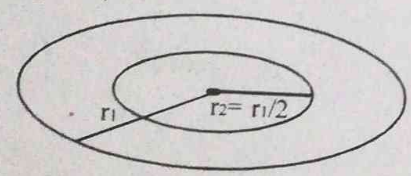
95. (D)

$$a = r\omega^2 = (0.1)(5 \times 2\pi)^2 = (0.1)(100\pi^2) = 10\pi^2 \text{ m/s}^2$$

96. (C)

$$a_t = r\alpha$$

$$\frac{a_{t1}}{a_{t2}} = \frac{r_1\alpha}{r_2\alpha} = \frac{r_1}{r_1/2} = 2$$



97. (D)

$$a = r\omega^2$$

$$\frac{a_B}{a_A} = \frac{r\omega_B^2}{r\omega_A^2} = \frac{(2\omega_A)^2}{\omega_A^2} = 4 \qquad (\omega_B = 2\omega_A)$$

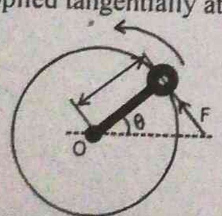
98. (B)

$$\tau = I\alpha$$

$$rF = I\alpha$$

$$\alpha = \frac{rF}{I}$$

Torque produces the angular acceleration in the body. The torque will be maximum if the force acted at larger distance from the fixed axis. In the given case the greatest angular acceleration is obtained if the force applied tangentially at the rim.



99. (B)

$$\tau = I\alpha = mr^2\alpha = (1)(2)^2(7) = 28 \text{ N m}$$

100. (C)

As two wheels roll side-by-side only if

$$v_1 = v_2$$

$$r_1\omega_1 = r_2\omega_2$$

$$r_1\omega_1 = (2r_1)\omega_2$$

$$\omega_2 = \frac{\omega_1}{2}$$

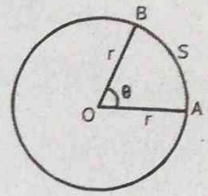
101. (B)

Two equal but opposite forces at different line of action form a couple. Couple produces the all angular quantities given in the question except linear momentum.

102. (B)

The angular displacement traced by the body is said to be one radian when the arc length is equal to the radius of the circle.

$$\angle AOB = 1 \text{radian}$$



103. (B)

$$\frac{\text{Circumfrence of circle}}{\text{Diameter}} = \frac{2\pi r}{2r} = \pi \text{ rad}$$

104. (B)

At center of Earth

$$g = 0$$

$$w = mg = m(0) = 0$$

105. (C)

A satellite communication system can be set up by placing several geostationary satellites in orbit over different points on the surface of the earth. One such satellite covers 120° covers of longitude. So whole of the Earth's surface can be covered by three properly positioned satellite.

106. (B)

$$v = \sqrt{gR}$$

$$v = \sqrt{(9.8)(6.4 \times 10^6)} = 7.9 \times 10^3 \text{ ms}^{-1} = 7.9 \text{ kms}^{-1}$$

107. (C)

A frame of reference, in which Newton's 1st law of motion does not hold, is known as non inertial frame of reference. It is accelerated frame of reference.

$$a \neq 0$$

The acceleration of satellite is the gravitational acceleration (g). So, it is a non-inertial frame of reference.

108. (C)

$$g_h = \frac{GM}{(R+h)^2}$$

$$g_h = \frac{GM}{(R+R)^2} = \frac{GM/R^2}{4} = \frac{g}{4}$$

109. (C)

$$g' = g\left(1 - \frac{x}{R}\right)$$

x = depth from surface of Earth
On moving below the surface of Earth "x" increases.
So, g' decreases.

110. (B)

$$r = 4.23 \times 10^4 \text{ km}$$

This is the radius of geostationary orbit from the centre of the Earth.

$R + h = 4.23 \times 10^4$ km

$h = 4.23 \times 10^4 \text{ km} - R = 4.23 \times 10^4 \text{ km} - 6400 \text{ km}$

≈ 36000 km

This height above the equator is 36000 km.

111. (C)

The largest satellite system is arranged by 126 countries, international telecommunication satellite organization (INTELSAT). An INTELSAT VI operates at microwave frequencies of 4,6,11 and 14 GHz.

112. (D)

2π rad = 1rev

$1 \text{ rad} = \frac{1}{2\pi} \text{ rev}$

113. (B)

$$a = r\alpha \Rightarrow \alpha = \frac{1}{r}(a)$$

114. (A)

The time period of the satellite is given by:

$$T = \frac{2\pi R}{v} \text{ because } \left(T = \frac{S}{v}\right)$$

$$T = \frac{2\pi(6.4 \times 10^6)}{7.9 \times 10^3} = 5060 \text{ s} \approx 84 \text{ min}$$

115. (A)

The largest satellite system is arranged by 126 countries, international telecommunication satellite organization (INTELSAT).

116. (B)

$$r^3 = \frac{GM\,T^2}{4\pi^2}$$

$$T^2 \propto r^3$$

117 (C)

$$v = r\omega = (0.5)(5) = 2.5 \text{ m/s}$$

118. (B)

$$F_c = \frac{mv^2}{r} = \frac{(8)(8)^2}{4} = 128 \text{ N}$$

119. (C)

This acceleration is directed along the radius towards the centre of circle. So it is also known as radial acceleration.

120. (D)

$$1 \text{ rev/min} = 1 \times \frac{2\pi}{60} \text{ rad/s} = \frac{\pi}{30} \text{ rad/s}$$

121. (A)

$$v = \sqrt{gR}$$

$$g = \frac{GM}{R^2}$$

When radius of Earth is doubled

$$g' = \frac{GM}{(2R)^2} = \frac{GM}{4R^2} = \frac{g}{4}$$

$$v' = \sqrt{(g/4)(2R)} = \sqrt{\frac{gR}{2}} = \frac{v}{\sqrt{2}}$$

122. (A)

$\theta = 57.3° = 1$ rad

$S = r\theta = (2)(1) = 2$m

123. (B)

$$F_c = \frac{mv^2}{r} = \frac{m(r\omega)^2}{r} = mr\omega^2$$

124. (B)

$$120 \text{ rev/min} = 120 \times \frac{2\pi}{60} \text{ rad/s} = 4\pi \text{ rad/s}$$

125. (B)

$$v = \sqrt{\frac{GM}{r}}$$

This is the velocity required for the satellite to orbit around the Earth. It does not depend upon the mass of satellite.

126. (A)

Points that are at different distances from the axis do not have same speed and acceleration, but all the points on rigid body rotating about a fixed axis do have the same angular displacement, angular speed and angular acceleration at any instant.

127. (B)

Satellites are the objects which are orbiting around the earth at different heights from the surface of Earth. Artificial satellites are put into their orbits by rockets and are held in orbits by the gravitational pull of the Earth.

128. (A)

$$v = r\omega \Rightarrow r = \frac{v}{\omega} = \frac{2}{2} = 1 \text{ m}$$

129. (C)

$$g = \frac{GM}{R^2}$$

$$\frac{g}{G} = \frac{M}{R^2}$$

130. (D)

$$g_h = \frac{GM}{(R+h)^2}$$

$$g_h = \frac{GM}{(R+2R)^2} = \frac{GM/R^2}{9} = \frac{9.8}{9} = 1.1 \text{ m/s}^2$$

(h = diameter = 2R)

131. (D)

M = Mass of Earth
M' = Mass of planet
R = R' = Radius of Earth = Radius of planet
v = speed of object near at the surface of Earth
v' = speed of object near at the surface of planet
According to third equation of motion
$(2aS = v_f^2 - v_i^2)$ taking $v_i = 0$ and h = R

$2g'R = v'^2$

As v' = 4v

$2g'R = (4v)^2 \Rightarrow 2g'R = 16v^2$

Due to Earth gravity

$2gR = v^2 - 0 \Rightarrow v^2 = 2gR$

$2g'R = 16(2gR) \quad \Rightarrow g' = 16g$

$$g' = \frac{GM'}{R^2} \Rightarrow 16g = \frac{GM'}{R^2} \Rightarrow 16\frac{GM}{R^2} = \frac{GM'}{R^2}$$

$M' = 16M$

132. (B)

$$\frac{T_M}{T_E} = \frac{2\pi\sqrt{\frac{L}{g_M}}}{2\pi\sqrt{\frac{L}{g_E}}} = \sqrt{\frac{g_E}{g_M}} = \sqrt{\frac{9.8}{1.6}}$$

$$T_M = \sqrt{\frac{9.8}{1.6}}\,T_E = \sqrt{\frac{9.8}{1.6}}\,(1\text{hr}) = \sqrt{\frac{9.8}{1.6}}\ \text{hr}$$

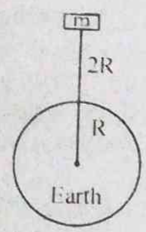
133. (B)

$$g' = \frac{GM'}{R'^2} = \frac{G(M/100)}{(R/4)^2} = \frac{16}{100} \times \frac{GM}{R^2} = \frac{16}{100}g$$

$$W' = mg' = m \times \frac{16}{100}g = \frac{16}{100}(mg)$$

$$= \frac{16}{100}(600) = 96\ \text{N}$$

134. (A)



$$g_h = \frac{GM}{(R+h)^2}$$

$$g_h = \frac{GM}{(R+2R)^2} = \frac{GM/R^2}{9} = \frac{g}{9}$$

$$W_h = mg_h = m \times \frac{g}{9} = (mg)\frac{1}{9} = (90)\frac{1}{9} = 10\ \text{N}$$

135. (C)

$$g_h = \frac{GM}{(R+h)^2} \Rightarrow g_h \propto \frac{1}{(R+h)^2}$$

$W_h = mg_h$

As $g_h < g$

So,

$W_h < W$

Mass remains same in any situation.

136. (A)

$W = mg$

The weight of body will be maximum where the gravity will be maximum. In the given case the gravity is maximum at pole. So, the buyer gets the most sugar to a newton at the pole.

UHS PAST MDCAT (2008-2019)

1. The force required to bend the normally straight path of a particle into a circular path is called ______ force. (UHS 2008)

(A) Traveling (C) Centrifugal
(B) Bending (D) Centripetal

> **(D)**
> Definition of centripetal force.

2. Two cylinders of equal mass are made from same material. The one with the larger diameter accelerates ______ the other under the action of same torque. (UHS 2008)

(A) Faster than (C) Equal to
(B) Slower than (D) None of these

> **(B)**
> $$\tau = I\alpha = mr^2\alpha = \frac{md^2\alpha}{4} \Rightarrow \alpha = \frac{4\tau}{md^2} \Rightarrow \alpha \propto \frac{1}{d^2}$$
> This shows that the cylinder having larger diameter will accelerate slower than others.

3. If the body is rotating with uniform angular velocity, then its torque is: (UHS 2009)

(A) Zero (C) Maximum
(B) Clockwise (D) Remains same

> **(A)**
> $\tau = I\alpha$
> As the body is rotating with uniform velocity.
> So, $\alpha = 0$
> $\tau = I(0) = 0$

4. Linear velocity or tangential velocity of any particle moving in a circular path of radius 2 m with angular velocity 8 rads^{-1} will be: (UHS 2009)

(A) 16 ms^{-1} (C) 10 ms^{-1}
(B) 4 ms^{-1} (D) 6 ms^{-1}

> **(A)**
> $v = r\omega = (2)(8) = 16$ m/s

5. What is torque "τ" in a circular motion: (UHS 2009)

(A) $\tau = mr^2\pi$ (C) $\tau = mr\alpha$
(B) $\tau = mr^2\alpha$ (D) $\tau = mr^2/\alpha$

> **(B)**
> $\tau = I\alpha = mr^2\alpha$ $(I = mr^2)$

6. A wheel of radius 1 m covers an angular displacement of 180°. Its linear distance is: (UHS 2010)

(A) 3.14 m (C) 6.28 m
(B) π rad (D) 0.157 m

> **(A)**
> $\theta = 180^\circ = \pi$ rad
> $S = r\theta = (1)(\pi) = \pi$ m $= 3.14$ m

7. A body moves in a circle with increasing angular velocity. At time t= 6sec, the angular velocity is 27 rad/s. What is the radius of circle made by the

body where linear velocity is 81cm/s? (UHS 2017)

(A) 6cm (C) 9cm

(B) 3cm (D) 7cm

(B)

$$v = r\omega \Rightarrow r = \frac{v}{\omega} = \frac{81}{27} = 3 \text{ cm}$$

8. The moon rotates about its axis, in future, scientists may wish to put a satellite into an orbit around the moon such that satellite remains stationary above one point on the moon's surface. The period of rotation of the moon about its axis is 27.4 days. Calculate the radius of required orbit? $M_m = 7.35 \times 10^{22}$kg. (UHS 2017)

(A) 3.59×10^7m (C) 6.96×10^6m

(B) 4.23×10^7m (D) 8.86×10^7m

(D)

$$r^3 = \frac{GM\,T^2}{4\pi^2}$$

$$= \frac{(6.67 \times 10^{-11})(7.35 \times 10^{22})(27.4 \times 86400)^2}{4\pi^2}$$

$$r = \sqrt[3]{\frac{(6.67 \times 10^{-11})(7.35 \times 10^{22})(27.4 \times 86400)^2}{4\pi^2}}$$

$$r = 8.86 \times 10^7 \text{ m}$$

9. A wheel starts rotating from rest with angular acceleration of 2 rad s^{-2} till its angular speed becomes 6 rad/s. the angular displacement of the wheel will be equal to: (UHS 2018)

(A) 9 rad (C) 7 rad

(B) 12 rad (D) 4 rad

(A)

$$2\alpha\theta = \omega_f^2 - \omega_i^2 = \Rightarrow (2)(2)\theta = 6^2 - 0$$

$$\theta = \frac{36}{4} = 9 \text{ rad}$$

10. Which of the following gives the relationship between linear velocity and angular velocity? (UHS 2018)

(A) $v = r\omega$ (C) $v = s\omega$

(B) $S = r\theta$ (D) $v = r\theta$

(A)

$$v = r\omega$$

11. An object is moving along a circular path of radius 4 m. what will be its angular displacement if it moves 14 m on this circular path? (UHS 2019)

(A) 5.5 radians (C) 5.0 radians

(B) 3.5 radians (D) 4.5 radians

(B)

$$S = r\theta \Rightarrow \theta = \frac{S}{r} = \frac{14}{4} = 3.5 \text{ radian}$$

12. Work done due to centripetal force for circular motion will be: (UHS 2019)

(A) Reduced (C) Half

(B) Maximum (D) Zero

(D)

$$W = F_c d\cos 90^\circ = 0$$

The angle between centripetal force and displacement is 90°.

UNIT 05 OSCILLATIONS

01. **Which of the following is a simple harmonic motion?**
(A) Particle moving through a string fixed at both ends
(B) Wave moving through a string fixed at both ends.
(C) Earth spinning about its axis
(D) Ball bouncing between two rigid vertical walls

02. **Starting from extreme position, an object executes SHM such that it covers half of amplitude in 1 s then time period of oscillator is:**
(A) 4 s (C) 8 s
(B) 6 s (D) 12 s

03. **The graph plotted between the velocity and displacement from mean position of a particle executing SHM is:**
(A) Circle (C) parabola
(B) ellipse (D) straight line

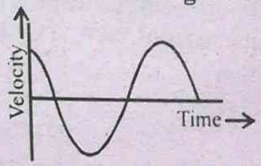
04. **Acceleration of a particle executing SHM, at its mean position is:**
(A) Infinity (C) maximum
(B) variable (D) zero

05. **If an SHM is executed with frequency "f", the frequency with K.E changes is:**
(A) f (C) f/4
(B) f/2 (D) 2f

06. **A particle executes S.H.M. having time period T, then the time period with which the potential energy changes is:**
(A) T (C) T/2
(B) 2 T (D) ∞

07. **If the magnitude of the displacement is numerically equal to that of acceleration, then the time period is:**
(A) 1 second (C) 2π second
(B) π second (D) 4π second

08. **The graph shown in the figure represents:**

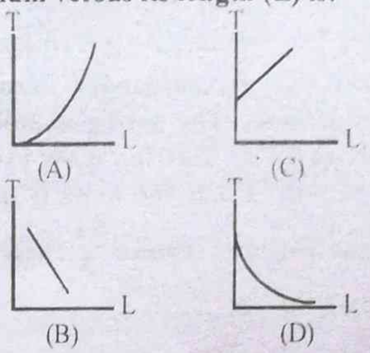


(A) motion of a simple pendulum starting from mean position
(B) motion of a simple pendulum starting from a extreme position
(C) Simple pendulum describing a horizontal circle
(D) Simple pendulum describing a vertical circle

09. **The period of oscillation of a mass "M" suspended from a spring of negligible mass is "T". If along with it another mass "M" is also suspended, the period of oscillation will now be**
(A) T (C) 2T
(B) $T/\sqrt{2}$ (D) $\sqrt{2}T$

10 A child is swinging on swing in sitting position stands up. The time period of the swing will:
(A) Increase
(B) decrease
(C) remain same
(D) Increase if the child is tall and decrease if the child is short

11. **The graph of the time period (T) of simple pendulum versus its length (L) is:**



12. **A simple pendulum has a metal bob, which is negatively charged. If it is allowed to oscillate above a positively charged metallic plate, then its time period will:**
(A) Increase (C) become zero
(B) decrease (D) remain the same

13. **A pendulum is undergoing S.H.M. The velocity of the bob in the mean position is "v". If now its amplitude is doubled, keeping the length same, its velocity in the mean position will be:**
(A) v/2 (C) 2v
(B) v (D) 4v

14. **A particle moves such that its acceleration "a" is given by a = –bx where "x" is the displacement from equilibrium position and "b" is constant. The period of oscillation is:**
(A) $2\pi/b$ (C) $\sqrt{2\pi/b}$
(B) $2\pi/\sqrt{b}$ (D) $2\sqrt{\pi/b}$

15. **Distance covered during one vibration of an oscillating body in terms of amplitude "A" is:**
(A) Zero (C) 2A
(B) A (D) 4A

16. **The tension in the string of a simple pendulum is:**
(A) Remains Constant
(B) maximum in extreme position
(C) zero in mean position
(D) maximum at mean position

17. **Resonance is an example of**
(A) Tuning fork (C) free vibration
(B) forced vibration (D) damped vibration

18. **The total mechanical energy of a spring–mass system in simple harmonic motion is $E=\frac{1}{2}m\omega^2A^2$. Suppose the oscillating particle is replaced by another particle of double the mass while the amplitude "A" remains the same. The new mechanical energy will:**
(A) Becomes 2E (C) Become $\sqrt{2}E$
(B) Become E/2 (D) remains same

19. What fraction of total energy is kinetic at half of amplitude during SHM?
(A) 1/2
(B) 1/4
(C) 2/3
(D) 3/4

20. A body of mass 5 kg is executing S.H.M about a fixed point with amplitude of 10 cm, its maximum velocity is 100 cm/s. Its velocity will be 50 cm s^{-1} at a distance(in cm)
(A) 5
(B) $5\sqrt{2}$
(C) $5\sqrt{3}$
(D) $10\sqrt{2}$

21. A mass "M" is suspended form a spring of negligible mass. The spring is pulled a little and then released so that the mass executes SHM of time period "T". If the mass is increased by m, the time period becomes $\frac{5T}{3}$ Then the ratio is of "m" and "M" is:
(A) $\frac{25}{9}$
(B) $\frac{16}{9}$
(C) $\frac{5}{3}$
(D) $\frac{3}{5}$

22. A tunnel has been dug through the center of the Earth and a ball is released in it. It executes S.H.M. with time period:
(A) 42 minutes
(B) 1 day
(C) 1 hour
(D) 84.6 minutes

23. At resonance, the energy transfer becomes:
(A) Minimum
(B) Maximum
(C) Zero
(D) Negative

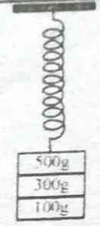
24. The length of a second's pendulum at the surface of Earth is 1m. The length of the second's pendulum at the surface of moon where g is 1/6th that at Earth's surface is:
(A) 1/6 m
(B) 6 m
(C) 1/36 m
(D) 36m

25. The displacement of a particle performing S.H.M. when K.E.= P.E. (amplitude = 4 cm) is:
(A) $2\sqrt{2}$ cm
(B) 2 cm
(C) $1/\sqrt{2}$ cm
(D) $\sqrt{2}$ cm

26. A simple pendulum has time period "t" Its time period in a lift which is moving upwards with acceleration 3 ms^{-2} is:
(A) $t\sqrt{\frac{9.8}{12.8}}$
(B) $t\sqrt{\frac{12.8}{9.8}}$
(C) $t\sqrt{\frac{9.8}{6.8}}$
(D) $t\sqrt{\frac{6.8}{9.8}}$

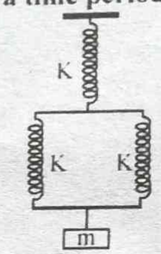
27. Time period of second pendulum on surface of moon is:
(A) 2 s
(B) 2 × 6 s
(C) 1/6 s
(D) 2/6 s

28. Three masses of 500g, 300g and 100 gram are suspended at the end of a spring as shown, and are in equilibrium. When the 500 g mass is removed, the system oscillates with a period of 2 second. When the 300 g mass is also removed, it will oscillate with a period of:



(A) 2s
(B) 4s
(C) 8s
(D) 1s

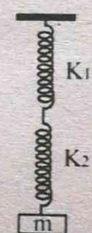
29. If the mass shown in the figure is slightly displayed and then let go, then the system shall oscillate with a time period of:



(A) $2\pi\sqrt{\frac{m}{3K}}$
(B) $2\pi\sqrt{\frac{3m}{2K}}$
(C) $2\pi\sqrt{\frac{2m}{3K}}$
(D) $2\pi\sqrt{\frac{3K}{m}}$

30. Which of the following becomes maximum at mean position?
(A) P.E
(B) Acceleration
(C) Displacement
(D) K.E

31. The time period of the oscillating system (see figure) is:

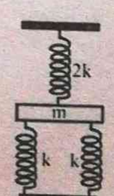


(A) $T = 2\pi\sqrt{\frac{m(K_1+K_2)}{K_1K_2}}$
(B) $T = 2\pi\sqrt{\frac{m(K_1+K_2)}{K_1-K_2}}$
(C) $T = 2\pi\sqrt{\frac{m(K_1K_2)}{K_1+K_2}}$
(D) $T = 2\pi\sqrt{\frac{m(K_1K_2)}{K_1-K_2}}$

32. A particle undergoes simple harmonic motion having time period "T". The time taken in 3/8th oscillation is:
(A) 3T/8
(B) 5T/8
(C) 5T/12
(D) 7T/12

31. The product of frequency and time period is:
(A) 0
(B) 2π
(C) π
(D) 1

32. The spring constant form adjoin combination of spring is:



(A) K
(B) 2K
(C) 4K
(D) 5K/2

33. **A second's pendulum is placed in a space laboratory orbiting around the Earth at a height "3R" form the Earth's surface where "R" is Earth's radius. The time period of the pendulum will be:**
(A) Zero (C) 4 sec
(B) $2\sqrt{3}$ (D) infinity

34. **A simple pendulum is attached to the roof of a lift has a time period of 2s in a stationary lift. If the lift is allowed to fall freely the frequency of oscillations of pendulum will be:**
(A) Zero (C) 0.5 Hz
(B) 2 Hz (D) infinity

35. **The acceleration–displacement graph of a body executing SHM is a:**
(A) straight line (C) circle
(B) sine curve (D) parabola

36. **The frequency of second pendulum is:**
(A) 2 Hz (C) 0.5 Hz
(B) 1 Hz (D) 0.1 Hz

37. **If mass attached to a spring is made four times, the time period becomes:**
(A) doubled (C) remains same
(B) one half (D) four times

38. **A body executes SHM with an amplitude x_o. Its energy is half kinetic and half potential when displacement is:**
(A) $\frac{x_o}{2}$ (C) $\frac{x_o}{\sqrt{2}}$
(B) $\frac{x_o}{3}$ (D) $\frac{x_o}{4}$

39. **If a particle is rotating uniformly along a circular path, its projection would execute _____ along diameter.**
(A) vibratory motion (C) SHM
(B) rotatory motion (D) Translational motion

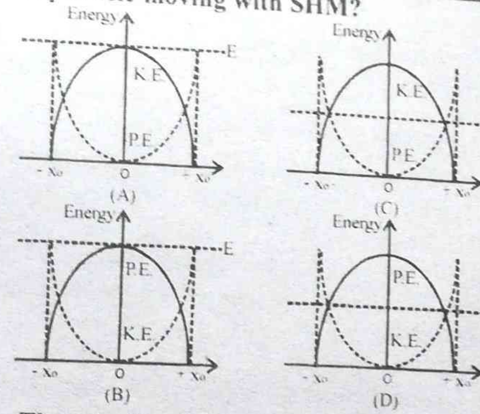
40. **The direction of weight of bob of a pendulum is:**
(A) opposite to the tension
(B) towards the mean position
(C) along the tension
(D) vertically downward

41. **For simple pendulum the graph between "L" and "T" will be :**
(A) a hyperbola (C) a parabola
(B) a curved line (D) a straight line

42. **A particle is performing SHM with amplitude "x_o" and angular velocity "ω". The ratio of maximum velocity to the maximum acceleration is:**
(A) ω (C) $1/\omega$
(B) ω^2 (D) $1/\omega^2$

43. **Free oscillations are always produced by:**
(A) An applied force
(B) Restoring force and inertia
(C) Gravitation force
(D) Inertia only

44. **Which of the following graph best represents the relation between the K.E, P.E and total energy of a particle moving with SHM?**



45. **The velocity of a particle in SHM:**
(A) leads the displacement by $\frac{\pi}{4}$ rad
(B) lags behind the displacement by $\frac{\pi}{4}$ rad
(C) leads the displacement by $\frac{\pi}{2}$ rad
(D) lags behind the displacement by $\frac{\pi}{2}$ rad

46. **A simple pendulum has length "L" and period "T". As it passes through its equilibrium position, the string is suddenly clamped at its midpoint. The period then becomes:**
(A) 2T (C) $T/\sqrt{2}$
(B) T/2 (D) T/4

47. **Time period of horizontal mass spring system will be maximum:**
(A) at Lahore (C) at Mount Everest
(B) at Murree (D) equal at all places

48. **Acceleration of spring–mass system is:**
(A) uniform
(B) variable due to change in direction
(C) variable due to change in magnitude
(D) variable due to change in magnitude and direction

49. **A 0.25 kg block oscillates on the end of the spring with a spring constant of 200N/m. If the system has an energy of 9.0 J, then the amplitude of the oscillation is:**
(A) 0.3m (C) 0.17m
(B) 0.24m (D) 4.9m

50. **Resonance is dangerous in:**
(A) microwave (C) aero planes wing
(B) tuning of radio (D) swing

51. **A particle executing SHM with amplitude "A" and has maximum velocity "v_o". Its speed at displacement "A/2" will be:**
(A) $\sqrt{3}\left(\frac{v_o}{2}\right)$ (C) v_o
(B) $\frac{v_o}{\sqrt{2}}$ (D) $\frac{v_o}{4}$

52. **The acceleration–displacement graph of a body executing SHM is a:**
(A) straight line (C) circle

(B) sine curve (D) parabola

53. **The equation of displacement of a body executing S.H.M is $x = x_o \cos \omega t$, what is the initial phase:**
(A) 0° (C) 90°
(B) 60° (D) 180°

54. **The displacement of particle executing SHM is given by $x = 0.01 \sin(100\pi t)$. The time period is:**
(A) 0.01sec (C) 0.02 sec
(B) 0.2 sec (D) 0.1 sec

55. **The SI unit of spring constant is same as that of:**
(A) force (C) pressure
(B) surface tension (D) intensity

56. **If three identical springs each of constant "k" are hooked together the spring constant of resultant spring will be:**
(A) 3k (C) 6k
(B) k/9 (D) k/3

57. **For a simple harmonic oscillator the potential energy will be equal to the kinetic energy during a cycle:**
(A) at one point
(B) at two different points
(C) at three different points
(D) at four different points

58. **A particle moves in simple harmonic motion according to x = 2 cos(50t), where "x" is in meters and "t" is in seconds. Its maximum velocity in m/s is:**
(A) 100 sin(50t) (C) 100 cos(50t)
(B) 100 (D) 200

59. **In simple pendulum the time period of oscillation is related to the length of pendulum as:**
(A) L/T= constant (C) L^2/T^2=constant
(B) L/T^2=constant (D) L^2/T= constant

60. **A simple harmonic oscillator consists of an particle of mass "m" and an ideal spring with spring constant "k". If the spring is cut in half and used with the same particle, the period will be:**
(A) 2T (C) $\sqrt{2}T$
(B) $T/\sqrt{2}$ (D) T

61. **In a second's pendulum mass of the bob is 30 g. If it is replaced by 90 g mass than time period will be:**
(A) 1 sec (C) 2 sec
(B) 4 sec (D) 3 sec

62. **A student wanted to make a pendulum. Whose time period would be one second. He used a string of length L and found that the period was ½ sec. To get the desired period he should use a string whose length equals:**
(A) ¼ L (C) 2L
(B) ½ L (D) 4 L

63. **During simple harmonic oscillations, a body overshoots its rest position due to:**
(A) applied force (C) inertia
(B) restoring force (D) damping

64. **A particle "P" is moving along a circular path, what will be the motion of its projection (along the diameter of the circle)?**
(A) diametrical motion
(B) circular motion
(C) translational motion
(D) simple harmonic motion

65. **A force of 0.4 N produces an elongation of 4 mm in a spring. The spring constant of the spring has magnitude:**
(A) 0.1 N/m (C) 0.01 N/m
(B) 1.6 N/m (D) 100 N/m

66. **In SHM, the restoring force is directly proportional to:**
(A) velocity (C) displacement
(B) acceleration (D) time period

67. **A person ties four springs, each of constant k, in series. The resultant spring constant he gets will be:**
(A) 4k (C) 16k
(B) k/4 (D) k/16

68. **The acceleration of a body during SHM is minimum at:**
(A) Mean position (C) extreme position
(B) Equilibrium Position (D) Both "A" and "B"

69. **The time period of simple pendulum is 2π then its angular frequency is:**
(A) 50 Hz (C) 1 Hz
(B) 2 Hz (D) 5 Hz

70. **For an SHM oscillator, the ratio of which two quantities is always constant?**
(A) mass and momentum
(B) acceleration and displacement
(C) weight and velocity
(D) restoring force and time period

71. **The mean position of an SHM oscillator is also called equilibrium position because:**
(A) it is the middle position between two extremes
(B) acceleration is zero at this position
(C) displacement is zero at this position
(D) both "B" and "C"

72. **Motion of an SHM oscillator is given by $x=0.25\cos(\pi/4)t$. What is its time period?**
(A) 0.125 seconds (C) 0.25 seconds
(B) 8 seconds (D) 4 seconds

73. **If "x" and "x_o" are the displacement and amplitude of an oscillator, where "ω" is the angular frequency. The velocity is given by:**
(A) $v = \frac{\omega}{\sqrt{x_o^2 - x^2}}$ (C) $v = \sqrt{\omega(x_o^2 - x^2)}$
(B) $v = \omega\sqrt{x_o^2 - x^2}$ (D) $v = \frac{\sqrt{x_o^2 - x^2}}{\omega}$

74. **The phase angle (θ = ωt) of a body performing S.H.M. indicates:**
(A) only the direction of displacement
(B) only the magnitude of displacement
(C) both magnitude and direction of displacement
(D) Driving force

75. **Forced vibration are known as:**
(A) Simple harmonic vibration

(B) Driven harmonic vibration
(C) Natural vibration
(D) Free vibration

76. **For a simple harmonic oscillator what percentage of total energy is potential energy when instantaneous displacement is half of the amplitude?**
(A) 50% (C) 75%
(B) 100% (D) 25%

77. **The ratio of spring constants of two springs is 4:1, the respective ratio of the elastic energy stored in them will be:**
(A) 1:4 (C) 16:4
(B) 4:1 (D) 16:1

78. **The kinetic and potential energies of an oscillating system at mean position, in terms of total energy (E), are E and 0 respectively. After 7/2 vibrations, the kinetic and potential energies will be:**
(A) kinetic energy = E/2, potential energy = E/2
(B) kinetic energy = 0, potential energy = E
(C) kinetic energy = E, potential energy = E
(D) kinetic energy = E, potential energy = 0

79. **If "f" is the frequency, then how many times in a vibration do potential and kinetic energies of an oscillator become equal?**
(A) f times (C) f/2 times
(B) 2f times (D) 4f times

80. **A simple pendulum is oscillating with frequency "f". If series of regular pushes are given to it such that its amplitude is doubled, then its new frequency will be:**
(A) f (C) f/2
(B) 2f (D) 0.2f

81. **When engine of a stationary car is left running, the vibrations are produced in the body of the car. These vibrations are best described under:**
(A) resonant oscillations (C) free oscillations
(B) damped oscillations (D) forced oscillations

82. **A sinusoidal force with a given amplitude is applied to an oscillator. To maintain the largest amplitude of oscillation the frequency of the applied force should be:**
(A) half the natural frequency of the oscillator
(B) 1/4 the natural frequency of the oscillator
(C) same as the natural frequency of the oscillator
(D) twice the natural frequency of the oscillator

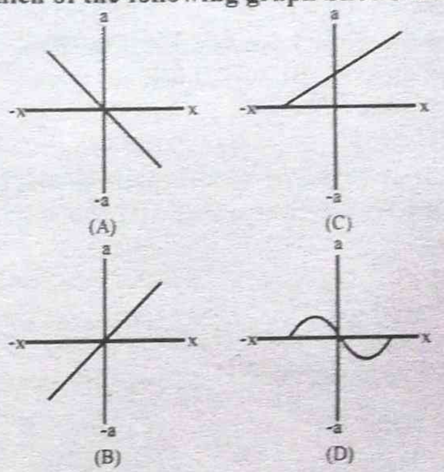
83. **Example of electrical resonance is:**
(A) tuning of a string instrument
(B) tuning of radio
(C) tuning of violin
(D) all of these

84. **The resonance situation must be avoided in case of:**
(A) a swinging cradle (C) an oscillating charge
(B) a vibrating bridge (D) Tuning of radio

85. **Resonance curve is the graph between:**
(A) kinetic and potential energies of the oscillating body
(B) amplitude and frequency of the oscillating body
(C) applied force and frequency of the oscillating body
(D) total energy and amplitude of the oscillating body

86. **The resonance curve is flat if damping is:**
(A) feeble (C) large
(B) small (D) moderate

87. **Which of the following graph Shows SHM?**



88. **What should be the length of the simple pendulum (in meters) whose period is 1sec at a place where $g=10ms^{-2}$**
(A) $1/2\pi$ (C) $10/2\pi^2$
(B) $1/4\pi$ (D) $10/4\pi^2$

89. **The body of a car is supported by four springs each of constant 2000 Nm^{-1}. What will be the value of spring constant for this combination of springs?**
(A) 2000 Nm^{-1} (C) 500 Nm^{-1}
(B) 8000 Nm^{-1} (D) 4000 Nm^{-1}

90. **In damped harmonic oscillation, which one deceases?**
(A) Amplitude of vibration
(B) Both amplitude and energy
(C) Energy of vibration
(D) Neither amplitude nor energy

91. **The motion of simple pendulum is SHM only if:**
(A) Amplitude is large (C) Amplitude is small
(B) Mass is small (D) Length is small

92. **In SHM the restoring force is directly proportional to:**
(A) Velocity (C) acceleration
(B) Displacement (D) Time period

93. **Mass attached to spring is moved slowly from mean position to "x_o". Then work done will be:**
(A) $\frac{1}{2}kx_o^2$ (C) $\frac{1}{2}kx_o$
(B) kx_o^2 (D) ω^2x_o

94. **The wave from of SHM is:**
(A) Sine wave (C) Pulsed wave
(B) Square wave (D) tangent curve

95. **The bob of a simple pendulum is pulled to one side by a horizontal force from the mean position. The tension in the string is:**
(A) Less than before
(B) Greater than before

(C) Unchanged
(D) It depends upon the force

96. The angular frequency "ω" and frequency "f" of SHM are related are:
(A) $f = 2\pi\omega$
(C) $f = \frac{1}{2\pi\omega}$
(B) $\omega = 2\pi f$
(D) $f = \frac{1}{\omega}$

97. A pendulum 1.5m and executes 100 vibrations in 246 seconds. Its period will be:
(A) 2.46s
(C) 2.59s
(B) 24.6Hz
(D) 246 s

98. A mass attached to an elastic spring is executing SHM with frequency of 5Hz, its angular velocity is:
(A) 10π rad s^{-1}
(C) 20π rad s^{-1}
(B) $\pi/10$ rad s^{-1}
(D) 2π rad s^{-1}

99. Unit used for the factor $\sqrt{\frac{\ell}{g}}$ may be:
(A) meter
(C) kilogram
(B) second
(D) radian

100. At mean position:
(A) P.E is maximum and K.E is minimum
(B) Both P.E and K.E are maximum
(C) P.E is minimum and K.E is maximum
(D) Both P.E and K.E are minimum

101. The waves produced in microwaves oven have a wavelength of:
(A) 12cm
(C) 18cm
(B) 12m
(D) 18m

102. In SHM, if 'a' is the amplitude, then displacement of the body from origin after the time "T/4" is:
(A) a/8
(C) a/2
(B) a/4
(D) a

103. When a body moves such that the magnitude of its acceleration is directly proportional to the magnitude of the displacement and is always directed towards the mean position is called:
(A) Angular motion
(B) Constant acceleration
(C) Constant angular acceleration
(D) Simple harmonic motion

104. The potential energy of a particle executing simple harmonic motion at a distance "x" from the equilibrium position is proportional to:
(A) $\sqrt{x}$
(C) x^2
(B) x
(D) x^3

105. If the mass of pendulum is double, its time period is:
(A) Remains unchanged
(C) One third
(B) Doubled
(D) Half

106. If a simple pendulum is shifted from Lahore to Murree, then its time period:
(A) Does not change
(C) Increases
(B) Decreases
(D) Slightly decreases

107. If F=0.04 N and x=4 cm then k =
(A) $1Nm^{-1}$
(C) $3\ Nm^{-1}$
(B) $2Nm^{-1}$
(D) $4Nm^{-1}$

108. A body is said to be executing free vibrations if it oscillates with:
(A) natural time period
(B) Natural frequency
(C) without interference of any external force
(D) All of these

109. The restoring force in case of simple pendulum is:
(A) mg cosθ
(C) mg tanθ
(B) mg sinθ
(D) mg secθ

110. The product of frequency and time period of second pendulum is:
(A) 0.5 Hz
(C) 1 sec
(B) 2 sec
(D) 1

111. Length of the pendulum has time period of 1 second is:
(A) 0.5m
(C) 0.5m
(B) 0.25 sec
(D) 0.25m

112. Displacement of a body executing SHM when initial phase is π/2:
(A) $x = x_o \sin(\omega t + 4)$
(C) $x = x_o \cos \omega t$
(B) $x = x_o \sin(\omega t)$
(D) $x = x_o \cos(\omega t + \Phi)$

113. K.E. of spring executing SHM at any instant of time is:
(A) $K.E = \frac{1}{2} K x_o^2\left(1 - \frac{x^2}{x_o^2}\right)$
(C) Both "A" and "B"
(B) $K.E = (K.E)_{max}\left(1 - \frac{x^2}{x_o^2}\right)$
(D) $K.E = \frac{1}{2} Kx^2$

114. Shock absorber is the application of:
(A) oscillation
(C) Damped oscillation
(B) Forced oscillation
(D) Free oscillation

115. When the length of the simple pendulum is doubled, find the ratio of the new frequency to the old frequency:
(A) 2
(C) $1/\sqrt{2}$
(B) 1/2
(D) $\sqrt{2}$

116. The ratio of maximum potential energy and instantaneous K.E is always:
(A) equal to one
(B) less than or equal to one
(C) less than one
(D) greater than or equal one

117. Damping means:
(A) increase in energy
(C) Resonanting energy
(B) Dissipation of energy
(D) Oscillating energy

118. Which one does not work according to resonance?
(A) T.V
(C) Radio
(B) Microwave oven
(D) Bulb

119. In SHM K.E is greater than potential energy at the distance of :
(A) $x_o/2$
(C) $x_o/8$
(B) $x_o/4$
(D) All of these

120. Which of the following is not an example of SHM:
(A) Motion of pendulum
(B) Motion of spring mass system
(C) Vibration of tuning fork
(D) Motion of fan

121. Particle is in simple harmonic motion with period "T". At time t = 0 it is at the equilibrium point. Of

the following times, at which time is it farthest from the equilibrium point?
(A) 1.5T (C) 0.7T
(B) T (D) 1.25T

122. A particle moves back and forth along the x axis from $x = -x_m$ to $x = +x_m$, in simple harmonic motion with period T. At time t = 0 it is at $x = +x_m$. When t = 0.75T:
(A) it is at x = 0 and is traveling toward $x = +x_m$
(B) it is at x = 0 and is traveling toward $x = -x_m$
(C) it at $x = +x_m$ and is at rest
(D) it is between x = 0 and $x = +x_m$ and is traveling toward $x = -x_m$

123. A block attached to a spring oscillates in simple harmonic motion along the x axis. The limits of its motion are x = 10 cm and x = 50 cm and it goes from one of these extremes to the other in 0.25 s. Its amplitude and frequency are:
(A) 20 cm, 2 Hz (C) 20 cm, 4 Hz
(B) 40 cm, 2 Hz (D) 25 cm, 4 Hz

124. The acceleration of a body executing simple harmonic motion leads the velocity by what phase?
(A) 0 rad (C) $\pi/8$ rad
(B) $\pi/4$ rad (D) $\pi/2$ rad

125. A 3 kg block, attached to a spring, executes simple harmonic motion according to x = 2 cos(50t) where "x" is in meters and "t" is in seconds. The spring constant of the spring is:
(A) 1N/m (C) 100N/m
(B) 150N/m (D) 7500N/m

126. The period of a simple pendulum is 1 s on Earth. When brought to a planet where g is one-tenth that on Earth, its period becomes:
(A) 1 s (C) $1/\sqrt{10}$ s
(B) 1/10 s (D) $\sqrt{10}$ s

127. A simple pendulum of length "L" and mass "M" has frequency "f". To increase its frequency to 2f:
(A) increase its length to 4L
(B) decrease its length to L/2
(C) increase its length to 2L
(D) decrease its length to L/4

128. An object of mass "m", oscillating on the end of a spring with spring constant "k", has amplitude "A" its maximum speed is:
(A) $A\sqrt{k/m}$ (C) A^2k/m
(B) $A\sqrt{m/k}$ (D) Am/k

129. When K.E energy of SHM is maximum, its:
(A) P.E is zero
(B) Acceleration is zero
(C) Restoring force is zero
(D) All P.E acceleration & restoring force are zero

130. Sharpness of resonance is:
(A) directly proportional to damping force
(B) inversely proportional to damping force
(C) equal to square of damping force
(D) equal to square of damping force

131. A simple pendulum suspended from the ceiling of a lift has time period "T", when the lift is at rest. When the lift falls freely, the time period is:
(A) Infinite (C) T/g
(B) Zero (D) g/T

132. The energy of S.H.M is constant at:
(A) Mean position
(B) In between mean position
(C) Extreme position
(D) All positions during SHM

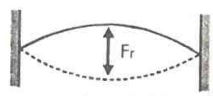
133. Total distance traveled by bob of simple pendulum in one vibration is equal to:
(A) Amplitude (C) Square of amplitude
(C) 2 × amplitude (D) 4 × amplitude

134. Natural frequency of simple pendulum depends upon:
(A) Its mass
(B) Square of its length
(C) Its length
(D) Square root of its length

135. For what displacement the P.E becomes ¼ of its maximum value?
(A) $x = x_o$ (C) $x = x_o/2$
(B) $x = x_o/4$ (D) $x = x_o^2/2$

UNIT 05 OSCILLATIONS (SOLUTIONS)

01. (B)



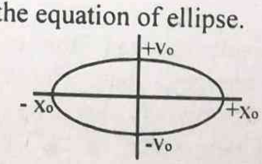
The oscillatory motion taking place under the action of restoring force is called simple harmonic motion.

02. (B)

$$x = x_o\cos(\omega t)$$
$$\frac{x_o}{2} = x_o\cos(\omega t) \Rightarrow \cos(\omega t) = (1/2)$$
$$\omega t = \cos^{-1}(1/2) = \pi/3$$
$$\frac{2\pi}{T} \times t = \frac{\pi}{3} \Rightarrow T = 6t = 6(1s) = 6\ s$$

03. (B)

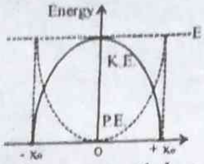
$$x = x_o\sin\theta \Rightarrow x^2 = x_o^2\sin^2\theta \Rightarrow \frac{x^2}{x_o^2} = \sin^2\theta$$
$$v = v_o\cos\theta \Rightarrow v^2 = v_o^2\cos^2\theta \Rightarrow \frac{v^2}{v_o^2} = \cos^2\theta$$
$$\frac{x^2}{x_o^2} + \frac{v^2}{v_o^2} = \sin^2\theta + \cos^2\theta = 1$$
which is the equation of ellipse.



04. (D)

$$a = -\omega^2 x$$
at mean position x= 0
$$a = -\omega^2(0) = 0$$

05. (D)



In one vibration potential energy is completely converted in to kinetic energy two times.

06. (C)

In one time period potential energy is completely converted in to kinetic energy two times. So, the time by which potential energy is completely converted into kinetic energy once in half of time period (T/2).

07. (C)

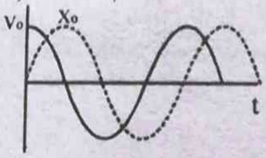
$a = \omega^2 x$

according to given condition

$\omega^2 = 1 \Rightarrow \omega = 1 \Rightarrow \dfrac{2\pi}{T} = 1 \Rightarrow T = 2\pi$ second

08. (A)

$v = v_o\cos(\omega t)$



Staring from mean position t = 0

$v = v_o\cos 0^\circ = v_o$

09. (D)

$$T = 2\pi\sqrt{\frac{M}{k}}$$

$$T' = 2\pi\sqrt{\frac{M+M}{k}}$$

$$T' = 2\pi\sqrt{\frac{2M}{k}} = \sqrt{2}\left(2\pi\sqrt{\frac{M}{k}}\right) = \sqrt{2}T$$

10. (B)

$$T = 2\pi\sqrt{\frac{\ell}{g}}$$

$T \propto \sqrt{\ell}$

As the length of pendulum is measured from center of mass of bob to the rigid support. When child stands up in the swing, length of pendulum will decrease. So, time period will also decrease.

11. (A)

$$T = 2\pi\sqrt{\frac{\ell}{g}}$$

$T \propto \sqrt{\ell}$

Time period of pendulum increases exponentially ($T \propto \ell^{1/2}$) with length of pendulum.

12. (B)

The negatively charged Bob will be attracted by positively charged plate. Hence the net force in vertically downwards direction in increased. This leads to a new value of "g" Which is obviously increased. With the new increased value of "g" being used in the formula we can conclude that the expression of time period decreases as "T" is inversely proportional to acceleration due to gravity. Therefore time period will decrease.

13. (C)

The velocity of body performing SHM at mean position is given by:

$v_o = x_o\omega \Rightarrow v_o \propto x_o$ (ω = constant)

14. (B)

Compare the given equation with

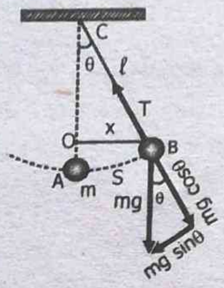
$a = -\omega^2 x$

$$\omega^2 = b \Rightarrow \omega = \sqrt{b} \Rightarrow \frac{2\pi}{T} = \sqrt{b} \Rightarrow T = \frac{2\pi}{\sqrt{b}}$$

15. (D)

Distance covered during 1 vibration = 4(amplitude) = 4A

16. (D)



In simple pendulum

$T = mg\cos\theta$

At mean position $\theta = 0^\circ$

$T = mg$ (maximum)

17. (B)

When a periodic force acts on a body and the time period of the periodic force is equal to the natural time period of the vibrating body, then the amplitude of the vibration markedly increases. This process is called resonance.

18. (D)

$$E = \frac{1}{2}m\omega^2A^2 = \frac{1}{2}m\left(\sqrt{\frac{k}{m}}\right)^2A^2 = \frac{1}{2}m\left(\frac{k}{m}\right)A^2 = \frac{1}{2}kA^2$$

If "A" same, the energy will remain same.

19. (D)

$$K.E. = \frac{1}{2}kx_o^2\left(1 - \frac{x^2}{x_o^2}\right) = T.E.\left(1 - \frac{x^2}{x_o^2}\right)$$

$$= T.E.\left(1 - \frac{(x_o/2)^2}{x_o^2}\right) = T.E.\left(1 - \frac{1}{4}\right) = T.E.\left(\frac{3}{4}\right)$$

20. (C)

$$v = v_o\sqrt{1 - \frac{x^2}{x_o^2}}$$

$$50 = 100\sqrt{1 - \frac{x^2}{10^2}} \Rightarrow \frac{1}{2} = \sqrt{1 - \frac{x^2}{10^2}}$$

$$1 - \frac{x^2}{10^2} = \frac{1}{4} \Rightarrow 1 - \frac{1}{4} = \frac{x^2}{100}$$

$$\frac{x^2}{100} = \frac{3}{4}$$

$$x^2 = \frac{(3)(100)}{4} \Rightarrow x = \sqrt{\frac{(3)(100)}{4}} = \frac{10}{2}\sqrt{3} = 5\sqrt{3}\text{ cm}$$

21. (B)

$$T = 2\pi\sqrt{\frac{M}{k}}$$

$$\frac{5T}{3} = 2\pi\sqrt{\frac{M+m}{k}}$$

$$\frac{5T/3}{T} = \frac{2\pi\sqrt{\frac{M+m}{k}}}{2\pi\sqrt{\frac{M}{k}}} = \sqrt{\frac{M+m}{M}} = \sqrt{1+\frac{m}{M}}$$

$$\frac{5}{3} = \sqrt{1+\frac{m}{M}} \Rightarrow 1+\frac{m}{M} = \frac{25}{9} \Rightarrow \frac{m}{M} = \frac{25}{9} - 1 = \frac{16}{9}$$

22. (D)

As we know that when a body is moving along the circumference of circle with constant angular velocity, then its projection performs SHM along the diameter of circle. So,
time period of its projection along diameter (SHM) = Time period of particle moving along the circle
As, the motion of particle along the circle is similar to the motion of low orbiting satellite. We know that the time period of low orbiting satellite is ≈ 84 min.

23. (B)

The energy of the oscillation comes from the driving source. At resonance, the transfer of energy is maximum.

24. (A)

$$T = 2\pi\sqrt{\frac{\ell}{g}} \Rightarrow T^2 = 4\pi^2\frac{\ell}{g} \Rightarrow \ell = \frac{gT^2}{4\pi^2}$$

$$\ell_E = \frac{g_E T^2}{4\pi^2}$$

$$\ell_m = \frac{g_m T^2}{4\pi^2}$$

$$\frac{\ell_m}{\ell_E} = \frac{\frac{g_m T^2}{4\pi^2}}{\frac{g_E T^2}{4\pi^2}} = \frac{g_m}{g_E} = \frac{g_E/6}{g_E} = \frac{1}{6} \Rightarrow \ell_m = \frac{1}{6}\ell_E = \frac{1}{6}\text{ m}$$

25. (A)

K.E. = P.E.

$$\frac{1}{2}k(x_o^2 - x^2) = \frac{1}{2}kx^2$$

$$x_o^2 - x^2 = x^2$$

$$2x^2 = x_o^2 \Rightarrow x^2 = \frac{x_o^2}{2} \Rightarrow x = \frac{x_o}{\sqrt{2}} = \frac{4}{\sqrt{2}}\text{cm} = 2\sqrt{2}\text{ cm}$$

26. (A)

$$t = 2\pi\sqrt{\frac{\ell}{g}} = 2\pi\sqrt{\frac{\ell}{9.8}}$$

$$T = 2\pi\sqrt{\frac{\ell}{g+a}} = 2\pi\sqrt{\frac{\ell}{9.8+3}} = 2\pi\sqrt{\frac{\ell}{12.8}}$$

$$\frac{T}{t} = \frac{2\pi\sqrt{\frac{\ell}{12.8}}}{2\pi\sqrt{\frac{\ell}{9.8}}} = \sqrt{\frac{9.8}{12.8}} \Rightarrow T = \sqrt{\frac{9.8}{12.8}}\,t$$

27. (A)

Pendulum having time period equals to 2 seconds is known as 2nd pendulum.

28. (D)

$$T_1 = 2\pi\sqrt{\frac{m_1}{k}}$$

$$T_2 = 2\pi\sqrt{\frac{m_2}{k}}$$

$$\frac{T_2}{T_1} = \frac{2\pi\sqrt{\frac{m_2}{k}}}{2\pi\sqrt{\frac{m_1}{k}}} = \sqrt{\frac{m_2}{m_1}} = \sqrt{\frac{100g}{400g}} = \frac{1}{2}$$

$(m_1 = 900g - 500g = 400\text{ g})$

$$T_2 = \frac{1}{2}T_1 = \frac{1}{2}(2) = 1\text{s}$$

29. (B)

$k' = k + k = 2k$ (for parallel combination)

$k_e = \frac{(k)(k')}{k+k'} = \frac{(k)(2k)}{k+2k} = \frac{2k}{3}$ (for series combination)

$$T = 2\pi\sqrt{\frac{m}{2k/3}} = 2\pi\sqrt{\frac{3m}{2k}}$$

30. (D)

$$\text{K.E.} = \frac{1}{2}k(x_o^2 - x^2)$$

At mean position x = 0

$\text{K.E.} = \frac{1}{2}kx_o^2$ (maximum)

31. (A)

$k_e = \frac{k_1 k_2}{k_1 + k_2}$ (for series combination)

$$T = 2\pi\sqrt{\frac{m}{k_1k_2/(k_1+k_2)}} = 2\pi\sqrt{\frac{m(k_1+k_2)}{k_1k_2}}$$

32. (A)

Time for 1 oscillation = T

Time for 3/8th oscillation = $\frac{3}{8}T$

31. (D)

$$f = \frac{1}{T} \Rightarrow fT = 1$$

32. (C)

$k' = 2k + k + k = 4k$ (for parallel combination)

33. (D)

$$T = 2\pi\sqrt{\frac{\ell}{g-a}}$$

As space laboratory orbiting around the Earth is a freely falling object. So, a = g

$$T = 2\pi\sqrt{\frac{\ell}{g-g}} = \infty$$

$$f = \frac{1}{T} = \frac{1}{\infty} = 0$$

34. (A)

$$T = 2\pi\sqrt{\frac{\ell}{g-a}}$$

For freely falling body a = g

$$T = 2\pi\sqrt{\frac{\ell}{g-g}} = \infty$$

$$f = \frac{1}{T} = \frac{1}{\infty} = 0$$

35. (A)

By the definition of SHM

$$\vec{a} \propto -\vec{x}$$

36. (C)

$$f = \frac{1}{T} = \frac{1}{2} = 0.5 \text{ Hz}$$

37. (A)

$$T = 2\pi\sqrt{\frac{m}{k}} \Rightarrow T \propto \sqrt{m}$$

38. (C)

K.E. = P.E.

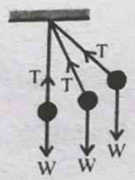
$$\frac{1}{2}k(x_o^2 - x^2) = \frac{1}{2}kx^2 \Rightarrow x_o^2 - x^2 = x^2$$

$$2x^2 = x_o^2 \Rightarrow x^2 = \frac{x_o^2}{2} \Rightarrow x = \frac{x_o}{\sqrt{2}}$$

39. (C)

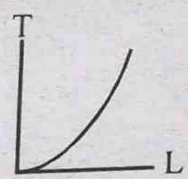
When a body is moving along the circumference of circle with constant angular velocity, then its projection performs SHM along the diameter of circle.

40. (D)



41. (B)

$$T \propto \sqrt{\ell}$$



42. (C)

$$\frac{v_o}{a_o} = \frac{x_o\omega}{x_o\omega^2} = \frac{1}{\omega}$$

43. (B)

When a body is oscillating with its natural frequency without the interference of an external force, then its oscillations are called free oscillations.

44. (A)

Point "O" represents the mean position.

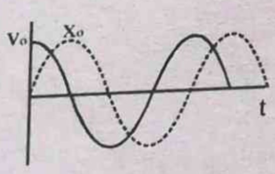
At mean position

$K.E = \frac{1}{2}kx_o^2$ and $P.E = 0$

At extreme position

$P.E = \frac{1}{2}kx_o^2$ and $K.E = 0$

45. (C)



46. (C)

$$T = 2\pi\sqrt{\frac{\ell}{g}}$$

$$\frac{T'}{T} = \frac{2\pi\sqrt{\frac{\ell/2}{g}}}{2\pi\sqrt{\frac{\ell}{g}}} = \frac{1}{\sqrt{2}} \Rightarrow T' = \frac{1}{\sqrt{2}}T$$

47. (D)

$$T = 2\pi\sqrt{\frac{m}{k}}$$

"m" and "k" is independent on the height.

48. (D)

$$\vec{a} = -\omega^2\vec{x}$$

Acceleration is a vector quantity it will vary by varying the magnitude and direction.

49. (A)

$$E = \frac{1}{2}kx_o^2$$

$$9 = \frac{1}{2}(200)x_o^2 \Rightarrow x_o^2 = \frac{9}{100} \Rightarrow x_o = \frac{3}{10} = 0.3 \text{ m}$$

50. (C)

The resonance in th wing of plane will disturb the motion of plane. So, it will be dangerous.

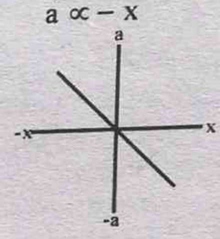
51. (A)

$$v = v_o\sqrt{1 - \frac{(A/2)^2}{A^2}} = v_o\sqrt{1 - \frac{1}{4}} = v_o\sqrt{\frac{3}{4}} = \sqrt{3}\left(\frac{v_o}{2}\right)$$

52. (A)

$$\vec{a} = -\omega^2\vec{x}$$

$$\vec{a} \propto -\vec{x}$$



(straight line)

53. (C)

If we take initial phase "$\Phi = 90^o$ or $\left(\frac{\pi}{2}\right)$". So,

$$x = x_o \sin(\omega t + 90^o) = x_o \cos \omega t$$

54. (C)

$x = 0.01\sin(100\pi t)$

$x = x_o\sin(\omega t)$

by comparing

$$\omega = 100\pi \Rightarrow \frac{2\pi}{T} = 100\pi \Rightarrow T = \frac{1}{50} = 0.02 \text{ sec}$$

55. (B)

The unit if surface tension and spring constant is N/m.

56. (A)

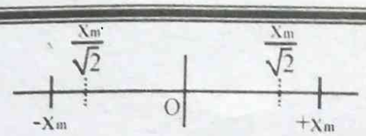
As the springs are in parallel with same hook. So,

$k_e = k + k + k = 3k$

57. (B)

The K.E and P.E will be same at a distance $x = \frac{x_o}{\sqrt{2}}$.

This will happen at two different points in half vibration. This will repeat at same two points in next half vibration.



58. (B)

$x = 2\cos(50t)$
compare it with
$x = x_o\cos(\omega t)$
$x_o = 2$ and $\omega = 50$
$v_o = x_o\omega = (2)(50) = 100$ m/s

59. (B)

$$T = 2\pi\sqrt{\frac{L}{g}} \Rightarrow T^2 = 4\pi^2\frac{L}{g} \Rightarrow \frac{L}{T^2} = \frac{g}{4\pi^2} = \text{constant}$$

60. (B)

$$T = 2\pi\sqrt{\frac{m}{k}}$$

If a spring is cut into two halves then the spring constant of each half will be doubled.

$k' = 2k$

$$T' = 2\pi\sqrt{\frac{m}{k'}} = 2\pi\sqrt{\frac{m}{2k}} = \frac{1}{\sqrt{2}}\left(2\pi\sqrt{\frac{m}{k}}\right) = \frac{1}{\sqrt{2}}T$$

61. (C)

$$T = 2\pi\sqrt{\frac{\ell}{g}}$$

As the time period of simple pendulum does not depends upon the mass of bob. So, it will remain same.

62. (A)

$$T = 2\pi\sqrt{\frac{L}{g}} \Rightarrow T^2 = 4\pi^2\frac{L}{g} \Rightarrow L = \frac{gT^2}{4\pi^2}$$

$$L' = \frac{gT'^2}{4\pi^2}$$

$$\frac{L'}{L} = \frac{\frac{gT'^2}{4\pi^2}}{\frac{gT^2}{4\pi^2}} = \frac{T'^2}{T^2}$$

$$L' = \frac{T'^2}{T^2} \times L = \frac{(1/2)^2}{(1)^2} \times L = \frac{1}{4}L$$

63. (C)

During simple harmonic oscillations, a body overshoots its rest position due to inertia.

64. (D)

As we know that when a body is moving along the circumference of circle with constant angular velocity, then its projection performs SHM along the diameter of circle.

65. (D)

$$k = \frac{F}{x} = \frac{0.4}{0.4 \times 10^{-2}} = 100 \text{ N/m}$$

66. (C)

$$\vec{F}_{rst} = -k\vec{x}$$

$$\vec{F}_{rst} \propto -\vec{x}$$

67. (B)

For series combination

$$k_e = \frac{k}{n} = \frac{k}{4}$$

68. (D)

$a = \omega^2 x$
at mean ((equilibrium)) position $x = 0$
$a = \omega^2(0) = 0$ (minimum)

69. (C)

$$\omega = \frac{2\pi}{T} = \frac{2\pi}{2\pi} = 1 \text{ Hz}$$

70. (B)

In SHM

$$a \propto x \Rightarrow \frac{a}{x} = \text{constant.}$$

71. (D)

A body is in equilibrium position during SHM if it has zero acceleration and acceleration will be zero if displacement is also zero.

$$\vec{a} = -\frac{k}{m}\vec{x}$$

72. (B)

$x = 0.25\sin(\pi/4)t$
$x = x_o\sin(\omega t)$
by comparing

$$\omega = \pi/4 \Rightarrow \frac{2\pi}{T} = \frac{\pi}{4} \Rightarrow T = 8 \text{ s}$$

73. (B)

$$v = \omega\sqrt{x_o^2 - x^2} = x_o\omega\sqrt{\left(1 - \frac{x^2}{x_o^2}\right)}$$

74. (C)

Angle "$\theta = \omega t$" which specifies the magnitude of displacement as well as the direction of motion of the point performing SHM is known as phase.

75. (B)

A physical system under going forced vibrations is known as driven harmonic oscillator.

76. (D)

$$P.E. = \frac{1}{2}kx^2$$

$$P.E. = \frac{1}{2}k(x_o/2)^2 = \frac{1}{4}\left(\frac{1}{2}kx_o^2\right) = \frac{1}{4}(T.E) \text{ or } 25\% \text{ of T.E.}$$

77. (D)

$$E = \frac{1}{2}kx_o^2 \Rightarrow E \propto k$$

$$\frac{E_1}{E_2} = \frac{k_1}{k_2} = \frac{4}{1} \Rightarrow E_1 : E_2 = 4:1$$

78. (B)

As body starts from mean position after 7/2 vibrations (3 and ½ vibration) the body will remain on the mean position.
K.E. = E
P.E. = 0

79. (D)

The kinetic and potential energies will be equal at $x = \frac{x_o}{\sqrt{2}}$. This condition appears 4times in complete vibration. So, its frequency is 4f.

80. (A)

The frequency of oscillating simple pendulum is given by:

$$f=\frac{1}{2\pi}\sqrt{\frac{g}{\ell}}$$

It is independent to amplitude.

81. (D)

If an oscillating system is subjected to an external force, then its oscillations are called forced oscillation.

82. (C)

Resonance occurs when the frequency of the applied force is equal to one of the natural frequencies of the vibration of the forced or driven harmonic oscillator then the amplitude of the vibration markedly increases.

83. (B)

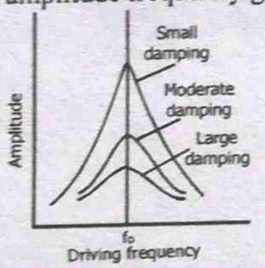
Radio and microwaves are the applications of electrical resonance.

84. (B)

The collapse of bridge is suspected to be due to violent resonance oscillations.

85. (B)

A heavily damped system has fairly flat resonance curve in an amplitude frequency graph.



86. (C)

A heavily damped system has fairly flat resonance curve in an amplitude frequency graph.

87. (A)

$\vec{a} \propto -\vec{x}$

When a body moves from mean to extreme position then displacement increases, magnitude of acceleration increases but in opposite to displacement.

88. (D)

$$T = 2\pi\sqrt{\frac{\ell}{g}} \Rightarrow T^2 = 4\pi^2\frac{\ell}{g} \Rightarrow \ell = \frac{gT^2}{4\pi^2} = \frac{(10)(1)^2}{4\pi^2} = \frac{10}{4\pi^2}$$

89. (B)

$k_e = nk = (4)(2000) = 8000$ N/m

90. (B)

i. The oscillations in which the amplitude decreases steadily with time are called damped oscillations.

ii. Such a process in which energy is dissipated from the oscillating system is called damped oscillations or damping.

91. (C)

Any pendulum undergoes simple harmonic motion when the amplitude of oscillation is small.

92. (B)

$\vec{F} = -k\vec{x}$

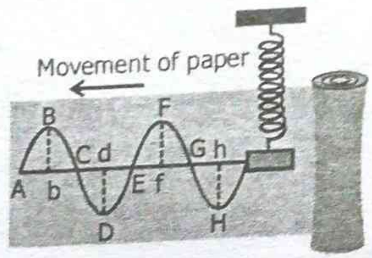
$\vec{F} \propto -\vec{x}$

93. (A)

$$W = (F_{avg})(d) = \left(\frac{1}{2}k\,x_o\right)(x_o)$$

$$P.E = \frac{1}{2}k\,x_o^2$$

94. (A)



This is sine curve.

95. (A)

The tension in the string will be maximum at mean position

$$T = mg$$

In all other cases the tension will be less than maximum value.

96. (B)

$$\omega = \frac{\theta}{T}$$

For one revolution

$\theta = 2\pi$ rad

So, $\omega = 2\pi\left(\frac{1}{T}\right) = 2\pi f$

97. (A)

$$T = \frac{t}{100} = \frac{246}{100} = 2.46\text{ s}$$

98. (A)

$\omega = 2\pi f = (2)(\pi)(5) = 10\pi$ rad/s

99. (B)

$$T = 2\pi\sqrt{\frac{\ell}{g}} \Rightarrow \sqrt{\frac{\ell}{g}} = \frac{T}{2\pi} = s$$ (2π is unit less)

100. (C)

At mean position x= 0

$$K.E. = \frac{1}{2}kx_o^2\left(1-\frac{x^2}{x_o^2}\right) = \frac{1}{2}kx_o^2\left(1-\frac{0^2}{x_o^2}\right) = \frac{1}{2}kx_o^2$$

(maximum)

$$P.E. = \frac{1}{2}kx^2 = \frac{1}{2}k(0)^2 = 0$$ (minimum)

101. (A)

In microwave oven heating and cooking of food occurs due to resonance. The waves produced in this type oven have a wavelength of 12 cm at a frequency of 2450 MHz.

102. (D)

Distance covered in time period "T" = 4(amplitude) = 4a

Distance covered in time "T/4" = a

103. (D)

A vibratory motion in which the acceleration of the body is directly proportional to the displacement from the mean position and is always directed towards the mean position is called simple harmonic motion (SHM). Mathematically:

$$\vec{a} \propto -\vec{x}$$

104. (C)

$$P.E. = \frac{1}{2}kx^2$$

$$P.E. \propto x^2$$

105. (A)

The time period of the simple pendulum is given by:

$$T = 2\pi\sqrt{\frac{\ell}{g}}$$

As the time period of the simple pendulum is independent of mass of bob. So, if the suspended mass is double it does not affect the time period of simple pendulum.

106. (C)

$$T = 2\pi\sqrt{\frac{\ell}{g}}$$

$$T \propto \frac{1}{\sqrt{g}}$$

As

$$g = \frac{GM}{R^2} \Rightarrow g \propto \frac{1}{R^2}$$

$g_{Lahore} > g_{Murree}$

$T_{Murree} > T_{Lahore}$

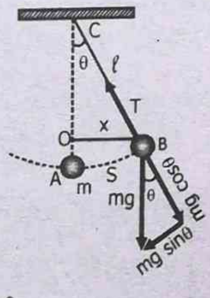
107. (A)

$$k = \frac{F}{x} = \frac{0.04}{0.04} = 1 \text{ N/m}$$

108. (D)

When a body is oscillating with its natural frequency without the interference of an external force, then its oscillations are called free oscillations.

109. (B)



$$F_r = -mg\sin\theta$$

110. (D)

$$f = \frac{1}{T} \Rightarrow fT = 1$$

111. (D)

$$T = 2\pi\sqrt{\frac{\ell}{g}} \Rightarrow T^2 = 4\pi^2\frac{\ell}{g} \Rightarrow \ell = \frac{gT^2}{4\pi^2} = \frac{(1)^2}{4} = 0.25 \text{ m}$$

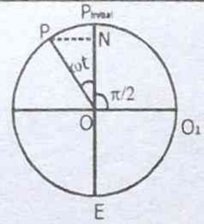
$(g \approx \pi^2)$

112. (C)

If we take initial phase "$\Phi = 90^o$ or $\left(\frac{\pi}{2}\right)$". So,

$$x = x_o \sin(\omega t + 90^o)$$

$$x = x_o \cos \omega t$$



113. (C)

$$K.E. = \frac{1}{2}kx_o^2\left(1 - \frac{x^2}{x_o^2}\right)$$

$$(K.E.)_{max} = \frac{1}{2}kx_o^2\left(1 - \frac{0^2}{x_o^2}\right) = \frac{1}{2}kx_o^2$$

$$K.E. = (K.E.)_{max}\left(1 - \frac{x^2}{x_o^2}\right)$$

114. (C)

Application of damped oscillations is the shock absorber of a car which provides a damping force to prevent excessive oscillations.

115. (C)

$$f = \frac{1}{2\pi}\sqrt{\frac{g}{\ell}} \Rightarrow f \propto \frac{1}{\sqrt{\ell}}$$

$$\frac{f'}{f} = \sqrt{\frac{\ell}{\ell'}} = \sqrt{\frac{\ell}{2\ell}}\frac{1}{\sqrt{2}}$$

116. (D)

$$K.E. = \frac{1}{2}kx_o^2\left(1 - \frac{x^2}{x_o^2}\right)$$

$$P.E_{max} = \frac{1}{2}kx_o^2$$

$$\frac{P.E_{max}}{K.E} = \frac{1}{\left(1 - \frac{x^2}{x_o^2}\right)}$$

If $x = 0$

$$\frac{P.E_{max}}{K.E} = 1$$

If $x \neq 0$

$$\frac{P.E_{max}}{K.E} > 1$$

117. (B)

Such a process in which energy is dissipated from the oscillating system is called damped oscillations or damping.

118. (D)

All work on the principle of resonance except bulb.

119. (D)

At $x = \frac{x_o}{2}$

$$K.E. = \frac{1}{2}kx_o^2\left(1 - \frac{x^2}{x_o^2}\right) = T.E.\left(1 - \frac{x^2}{x_o^2}\right) = T.E.\left(1 - \frac{(x_o/2)^2}{x_o^2}\right)$$

$$= T.E.\left(1 - \frac{1}{4}\right) = T.E.\left(\frac{3}{4}\right)$$

$$P.E. = \frac{1}{4}(T.E)$$

At $x = \frac{x_o}{4}$

$$K.E. = \frac{1}{2}kx_o^2\left(1 - \frac{x^2}{x_o^2}\right) = T.E.\left(1 - \frac{x^2}{x_o^2}\right) = T.E.\left(1 - \frac{(x_o/4)^2}{x_o^2}\right)$$

$$= T.E.\left(1 - \frac{1}{16}\right) = T.E.\left(\frac{15}{16}\right)$$

$P.E. = \frac{1}{16}(T.E)$

At $x = \frac{x_o}{8}$

$K.E. = \frac{1}{2}kx_o^2\left(1 - \frac{x^2}{x_o^2}\right) = T.E.\left(1 - \frac{x^2}{x_o^2}\right) = T.E.\left(1 - \frac{(x_o/8)^2}{x_o^2}\right)$

$= T.E.\left(1 - \frac{1}{64}\right) = T.E.\left(\frac{63}{64}\right)$

$P.E. = \frac{1}{64}(T.E)$

In all above cases K.E > P.E

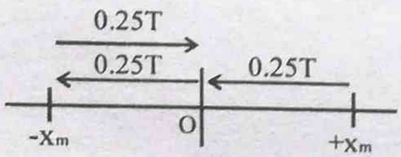
120. (D)

Motion of fan is a rotatory motion.

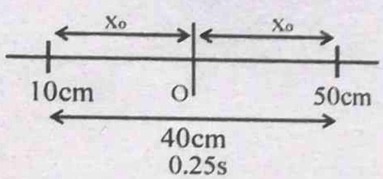
121. (D)

When body starts from mean position, after time T it completes one vibration. Four equal steps are covered in one vibration.
Time for 1 step (mean to extreme) = 0.25T
So, after 1.25T (T + 0.25T), the body will be farthest from equilibrium point.

122. (A)

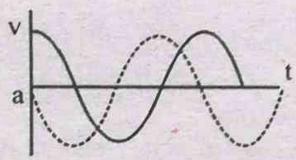


123. (A)



$2x_o = 40cm \Rightarrow x_o = 20$ cm
$T = 2(0.25)$ s $= 0.5$ s
$f = \frac{1}{0.5} = 2$ Hz

124. (D)



125. (D)

In mass spring system

$\omega^2 = \frac{k}{m} \Rightarrow k = m\omega^2 = (3)(50)^2 = 7500$ N/m

126. (D)

$T = 2\pi\sqrt{\frac{\ell}{g}}$

$\frac{T'}{T} = \frac{2\pi\sqrt{\frac{\ell}{g/10}}}{2\pi\sqrt{\frac{\ell}{g}}} = \sqrt{10}$

$T' = \sqrt{10}T = \sqrt{10}(1) = \sqrt{10}$ s

127. (D)

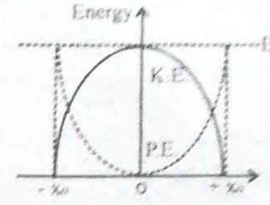
$f = \frac{1}{2\pi}\sqrt{\frac{g}{L}} \Rightarrow f^2 = \frac{1}{4\pi^2}\frac{g}{L} \Rightarrow L = \frac{g}{4\pi^2 f^2}$

$L' = \frac{g}{4\pi^2(2f)^2} = \frac{1}{4}\left(\frac{g}{4\pi^2 f^2}\right) = \frac{1}{4}L$

128. (A)

$v_o = x_o\sqrt{k/m} = A\sqrt{k/m}$

129. (A)



130. (B)

The amplitude as well as the sharpness, both depends upon the damping. Smaller the damping greater will be the amplitude and more sharp will be the resonance.

131. (A)

$T = 2\pi\sqrt{\frac{\ell}{g - a}}$

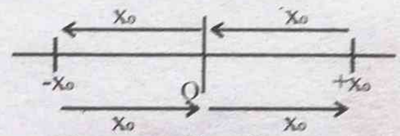
For freely falling a = g

$T = 2\pi\sqrt{\frac{\ell}{g - g}} = \infty$

132. (D)

E = K.E + P.E = constant

133. (D)



Distance = 4(amplitude)

134. (D)

$f = \frac{1}{2\pi}\sqrt{\frac{g}{L}} \Rightarrow f \propto \frac{1}{\sqrt{L}}$

135. (C)

At $x = x_o/2$

$U = \frac{1}{2}kx^2$

$U' = \frac{1}{2}k(x_o/2)^2 = \frac{1}{4}\left(\frac{1}{2}kx_o^2\right) = \frac{1}{4}U_{max}$

UHS PAST MDCAT (2008-2019)

1. **If the mass of the bob of a pendulum is doubled its time period is: (UHS 2008)**

(A) Halved
(B) Doubled
(C) Unchanged
(D) Increases four times

(C)

$T = 2\pi\sqrt{\frac{\ell}{g}}$

Time period of simple pendulum is independent of mass of bob.

2. **The angular frequency of simple pendulum is directly proportional to: (UHS 2008)**

(A) ℓ
(C) $\sqrt{\ell}$

(B) $1/\ell$ (D) $1/\sqrt{\ell}$

(D)

$$\omega = \sqrt{\frac{g}{\ell}} \Rightarrow \omega \propto \frac{1}{\sqrt{\ell}}$$

3. **The acceleration is proportional to the displacement and is directed towards mean position in _____ motion. (UHS 2008)**
(A) Gravity (C) Uniform
(B) Simple harmonic (D) Projectile

(B)
In SHM
$$\vec{a} = -\frac{k}{m}\vec{x} \Rightarrow \vec{a} \propto -\vec{x}$$

4. **If the mass attached with a spring becomes four times, the time period of vibration becomes: (UHS 2009)**
(A) One fourth (C) Half
(B) 3/4 (D) Double

(D)
$$T = 2\pi\sqrt{\frac{m}{k}} \Rightarrow T \propto \sqrt{m}$$

5. **In a microwave oven, the wave produced has a wavelength of 12 cm at a frequency of: (UHS 2009)**
(A) 2452 MHz (C) 2455 MHz
(B) 2456 MHz (D) 2450 MHz

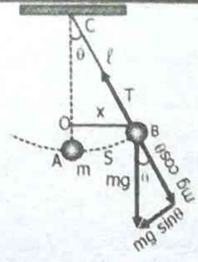
(D)
The frequency of waves produced in microwave oven is 2450 MHz

6. **At t = 0 a body performing simple harmonic motion is at mean position; when t = T/4, it will be: (UHS 2010)**
(A) Between mean and extreme position
(B) Again at mean position
(C) Beyond extreme position
(D) At extreme position

(D)
$$x = x_o\sin(\omega t) \Rightarrow x = x_o\sin\left(\frac{2\pi}{T} \times t\right) = x_o\sin\left(\frac{2\pi}{T} \times \frac{T}{4}\right)$$
$$x = x_o\sin\left(\frac{\pi}{2}\right) = +x_o \text{ (extreme position)}$$

7. **In a simple pendulum, the tension in the string is: (UHS 2010)**
(A) mg $\sin\theta$ (C) g $\cos\theta$
(B) mg $\cos\theta$ (D) $g\theta$

(B)

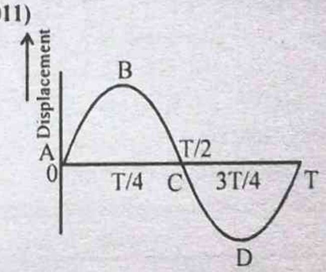


$T = mg\cos\theta$

8. **What is the period of mass spring system during SHM if the ratio of mass to spring constant is ¼? (UHS 2011)**
(A) π s (C) $1/\pi$ s
(B) 2π s (D) $1/2\pi$ s

(A)
$$T = 2\pi\sqrt{\frac{m}{k}} = 2\pi\sqrt{\frac{1}{4}} = \pi \text{ s}$$

9. **Waveform of SHM is given in figure. At what time/times displacement is equal to zero? (UHS 2011)**



(A) T/4 only (C) 0, T/4, 3T/4 and T
(B) 3T/4 only (D) 0, T/2 and T

(D)
At the time t = 0, T/2 and T the body is at mean position. So, the displacement is zero.

10. **A simple harmonic oscillator has a time period of 10 seconds. Which equation relates its acceleration "a" and displacement "x"? (UHS 2012)**
(A) $a = -10x$ (C) $a = -\left(\frac{2\pi}{10}\right)^2 x$
(B) $a = -(20\pi)x$ (D) $a = -(20\pi)^2x$

(C)
In SHM
$$a = -\omega^2 x$$
$$a = -\left(\frac{2\pi}{T}\right)^2 x = -\left(\frac{2\pi}{10}\right)^2 x$$

11. **When the length of a simple pendulum is doubled, find the ratio of the new frequency to the old frequency? (UHS 2012)**
(A) $\frac{1}{4}$ (C) $\sqrt{2}$
(B) $\frac{1}{2}$ (D) $\frac{1}{\sqrt{2}}$

(D)
$$f = \frac{1}{2\pi}\sqrt{\frac{g}{\ell}} \Rightarrow f \propto \frac{1}{\sqrt{\ell}}$$

$$\frac{f'}{f} = \sqrt{\frac{\ell}{\ell'}} = \sqrt{\frac{1}{2}} = \frac{1}{\sqrt{2}}$$

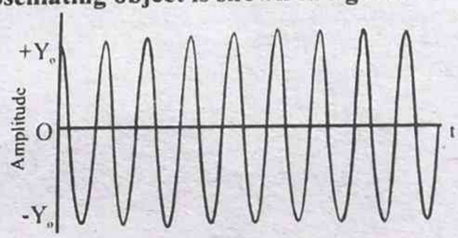
12. For vibrating mass-spring system, the expression of kinetic energy at any displacement "x" is given by? (UHS 2013)

(A) $\frac{1}{2}kx_o^2\left(1-\frac{x^2}{x_o^2}\right)$ (C) $\frac{1}{2}m\omega\left(1-\frac{x^2}{x_o^2}\right)$

(B) $\frac{1}{2}kx_o^2$ (D) $\frac{1}{2}m\omega^2x_o$

(A)
The K.E of mass- spring system at any displacement "x" is given by:
$$K.E = \frac{1}{2}kx_o^2\left(1-\frac{x^2}{x_o^2}\right)$$

13. Variation of amplitude with respect to time for an oscillating object is shown in figure.



Identify the oscillation: (UHS 2013)

(A) Damped (C) Un-damped
(B) Critical (D) Heavily damped

(C)
As the amplitude of vibrating body remains same with the passage of time. So, the oscillation is un-damped.

14. In a simple Harmonic Motion with a radius "x_o", the velocity of the particle at any point is: (UHS 2013)

(A) $v = \omega\sqrt{x_o^2 - x^2}$ (C) $v = \omega\sqrt{x_o - x}$
(B) $v = \omega(x^2 - x_o^2)$ (D) $v = \omega\sqrt{x - x_o}$

(A)
The velocity of particle performing SHM at any displacement "x" is given by:
$$v = \omega\sqrt{x_o^2 - x^2}$$

15. Frequency of simple pendulum of length 9.8 m will be: (UHS 2014)

(A) 2π hertz (C) $\frac{1}{2\pi}$ hertz
(B) $\frac{\pi}{2}$ hertz (D) $\frac{\pi}{4}$ hertz

(C)
$$f = \frac{1}{2\pi}\sqrt{\frac{g}{\ell}} = \frac{1}{2\pi}\sqrt{\frac{9.8}{9.8}} = \frac{1}{2\pi}$$

16. A body performs simple harmonic motion with a period of 0.063 s. the maximum speed of the body is 3.0 ms^{-1}. What are the values of the amplitude x_0 (m) and angular frequency ω (rads^{-1})?(UHS 2014)

(A) $x_o = 0.03, \omega = 100$ (C) $x_o = 5.3, \omega = 16$
(B) $x_o = 0.19, \omega = 16$ (D) $x_o = 3.3, \omega = 100$

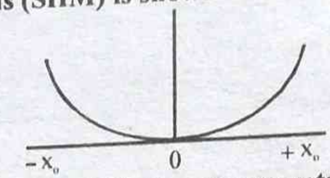
(A)
$$v_o = x_o\omega = (0.03)(100) = 3 \text{ m/s}$$

17. Food being cooked in microwave oven is an example of: (UHS 2014)

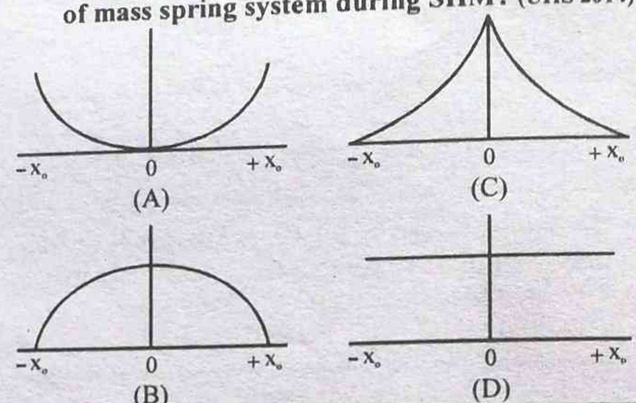
(A) Beats (C) Resonance
(B) Overtones (D) Stationary waves

(B)
Microwave oven is an example of electrical resonance.

18. Potential energy of a mass spring system with respect to displacement in simple harmonic motions (SHM) is shown in the figure.



Which of the following represents the total energy of mass spring system during SHM? (UHS 2014)



(D)
Total energy remains constant during SHM. So, the graph will be straight line and parallel to amplitude axis.

19. Mathematical formula of maximum velocity (v_o) for a body executing simple harmonic motion is: (UHS 2015)

(A) $v_o = x_o\omega$ (C) $v_o = v\left(1-\frac{x^2}{x_o^2}\right)$
(B) $v_o = \frac{k}{m}\sqrt{x_o^2 - x^2}$ (D) $v_o = m\sqrt{x_o^2 - x^2}$

(A)
The maximum velocity at mean position of body performing SHM is
$$v_o = x_o\omega$$

20. What should be the length of a simple pendulum whose period is 6.28 second at a place where g = 10 ms^{-2}. (UHS 2015)

(A) 9.8 m (C) 6.28 m
(B) 10.8 m (D) 10 m

(D)
$$T = 2\pi\sqrt{\frac{\ell}{g}}$$
$$6.28 = 2\pi\sqrt{\frac{\ell}{10}} \Rightarrow \sqrt{\frac{\ell}{10}} = 1 \Rightarrow \ell = 10 \text{ m}$$

21. What should be the ratio of kinetic energy to total energy for simple harmonic oscillator? (UHS 2015)

(A) $\left(1-\frac{x^2}{x_o^2}\right)$ (C) $(x_o^2 - x^2)$

(B) 1 (D) $\frac{1}{2}x^2$

(A)

$$K.E = \frac{1}{2}kx_o^2\left(1-\frac{x^2}{x_o^2}\right) = T.E.\left(1-\frac{x^2}{x_o^2}\right)$$

$$\frac{K.E.}{T.E.} = \left(1-\frac{x^2}{x_o^2}\right)$$

22. Resonance occurs when the driving frequency is: (UHS 2016)

(A) Greater than natural frequency
(B) Less than natural frequency
(C) Unequal the natural frequency
(D) Equal to the natural frequency

(D)

By definition of resonance.

23. Tuning a radio is an example: (UHS 2016)

(A) Natural resonance (C) Mechanical resonance
(B) Free resonance (D) Electrical resonance

(D)

Tuning of radio is an example of electrical resonance.

24. In mass spring system, mass "m" is attached with spring of constant "k" with time period "T_1" then mass is replaced by "2m" with the same spring. What will be the time period "T_2"? (UHS 2017)

(A) $T_2 = \sqrt{2}\,T_1$ (C) $T_2 = 2T_1$
(B) $T_2 = T_1$ (D) $T_2 = T_1/\sqrt{2}$

(A)

$$T = 2\pi\sqrt{\frac{m}{k}} \Rightarrow T \propto \sqrt{m}$$

$$\frac{T_2}{T_1} = \sqrt{\frac{m_2}{m_1}} = \sqrt{\frac{2m}{m}} = \sqrt{2} \Rightarrow T_2 = \sqrt{2}T_1$$

25. A body performing SHM with displacement $x = x_o \sin(\omega t + \phi)$ when t = 0, $x = x_o$. What is the value of phase angle "ϕ"? (UHS 2017)

(A) π (C) $-\pi$
(B) $\pi/4$ (D) $\pi/2$

(D)

$x = x_o \sin(\omega t + \phi)$
put t = 0 and $\phi = \pi/2$
$x = x_o \sin(0 + \pi/2) = x_o$

26. Angular displacement of a point moving in a circle of radius 10 cm when displacement of projection of this point along vertical diameter of circle is 8.66 cm will be: (UHS 2017)

(A) 30° (C) 60°
(B) 45° (D) 75°

(C)

$$x = x_o\sin\theta \Rightarrow \sin\theta = \frac{x}{x_o} = \frac{8.66}{10} = 0.866$$

$\theta = \sin^{-1}(0.866) = 60°$

27. In SHM the kinetic energy of the body is maximum when: (UHS 2018)

(A) The body is at extreme position
(B) The body is exactly half way down between mean and extreme position
(C) The body is at mean position
(D) The body is somewhere between mean and extreme position

(C)

$$K.E = \frac{1}{2}kx_o^2\left(1-\frac{x^2}{x_o^2}\right)$$

At mean position x = 0

$K.E = \frac{1}{2}kx_o^2$ (maximum)

28. If the time period of oscillations is 20 micro-sec, then what will be the frequency of that oscillating body : (UHS 2018)

(A) 5000 Hz (C) 50000 Hz
(B) 1000 Hz (D) 20000 Hz

(C)

$$f = \frac{1}{T} = \frac{1}{20\times10^{-6}} = \frac{100\times10^4}{20} = 50000 \text{ Hz}$$

29. Simple harmonic motion of a body is described by which statement mentioned below: (UHS 2018)

K : K.E is maximum when displacement x = 0
L : P.E is maximum when x = 0
M : P.E is maximum when $x = \pm x_o$

(A) K, L and M (C) L and M
(B) K and L (D) K and M

(D)

At mean position x = 0, ⇒ K.E = maximum
At extreme position $x = x_o$, ⇒ P.E = maximum

30. When the frequency of the applied force becomes equal to one of natural frequencies of body then the body oscillates with maximum displacement this phenomenon is called: (UHS 2018)

(A) Damping (C) Heating
(B) Reverberation (D) Resonance

(D)

At resonance the amplitude of vibrating body is maximum.

31. When the length of simple pendulum is doubled, then ratio of its new time period to old time period is: (UHS 2019)

(A) $2\sqrt{2}$ (C) $\sqrt{2}$
(B) $-\sqrt{2}$ (D) $1/\sqrt{2}$

(C)

$$T = 2\pi\sqrt{\frac{\ell}{g}} \Rightarrow T \propto \sqrt{\ell}$$

$$\frac{T'}{T} = \sqrt{\frac{\ell'}{\ell}} = \sqrt{\frac{2\ell}{\ell}} = \sqrt{2}$$

32. A wire has a spring constant of 5×10^4 N m^{-1}. It is stretched by a force to extension of 1.4 mm. calculate the strain energy stored in the wire: (UHS 2019)

(A) 4.9×10^{-5} J (C) 4.9×10^{5} J
(B) 4.9 J (D) 4.9×10^{-2} J

(D)

Energy $= \frac{1}{2}kx_o^2 = \frac{1}{2}(5 \times 10^4)(1.4 \times 10^{-3})^2$

$= \frac{1}{2}(5 \times 10^4)(1.4 \times 1.4 \times 10^{-6}) = \frac{196}{100} \times \frac{5}{2} \times 10^{-6+4}$ J

$= 4.9 \times 10^{-2}$ J

33. **In simple harmonic motion, acceleration will be maximum, when object is at:** **(UHS 2019)**

(A) Maximum displacement from mean position
(B) Center position
(C) Mean Position
(D) Half of the maximum displacement from mean position

(A)

$a = -\omega^2 x$

at extreme position $x = x_o$

$a = -\omega^2 x_o$ (maximum)

UNIT 06 WAVES

01. **Doppler's Effect is applicable to:**
(A) transverse waves
(B) longitudinal waves
(C) mechanical waves
(D) mechanical and electromagnetic waves

02. **The points in a wave separated by the displacement "x" have the phase difference of:**
(A) λ (C) $\frac{2\pi x}{\lambda}$
(B) $\frac{\lambda x}{\pi}$ (D) $\frac{2\pi\lambda}{x}$

03. **If the length of a piano wire (of given density) is increased by 5%, what approximate change in tension is necessary to keep its fundamental frequency unchanged?**
(A) Decrease of 10% (C) Decrease of 5%
(B) Increase of 5% (D) Increase of 10%

04. **A plane produces the sonic boom when:**
(A) its speed is greater than sound
(B) its sound is much louder
(C) it produces sound of high energy
(D) it produces sound of high amplitude

05. **The spectral line of a certain star is observed to be "Doppler shifted" from a wavelength of 500 nm to a wavelength of 650 nm. This is possible if the star is receding at:**
(A) $\frac{500}{650}c$ (C) $\frac{3}{10}c$
(B) $\frac{650}{500}c$ (D) $\frac{150}{500}c$

06. **If the distant star is receding from us, the spectral lines from such a star when examined on Earth will show:**
(A) No shift in frequency
(B) A shift in frequency towards the red end
(C) A shift in frequency towards the violet end
(D) shift in frequency towards ultraviolet

07. **Reflection of Radar waves from the aero-plane is an example of:**
(A) Resonance (C) Interference
(B) Doppler's effect (D) All of these

08. **A person moves with a speed 1/3 the speed of sound waves towards the stationary source of sound. Then the frequency of sound waves heard by the person will:**
(A) $\frac{2}{3}f$ (C) $\frac{4}{3}f$
(B) $\frac{3}{2}f$ (D) $\frac{3}{4}f$

09. **Due to overlapping of two identical waves the speed of resultant wave:**
(A) Decrease (C) Becomes velocity
(B) Increase (D) Remains same

10. **In the following properties of a wave, the one that is independent of the others in its:**
(A) Velocity (C) Frequency
(B) Amplitude (D) Wavelength

11. **A progressive wave of frequency 500 Hz is traveling with a speed of 350 m/s. A compression maximum appear, at a place at a given instant. The minimum time interval after which a rarefaction maximum occur, at the same place is:**
(A) $\frac{1}{250}s$ (C) $\frac{1}{1000}s$
(B) $\frac{1}{500}s$ (D) $\frac{1}{350}s$

12. **Longitudinal waves are also known as:**
(A) Transverse waves
(B) Pressure waves
(C) Particle waves
(D) Electromagnetic waves

13. **When source and observe moving away from each other then the new frequency will be:**
(A) $f' = \left(\frac{v-u_o}{v+u_o}\right)f$ (C) $f' = \left(\frac{v-u_o}{v+u_s}\right)f$
(B) $f' = \left(\frac{v+u_o}{v-u_o}\right)f$ (D) $f' = \left(\frac{v}{v+u_s}\right)f$

14. **Longitudinal and transverse waves can be distinguished by the property of:**
(A) interference (C) reflection
(B) diffraction (D) polarization

15. **With what speed should an observer move towards a stationary source of sound so that frequency of sound emitted by source may appear double of its actual frequency as listen by the observer. Take speed of sound "v" and that of observer as "u":**
(A) u = v (C) u = 2v
(B) u = v/2 (D) u = 3v

16. **A star is moving towards Earth shows:**
(A) blue shift (C) green shift
(B) red shift (D) All of these

17. **Which of the following cannot be used in RADAR system?**
(A) infrared rays (C) microwaves
(B) X-Rays (D) radio waves

18. **The frequency of sound appears 10% less to a moving observer. What is the speed of observer? (take speed of sound 350 m/s)**
(A) 10 m/s (C) 35 m/s
(B) 20 m/s (D) 40 m/s

19. **A stretched string fixed at both ends vibrates in "n" loop. Its length in terms of wavelength is:**
(A) $(n+1)\frac{\lambda}{2}$ (C) $\left(n+\frac{1}{2}\right)\lambda$
(B) $(n-1)\frac{\lambda}{2}$ (D) $n\frac{\lambda}{2}$

20. **The speed of the waves in the string in terms of the tension F and mass per unit length (m) of the string is given by:**

(A) $v=\sqrt{\frac{F\times \ell}{m}}$ (C) $v=\sqrt{\frac{m}{F}}$
(B) $v=\sqrt{\frac{F}{m}}$ (D) $v=\sqrt{\frac{F}{\ell m}}$

21. **Electric and magnetic fields constitute:**
(A) Electromagnetic wave
(B) Transverse waves
(C) Longitudinal waves
(D) Stationary Waves

22. **Distance between any two consecutive crests or troughs is called:**
(A) Frequency (C) Wavelength
(B) Period (D) Phase difference

23. **If 20 waves pass through the medium in 1 sec with speed of $20ms^{-1}$ then wavelength is:**
(A) 20m (C) 400m
(B) 2m (D) 1m

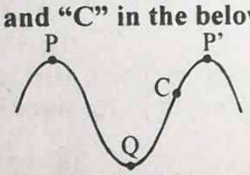
24. **Progressive wave of frequency 300 Hz are superimposed to produce a system of stationary waves in which adjacent nodes are 1.5 m apart. What is the speed of progressive waves?**
(A) 100 m/sec (C) 450 m/sec
(B) 200 m/sec (D) 900 m/sec

25. **In stationary wave, the velocity of particle at node is:**
(A) Maximum (C) Zero
(B) Minimum (D) Constant

26. **In each of the following two situations a source emits sound with a frequency of 1000 Hz. In situation I the source is moving at 100m/s toward an observer at rest. In situation II the observer is moving at 100m/s toward the source, which is stationary. The speed of sound is 340m/s. The frequencies heard by the observers in the two situations are:**
(A) I: 1417 Hz; II: 1294 Hz
(B) I: 1294 Hz; II: 1294 Hz
(C) I: 1417 Hz; II: 1417 Hz
(D) I: 773 Hz; II: 706 Hz

27. **Which of the following is not the case of Doppler's effect:**
(A) $\left(\frac{v-u_o}{v}\right)f$ (C) $\left(\frac{v+u_o}{v}\right)f$
(B) $\left(\frac{v-u_s}{\lambda}\right)f$ (D) $\left(\frac{v}{v+u_s}\right)f$

28. **When the wave propagates, what is true about points "P" and "C" in the below figure?**



(A) They are always in-phase with each other
(B) Sometimes in-phase but sometimes out-of-phase
(C) They are always out-of-phase with each other
(D) neither in-phase nor out-of-phase

29. **The frequency of sound is f and velocity is v, if frequency increases to 4f velocity will be:**
(A) v (C) v/4
(B) 4v (D) 2v

30. **Transverse mechanical waves can propagate:**
(A) both is gas and metal
(B) in gas but not in metal
(C) in metal but not in gas
(D) neither in gas not in metal

31. **A source emits sound with a frequency of 1000 Hz. It and an observer are moving in the same direction with the same speed, 100m/s. If the speed of sound is 340m/s, the observer hears sound with a frequency of:**
(A) 294 Hz (C) 545 Hz
(B) 1000 Hz (D) 1830 Hz

32. **If stretching force in a stretched wired is increased then its frequency of oscillation:**
(A) decreases (C) remains same
(B) increases (D) none of these

33. **The frequency of stationary waves in an organ pipe for third overtone when both ends are open is given by:**
(A) $f_4 = v/2L$ (C) $f_4 = 3v/(2L)$
(B) $f_4 = 4/2L$ (D) $f_4 = 4v/(2L)$

34. **A 100 cm long string fixed at its two end is plucked from the middle. The wave length of stationary waves generated is :**
(A) 0.5m (C) 2m
(B) 1m (D) 3m

35. **In standing wave if $\lambda = \ell/2$ in case of string when the number of loops are:**
(A) one (C) three
(B) two (D) four

36. **In stretched string, the speed of wave is independent of:**
(A) tension
(B) length
(C) total mass of string
(D) the point from where the string is plucked

37. **A stationary source emits a sound wave of frequency "f". If it were possible for a man to travel toward the source at the speed of sound, he would observe the emitted sound to have a frequency of:**
(A) zero (C) f/2
(B) 2f/3 (D) 2f

38. **The distance between node and anti-node is 85cm the velocity of sound is 340 ms^{-1} the frequency of waves is:**
(A) 100Hz (C) 200Hz
(B) 250Hz (D) 340 Hz

39. **The frequency of the fundamental node of open ends organ pipe is 400 Hz. If one end of pipe is closed the fundamental frequency will be:**
(A) 800 Hz (C) 400 Hz
(B) 600 Hz (D) 200 Hz

40. **When a wave moves through 10m, a point changes from crest to trough and time taken is 1s. then the wavelength of the wave and its frequency are:**
(A) 20m, 0.5 Hz (C) 10m, 1 Hz

(B) 0.5m, 20 Hz (D) 1m, 10 Hz

41. **Set of frequencies which are multiples of fundamental frequency is called:**
(A) amplitude (C) beat frequency
(B) speed (D) harmonics

42. **Which one is correct relation for fundamental frequency of open and close pipe:**
(A) $f_{open} = 2f_{closed}$ (C) $f_{open} = f_{closed}$
(B) $f_{closed} = 2f_{open}$ (D) $f_{open} = 1/f_{closed}$

43. **A phase angle of 180° is equivalent to the path difference of:**
(A) $\lambda/4$ (C) λ
(B) $\lambda/2$ (D) 2λ

44. **A piano wire has length L and mass M. If its fundamental frequency is f, its tension is:**
(A) 2Lf/m (C) $4LMf^2$
(B) $2Mf^2/L$ (D) $4f^2L^3/M$

45. **An observer is moving with ¼ of the speed of wave, away from the source its actual frequency is 100 Hz find it's apparent frequency:**
(A) 300 Hz (C) 125 Hz
(B) 175 Hz (D) 75 Hz

46. **The ratio of the nodes and antinodes in a closed pipe system (open at one end is always):**
(A) less than one (C) equal to one
(B) greater than one
(D) less than or equal to one

47. **Oscillating charge produces:**
(A) mechanical wave (C) matter waves
(B) electromagnetic wave (D) longitudinal wave

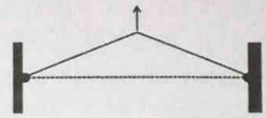
48. **A source of frequency "f" sends waves of wavelength "λ" traveling with speed "v" in some medium. If the frequency is changed from f to "2f", then the new wavelength and new speed are (respectively):**
(A) 2λ, v (C) $\lambda/2$, v
(B) λ, 2v (D) λ, v/2

49. **When a certain string is clamped at both ends, the lowest four resonant frequencies are measured to be 100, 150, 200, and 250 Hz. One of the resonant frequencies (below 200 Hz) is missing. What is it?**
(A) 25 Hz (C) 50 Hz
(B) 75 Hz (D) 125 Hz

50. **A stationary source generates 5.0Hz water waves whose speed is 2.0 m/s. A boat is approaching the source at 10m/s. The frequency of these waves, as observed by a person in the boat, is:**
(A) 15 Hz (C) 20 Hz
(B) 25 Hz (D) 30 Hz

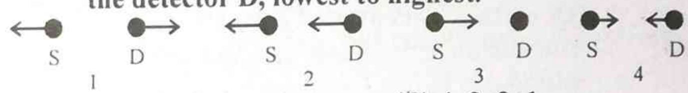
51. **A stationary source "S" generates circular outgoing waves on a lake. The wave speed is 5.0m/s and the crest-to-crest distance is 2.0m. A person in a motor boat heads directly toward S at 3.0m/s. To this person, the frequency of these waves is:**
(A) 1.0Hz (C) 1.5Hz
(B) 2.0Hz (D) 4.0Hz

52. **A stretched wire of length 1.0m is clamped at both ends. It is plucked at its center as shown. The three longest wavelengths in the wire are (in meters):**



(A) 4, 2, 1 (C) 2, 1, 0.67
(B) 2, 0.67, 0.4 (D) 1, 0.5, 0.33

53. **The diagram shows four situations in which a source of sound "S" with frequency "f" and a detector "D" are either moving or stationary. The arrows indicate the directions of motion. The speeds are all the same. Detector 3 is stationary. The frequency detected is the same. Rank the situations according to the frequency observed by the detector D, lowest to highest.**



(A) 1, 2, 3, 4 (C) 4, 3, 2, 1
(B) 1, 3, 4, 2 (D) 2, 1, 3, 4

54. **In transverse waves the particle of the medium vibrate:**
(A) along the direction of the motion
(B) perpendicular to the direction of wave motion
(C) opposite to the direction of motion of wave
(D) do not vibrate

55. **The waves which do not require a material medium for their propagation are called:**
(A) mechanical waves (C) matter waves
(B) electromagnetic waves (D) compressional waves

56. **The linear distance between two nearest points of a medium vibrating in phase is:**
(A) time period (C) frequency
(B) phase difference (D) wave length

57. **The rise in pitch of an approaching siren is an apparent increase in its:**
(A) speed (C) amplitude
(B) frequency (D) wavelength

58. **The distance covered by wave in 1 second is:**
(A) Wavelength (C) Wave number
(B) Frequency (D) Wave speed

59. **Which one of the following media can transmit both transverse and longitudinal waves:**
(A) Solid (C) Gas
(B) Liquid (D) Plasma

60. **An organ pipe with both ends open is 0.85 m long. Assuming that the speed of sound is 340m/s, the frequency of the third harmonic of this pipe is:**
(A) 200 Hz (C) 300 Hz
(B) 400 Hz (D) 600 Hz

61. **The sounds of the frequency greater than 20000 Hz are called:**
(A) supersonics (C) infrasonic
(B) ultrasonic (D) all of these

62. **The louder the sound the greater will be its:**
(A) Amplitude (C) speed
(B) wavelength (D) frequency

63. **Pitch of sound depends upon:**
(A) Intensity of sound (C) Loudness of sound
(B) Wavelength of sound (D) Frequency of sound

64. **If 30 waves per second pass through a medium at speed of 30 ms^{-1}, the wavelength is:**
(A) 30 m (C) 15 m
(B) 1 m (D) 900 m

65. **The waves associated with particles in motion are called:**
(A) Light waves
(B) Matter waves
(C) Electromagnetic waves
(D) Both "A" and "B"

66. **When a transverse wave is reflected on going from a denser to rarer medium, then:**
(A) there is 180° phase shift
(B) a crest is converted into trough
(C) there is no change in phase shift
(D) a trough is converted into crest

67. **The distance between two consecutive nodes or anti nodes is:**
(A) $\lambda/4$ (C) $\lambda/2$
(B) λ (D) 2λ

68. **A 200 cm organ pipe with one end open is in resonance with a sound wave of wavelength 270 cm. The pipe is operating in its:**
(A) fundamental frequency
(B) third harmonic
(C) second harmonic
(D) fourth harmonic

69. **The wavelength of the fundamental mode of vibration of closed pipe of length "ℓ":**
(A) $\ell/2$ (C) $\ell/4$
(B) ℓ (D) 4ℓ

70. **Sonar is the technique used for detecting the object:**
(A) In air (C) underground
(B) under water (D) on earth

71. **Stationary waves are generated on a string of length "ℓ". Its fundamental frequency is given by:**
(A) $f_1 = 2\ell/v$ (C) $f_1 = v/2\ell$
(B) $f_1 = v/\ell$ (D) $f_1 = 2v/\ell$

72. **The distance between the node and the next anti node is:**
(A) $\lambda/4$ (C) $\lambda/2$
(B) λ (D) 2λ

73. **A string of length "ℓ" can be maintain the stationary waves of wavelength "λ" given by:**
(A) $\lambda_n = \frac{2\ell}{n}$ (C) $\lambda_n = \frac{2n}{\ell}$
(B) $\lambda_n = 2\ell n$ (D) $\lambda_n = \ell/2n$

74. **The phase angle of 90° is equivalent to a path difference of:**
(A) $\lambda/4$ (C) $\lambda/2$
(B) λ (D) 2λ

75. **Stationary waves consist of:**
(A) Crest and troughs
(B) Compression and elongations
(C) Nodes and antinodes
(D) reflection and refraction

76. **Which one is the correct relation for one end closed pipe:**
(A) $\lambda_n = 2\ell/n$ (C) $\lambda_n = 4\ell/n$
(B) $\lambda_n = nv/\ell$ (D) $\lambda_n = nv/4\ell$

77. **During a time interval of exactly one period of vibration of a tuning fork, the emitted sound travels a distance:**
(A) equal to the length of the tuning fork
(B) of about 330m
(C) equal to twice the length of the tuning fork
(D) of one wavelength in air

78. **Car "A" has a siren sounding a note of 540 Hz. A listener in car "B" hears a note of 544 Hz. Both move in same direction. One concludes that :**
(A) "B" leads "A" and move faster
(B) "B" is behind and moves slower
(C) Both move with same speed
(D) "B" leads "A" and moves slower

79. **For same mass and length, if tension of a vibrating string is increased by four times, the speed of wave increases by:**
(A) 2 times (C) 4 times
(B) 6 times (D) $\sqrt{2}$ times

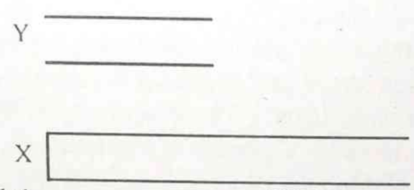
80. **The fixed ends of a vibrating string are:**
(A) Nodes (C) Antinodes
(B) Overtones (D) All of these

81. **The string of length "ℓ" fixed at both ends is vibrating in two segments, the wavelength of wave is:**
(A) $\ell/2$ (C) ℓ
(B) 2ℓ (D) 4ℓ

82. **When two identical waves move in the same direction, they give rise to:**
(A) Stationary waves (C) Interference
(B) beats (D) Doppler's Effect

83. **At open end of an organ pipe:**
(A) Nodes are formed
(B) Nodes and antinodes may be formed
(C) Antinodes are formed
(D) Neither node nor anti–node is be formed

84. **Organ pipe "Y" (open at both ends) is half as long as organ pipe "X" (open at one end) as shown. The ratio of their fundamental frequencies $f_X:f_Y$ is:**



(A) 1:1 (C) 1:2
(B) 2:1 (D) 1:4

85. **A stretched string 4m long and it has 4 loops of stationary waves, then the wavelength is:**
(A) 1 m (C) 2 m
(B) 3 m (D) 4 m

86. **A stationary wave is established in a string which vibrates in four segments at a frequency of 120Hz. Its fundamental frequency is:**
(A) 15 Hz (C) 30 Hz
(B) 60 Hz (D) 480 Hz

87. **If the speed of sound is 340 m/s, the length of the shortest closed pipe that resonates at 100 Hz is:**
(A) 170 cm (C) 17 cm
(B) 42.5 cm (D) 85 cm

88. **The lowest tone produced by a certain organ comes from a 3.0 m pipe with both ends open. If the speed of sound is 340 m/s, the frequency of this tone is approximately:**
(A) 7 Hz (C) 14 Hz
(B) 28 Hz (D) 57 Hz

89. **If the speed of sound is 340m/s, the two lowest frequencies of an 0.5-m organ pipe, closed at one end, are approximately:**
(A) 170 and 340 Hz (C) 170 and 510 Hz
(B) 340 and 680 Hz (D) 340 and 1020 Hz

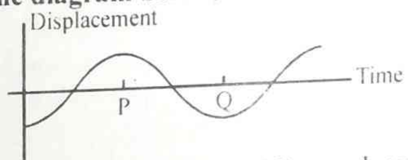
90. **The waves used in "Sonar" are:**
(A) Electromagnetic waves(C) Matter waves
(B) Sound waves (D) Water waves

91. **An organ pipe with one end closed and the other open has length "L". Its fundamental frequency is proportional to:**
(A) L (C) 1/L
(B) $1/L^2$ (D) L^2

92. **Four organ pipes are described below. Which one has the highest frequency fundamental?**
(A) A 2.3 m pipe with one end open and the other closed
(B) A 3.3 m pipe with one end open and the other closed
(C) A 1.6 m pipe with both ends open
(D) A 3.0 m pipe with both ends open

93. **The speed of stars and galaxies can be calculated by:**
(A) Compton effect (C) Stefan's law
(B) Doppler's effect (D) Pascal's law

94. **In the diagram below, the interval PQ represents:**



(A) wavelength/2 (C) wavelength
(B) 2 × amplitude (D) period/2

95. **Sinusoidal water waves are generated in a large ripple tank. The waves travel at 20 cm/s and their adjacent crests are 5.0 cm apart. The time required for each new whole cycle to be generated is:**
(A) 100 s (C) 4.0 s
(B) 2.0 s (D) 0.25 s

96. **Any point on a string carrying a sinusoidal wave is moving with its maximum speed when:**
(A) the magnitude of its acceleration is a maximum
(B) the magnitude of its displacement is a maximum
(C) the magnitude of its displacement is a minimum
(D) the magnitude of its displacement is half the amplitude

97. **A string carries a sinusoidal wave with an amplitude of 2.0 cm and a frequency of 100 Hz. The maximum speed of any point on the string is:**
(A) 2.0 m/s (C) 4.0 m/s
(B) 6.3 m/s (D) 13 m/s

98. **A transverse traveling sinusoidal wave on a string has a frequency of 100 Hz, a wavelength of 0.040 m, and an amplitude of 2.0mm. The maximum velocity in m/s of any point on the string is:**
(A) 0.2 (C) 1.3
(B) 4 (D) 15

99. **A transverse traveling sinusoidal wave on a string has a frequency of 100 Hz, a wavelength of 0.040 m, and an amplitude of 2.0 mm. The maximum acceleration in m/s^2 of any point on the string is:**
(A) 0 (C) 130
(B) 395 (D) 790

100. **The speed of a sinusoidal wave on a string depends on:**
(A) the frequency of the wave
(B) the amplitude of the wave
(C) the wavelength of the wave
(D) the tension in the string

101. **The tension in a string with a linear mass density of 0.0010 kg/m is 0.40 N. A sinusoidal wave with a wavelength of 20 cm on this string has a frequency of:**
(A) 0.0125 Hz (C) 0.25 Hz
(B) 100 Hz (D) 630 Hz

102. **When a 100 Hz oscillator is used to generate a sinusoidal wave on a certain string the wavelength is 10 cm. When the tension in the string is doubled the generator produces a wave with a frequency and wavelength of:**
(A) 200 Hz and 20 cm (C) 141 Hz and 10 cm
(B) 100 Hz and 20 cm (D) 100 Hz and 14 cm

103. **A column of organ is open at one end and closed at the other. The shortest length of such a column that will resonate with a 200 Hz tuning fork is 42.5 cm. The speed of sound in organ must be:**
(A) 85.0m/s (C) 170m/s
(B) 340m/s (D) 470m/s

104. **A long string is constructed by joining the ends of two shorter strings. The tension in the strings is the same but string I has 4 times the linear mass density of string II. When a sinusoidal wave passes from string I to string II:**
(A) the frequency decreases by a factor of 4
(B) the frequency decreases by a factor of 2
(C) the wavelength decreases by a factor of 4
(D) the wavelength decreases by a factor of 2

105. **Three separate strings are made of the same material. String 1 has length L and tension T, string 2 has length 2L and tension 2τ, and string 3 has length 3L and tension 3T. A pulse is started at one end of each string. If the pulses start at the same time, the order in which they reach the other end is:**
(A) 1, 2, 3 (C) 3, 2, 1
(B) 2, 3, 1 (D) 3, 1, 2

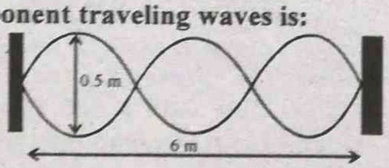
106. **A long string is constructed by joining the ends of two shorter strings. The tension in the strings is the same but string I has 4 times the linear mass density of string II. When a sinusoidal wave passes from string I to string II:**
(A) the frequency decreases by a factor of 4
(B) the frequency decreases by a factor of 2
(C) the wave speed decreases by a factor of 4
(D) the wave speed decreases by a factor of 2

107. **Two pipes are each open at one end and closed at the other. Pipe "A" has length "L" and pipe "B" has length 2L. Which harmonic of pipe "B" matches in frequency the fundamental of pipe "A"?**
(A) The fundamental (C) The second
(B) The third (D) The fourth

108. **A wave on a stretched string is reflected from a fixed end "P" of the string. The phase difference, at "P", between the incident and reflected waves is:**
(A) zero
(B) $\pi/2$ rad
(C) π rad
(D) depends on the velocity of the wave

109. **A standing wave:**
(A) can be constructed from two similar waves traveling in opposite directions
(B) must be transverse
(C) must be longitudinal
(D) has motionless points that are closer than half a wavelength

110. **A standing wave pattern is established in a string as shown. The wavelength of one of the component traveling waves is:**



(A) 0.5m (C) 1m
(B) 2m (D) 4m

111. **Standing waves are produced by the interference of two traveling sinusoidal waves, each of frequency 100 Hz. The distance from the second node to the fifth node is 60 cm. The wavelength of each of the two original waves is:**
(A) 50 cm (C) 40 cm
(B) 30 cm (D) 20 cm

112. **A string of length 100 cm is held fixed at both ends and vibrates in a standing wave pattern. The wavelengths of the constituent traveling waves CANNOT be:**
(A) 400 cm (C) 200 cm
(B) 100 cm (D) 66.7 cm

113. **A string of length L is clamped at each end and vibrates in a standing wave pattern. The wavelengths of the constituent traveling waves CANNOT be:**
(A) L (C) 2L
(B) L/2 (D) 4L

114. **Two sinusoidal waves, each of wavelength 5m and amplitude 10 cm, travel in opposite directions on a 20 m long stretched string that is clamped at each end. Excluding the nodes at the ends of the string, how many nodes appear in the resulting standing wave?**
(A) 3 (C) 4
(B) 5 (D) 7

115. **A string, clamped at its ends, vibrates in three segments. The string is 100 cm long. The wavelength is:**
(A) 33.3 cm (C) 66.7 cm
(B) 150 cm (D) 300 cm

116. **A stretched string, clamped at its ends, vibrates in its fundamental frequency. To double the fundamental frequency, one can change the string tension by a factor of:**
(A) 2 (C) 4
(B) $\sqrt{2}$ (D) ½

117. **A 40 cm long string, with one end clamped and the other free to move transversely, is vibrating in its fundamental standing wave mode. The wavelength of the constituent traveling waves is:**
(A) 20 cm (C) 40 cm
(B) 80 cm (E) 160 cm

118. **A 30 cm long string, with one end clamped and the other free to move transversely, is vibrating in its second harmonic. The wavelength of the constituent traveling waves is:**
(A) 10 cm (C) 30 cm
(B) 40 cm (D) 60 cm

119. **A 40 cm long string, with one end clamped and the other free to move transversely, is vibrating in its fundamental standing wave mode. If the wave speed is 320 cm/s the frequency is:**
(A) 2 Hz (C) 16 Hz
(B) 8Hz (D) 4 Hz

120. **Take the speed of sound to be 340 m/s. A thunder clap is heard about 3 s after the lightning is seen. The source of both light and sound is:**
(A) moving overhead faster than the speed of sound
(B) emitting a much higher frequency than is heard
(C) emitting a much lower frequency than is heard
(D) about 1000m away

121. **A sound wave has a wavelength of 3.0 m. The distance from a compression center to the adjacent rarefaction center is:**
(A) 0.75 m (C) 1.5 m
(B) 3.0 m (D) 4.0 m

UNIT 06 WAVES (SOLUTIONS)

01. (D)

Doppler's effect is applicable on both sound (mechanical) and light (electromagnetic) waves equally.

02. (C)

$$\frac{\text{Phase differnce}}{2\pi} = \frac{\text{Displacement}}{\lambda}$$

$$\text{Phase difference} = \frac{2\pi}{\lambda}(\text{Displacement})$$

$$\text{Phase difference} = \frac{2\pi x}{\lambda}$$

03. (C)

$$f = \frac{1}{2L}\sqrt{\frac{FL}{M}}$$

$$4f^2L^2 = \frac{FL}{M} \Rightarrow F = 4Mf^2L$$

$$F' = 4Mf^2\left(L + \frac{L}{100}\right)$$

$$= 4Mf^2\left(L + \frac{5L}{100}\right) = 4Mf^2L\left(\frac{105}{100}\right) = 1.05F$$

$$\Delta F = F' - F = 0.05F$$

$$\frac{\Delta F}{F} = 0.05 \times 100\% = 5\,\% \Rightarrow \Delta F = 5\%\text{ of }F$$

04. (A)

When plane moves faster than the speed of sound a conical surface of concentrated sound energy sweeps over the ground as a supersonic plane passes overhead. It is known as sonic bomb.

05. (D)

$$f' = \left(\frac{c}{c + u_s}\right)f$$

$$\frac{c}{\lambda'} = \left(\frac{c}{c + u_s}\right)\frac{c}{\lambda}$$

$$\frac{1}{\lambda'} = \left(\frac{c}{c + u_s}\right)\frac{1}{\lambda}$$

$$(c + u_s) = c\lambda' / \lambda$$

$$u_s = \frac{c\lambda'}{\lambda} - c$$

$$u_s = c(\frac{650}{500} - 1) = c(\frac{650 - 500}{500}) = \frac{150}{500}c$$

06. (B)

When a star is moving away from Earth show a red shift. The emitted waves have a longer wavelength than if the star had been at rest. So, the spectrum is shifted towards longer wavelength, i.e., towards the red end of the spectrum.

07. (B)

Radar is a device for transmitting and receiving radio waves and is used to determine the speed and the elevation of an airplane. When a plane is approaching towards the radar, then the wavelength of the wave reflected from airplane would be shorter and if it is moving away, then the wavelength would be larger.

08. (C)

$$f' = \left(\frac{v + u_o}{v}\right)f$$

$$f' = \left(\frac{v + v/3}{v}\right)f = \frac{4}{3}f$$

09. (D)

Due to the overlapping of waves the amplitude of wave may change but the speed of wave does not change. Speed of wave depends upon the nature of medium.

10. (B)

Speed, frequency and wavelength of a wave are related with each other but not amplitude.

$$v = f\lambda$$

11. (C)

$$T = \frac{1}{f} = \frac{1}{500}\text{ s}$$

For half wavelength (rarefaction)

$$t = \frac{1}{2}\left(\frac{1}{500}\right)\text{ s} = \frac{1}{1000}\text{ s}$$

12. (B)

Longitudinal waves are basically produced due to the pressure applied on the medium. From which compressions are produced, which further make rarefactions. That is why longitudinal waves are also called as pressure waves.

13. (C)

$$f' = f\left(\frac{v - u_o}{v + u_s}\right)$$

14. (D)

Only transverse waves can be polarized.

15. (A)

$$f' = \left(\frac{v + u}{v}\right)f$$

if $u = v$

$$f' = \left(\frac{v + v}{v}\right)f = 2f$$

16. (A)

When a star is moving towards the Earth show a blue shift. The emitted waves have a shorter wavelength than if the star had been at rest. So, the spectrum is shifted towards shorter wavelength, i.e., towards the blue end of the spectrum.

17. (B)

X-rays are very high energy electromagnetic waves. It is harmful to use for communication purposes.

18. (C)

As apparent frequency decreases. So, observer is moving away from the stationary source.

$$f' = \left(\frac{v - u_o}{v}\right)f$$

$$0.9f = \left(\frac{v - u_o}{v}\right)f$$

$$0.9v = v - u_o$$

$$u_o = v - 0.9v = (0.1)v = (0.1)(350) = 35\text{ m/s}$$

19. (D)

Length of 1 loop in terms of wave length $= \frac{\lambda}{2}$

Length of n loops in terms of wave length $= n\frac{\lambda}{2}$

20. (A)

The speed "v" of the waves in the string depends upon the tension "F" and mass per unit length of the string "m". the speed "v" of the wave is given by:

$$v = \sqrt{\frac{F}{m/\ell}} = \sqrt{\frac{F \times \ell}{m}}$$

21. (A)

Waves that do not require any medium for their propagation are called electromagnetic waves. These waves propagate due to the oscillations of electric and magnetic fields.

22. (C)

The distance between any two consecutive crests or troughs, is called wavelength.

23. (D)

The number of waves passing through a point per second in known as frequency. So,

$f = 20Hz$

$$v = f\lambda \Rightarrow \lambda = \frac{v}{f} = \frac{20}{20} = 1m$$

24. (D)

$\lambda/2 = 1.5 \Rightarrow \lambda = 3$ m

$v = f\lambda = (300)(3) = 900$ m/s

25. (C)

The points on stationary wave which are permanently at rest are known as nodes.

26. (A)

Situation I:

$$f' = \left(\frac{v}{v - u_s}\right) f = \left(\frac{340}{340 - 100}\right)(1000)$$

$$= \left(\frac{340}{240}\right)(1000) = \left(\frac{17}{12}\right)(1000) = 1417 \text{ Hz}$$

Situation II:

$$f' = \left(\frac{v + u_o}{v}\right) f = \left(\frac{340 + 100}{340}\right)(1000)$$

$$= \left(\frac{440}{340}\right)(1000) = \left(\frac{22}{17}\right)(1000) = 1294 \text{ Hz}$$

27. (B)

All are the cases of Doppler's effect except (B).

28. (C)

The points separated from one another through distances of λ, 2λ, 3λ, ... are all in phase with each other. The distance between "P" and "C" is not in integral multiple of wavelength. So. These are always in out of phase.

29. (A)

Speed of sound in any medium depends upon the properties of the medium. In a certain medium if frequency increases then its wavelength decreases with same rate. So, speed remains constant.

30. (C)

Transverse and longitudinal waves can be set up in solids. In gases transverse waves die out very quickly and usually cannot be produced at all.

31. (B)

As there is no relative motion between source and observer. So, apparent change in frequency will not be observed.

32. (B)

$$f = \frac{1}{2\ell}\sqrt{\frac{F}{m}}$$

$f \propto \sqrt{F}$

33. (D)

$$f_1 = \frac{v}{2L}$$

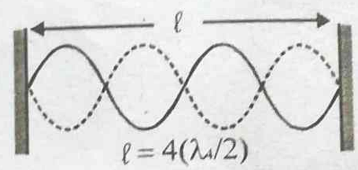
for 3rd overtone means 4th harmonic

$$f_4 = 4\left(\frac{v}{2L}\right)$$

34. (C)

$\lambda/2 = \ell \Rightarrow \lambda = 2\ell = 2(1) = 2m$

35. (D)



$\ell = 2\lambda_4 \Rightarrow \lambda_4 = \ell/2$

36. (D)

$$v = \sqrt{\frac{F}{m/\ell}} = \sqrt{\frac{F \times \ell}{m}}$$

37. (D)

$$f' = \left(\frac{v + u_o}{v}\right) f = \left(\frac{v + v}{v}\right) f = 2f$$

38. (A)

$\lambda/4 = 0.85 \Rightarrow \lambda = 4(0.85) = 3.4$ m

$$f = \frac{v}{\lambda} = \frac{340}{3.4} = 100 \text{ Hz}$$

39. (C)

$$f_o = \frac{v}{2\ell}$$

$$f_c = \frac{v}{4\ell} = \frac{1}{2}\left(\frac{v}{2\ell}\right) \Rightarrow f_c = \frac{1}{2} f_o = \frac{1}{2}(400) = 200 \text{ Hz}$$

40. (A)

Time for half wave (crest to trough), T = 1 s

Time for 1 wave (crest to crest), T = 2 s

$$f = \frac{1}{T} = \frac{1}{2} = 0.5 \text{ Hz}$$

wavelength (crest to crest) = 2(10) = 20 m

41. (D)

The frequencies which are integral multiples of the fundamental frequency are called harmonics or overtones.

Stationary waves can be set up in the string only with discrete set of frequencies ($f_1, 2f_1, 3f_1, 4f_1, \ldots, nf_1$) is called harmonic series.

42. (A)

$$f_{open} = \frac{v}{2\ell}$$

$$f_{closed} = \frac{v}{4\ell} = \frac{1}{2}\left(\frac{v}{2\ell}\right) \Rightarrow f_{closed} = \frac{1}{2} f_{open} \Rightarrow f_{open} = 2f_{closed}$$

43. (B)

$$\frac{\text{Phase differnce}}{2\pi} = \frac{\text{Path differnce}}{\lambda}$$

$$\frac{\pi}{2\pi} = \frac{\text{Path differnce}}{\lambda} \Rightarrow \text{path difference} = \frac{\lambda}{2}$$

44. (C)

$$f = \frac{1}{2L}\sqrt{\frac{FL}{M}} \Rightarrow 4f^2L^2 = \frac{FL}{M}$$

$F = 4Mf^2L$

45. (D)

$$f' = \left(\frac{v - u_o}{v}\right)f$$

$$f' = \left(\frac{v - v/4}{v}\right)f = \frac{3}{4}f = \frac{3}{4}(100) = 75 \text{ Hz}$$

46. (C)

In closed pipe

No. of nodes = No. of antinodes

$$\frac{\text{No. of nodes}}{\text{No. of antinodes}} = 1$$

47. (B)

Waves that do not require any medium for their propagation are called electromagnetic waves. These waves are produced by the oscillations of charge particles that produce changing electric and magnetic fields.

48. (C)

Speed of sound in any medium depends upon the properties of the medium. In a certain medium if frequency increases then its wavelength decreases with same rate. So, speed remains constant.

49. (C)

Stationary waves can be set up in the string only with discrete set of frequencies ($f_1, 2f_1, 3f_1, 4f_1, \ldots\ldots, nf_1$) is called harmonic series.

If first harmonic (f_1) is 50 Hz then next harmonics will be 100 Hz, 150 Hz, 200 Hz and 250 Hz.

50. (D)

$$f' = \left(\frac{v + u_o}{v}\right)f = \left(\frac{2 + 10}{2}\right)(5) = 30 \text{ Hz}$$

51. (D)

$$f' = \left(\frac{v + u_o}{v}\right)f = \left(\frac{v + u_o}{v/f}\right) = \left(\frac{v + u_o}{\lambda}\right) = \left(\frac{5 + 3}{2}\right) = 4 \text{ Hz}$$

52. (C)

$$\lambda_1 = \frac{2\ell}{1} = 2\ell = 2(1) = 2\text{m}$$

$$\lambda_2 = \frac{2\ell}{2} = \ell = 1\text{m}$$

$$\lambda_3 = \frac{2\ell}{3} = \frac{2(1)}{3} = 0.67\text{m}$$

53. (A)

Situations can be well explained by the following relation.

$$f_D = \left(\frac{v \pm u_o}{v \mp u_s}\right)f$$

In diagram 1	$f_D < f$
In diagram 2	$f_D = f$
In diagram 3	$f_D > f$
In diagram 3	$f_D >> f$

$$(f_D)_1 < (f_D)_2 < (f_D)_3 < (f_D)_4$$

54. (B)

The waves, in which particles of the medium vibrate in a line perpendicular to the direction of propagation of waves, are known as transverse waves.

55. (B)

Waves that do not require any medium for their propagation are called electromagnetic waves.

56. (D)

The points separated from one another through distances of λ, 2λ, 3λ, ... are all in phase with each other.

57. (B)

$$f' = \left(\frac{v}{v - u_s}\right)f$$

As $\frac{v}{v - u_s} > 1$

$f' > f$

So, the pitch of the sound increases.

58. (D)

$$v = \frac{S}{t} = \frac{\lambda}{T}$$

59. (A)

Both types of waves can be set up in solids. In fluids transverse waves die out very quickly and usually cannot be produced at all.

60. (D)

$$f_3 = 3\left(\frac{v}{2L}\right) = 3\left(\frac{340}{2(0.85)}\right) = 3\left(\frac{340}{1.7}\right) = 3(200) = 600 \text{ Hz}$$

61. (B)

Sound waves having frequency greater than 20000 Hz are called ultrasonic and less than 20 Hz are called infrasonic.

62. (A)

Loudness of sound depends upon the amplitude.

63. (D)

Pitch of sound depends upon the frequency of sound.

64. (B)

The number of waves passing through a point per second in known as frequency. So, f = 30Hz

$$v = f\lambda \Rightarrow \lambda = \frac{v}{f} = \frac{30}{30} = 1\text{m}$$

65. (B)

Waves associated with microscopic particles moving with very high speed are called matter waves.

66. (C)

If a transverse wave travelling in a denser medium is incident on a rarer medium then it is reflected such that there is no phase change.

67. (C)

The distance between two consecutive nodes = The distance between two consecutive antinodes = $\lambda/2$

68. (B)

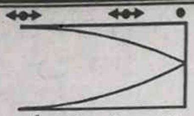
$$\lambda_n = \frac{4L}{n} \Rightarrow n = \frac{4L}{\lambda_n} = \frac{4(200)}{270} = 3$$

For closed end pipe harmonics are

$f_1, 3f_1, 5f_1, \ldots..$

69. (D)

$$\lambda/4 = \ell \Rightarrow \lambda = 4\ell$$



$\ell = \lambda_1/4$ $f_1 = v/4\ell$
Fig.(a)

70. (B)

Sonar is derived from sound navigation and ranging. It is a technique which is used to detect and locate the objects like submarine, antisubmarine weapons, mine hunting under water and depth measurement of sea.

71. (C)

$$f_1 = \frac{v}{2\ell}$$

72. (A)

The distance between node and next antinode = The distance between antinode and next node = $\lambda/4$

73. (A)

The general formula for wavelength of stationary wave in string is:

$$\lambda_n = \frac{2\ell}{n}$$

74. (A)

$$\frac{\text{Phase differnce}}{2\pi} = \frac{\text{Path differnce}}{\lambda}$$

$$\frac{\pi/2}{2\pi} = \frac{\text{Path differnce}}{\lambda} \Rightarrow \text{path difference} = \frac{\lambda}{4}$$

75. (C)

The wave in which some particles of medium are stationary is called stationary wave and such particles possessing zero displacement are called nodes. The particles having maximum displacement are called antinodes.

76. (C)

The general formula for wavelength of stationary wave closed end organ pipe: $\lambda_n = \frac{4\ell}{n}$

77. (D)

One time period is the interval in which one wavelength is completed.

78. (D)

As Car "A" is source and car "B" observer.
As

$$f_B > f_A$$

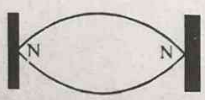
So, (D) is correct.

79. (A)

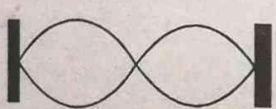
$$v = \sqrt{\frac{F}{m/\ell}} = \sqrt{\frac{F \times \ell}{m}}$$

$$v \propto \sqrt{F}$$

80. (A)



81. (C)



$$\ell = \lambda/2 + \lambda/2 = \lambda$$

82. (C)

Two waves having same frequencies and travelling in the same direction, when they superposed interference is produced.

83. (C)

If the reflecting end is open, the air molecules have complete freedom of motion and this behave as an antinode.

84. (D)

$$f_x = \frac{v}{4L}$$

$$f_y = \frac{v}{2L/2} = \frac{v}{L}$$

$$\frac{f_x}{f_y} = \frac{v/4L}{v/L} = \frac{1}{4} = 1:4$$

85. (C)

$$\lambda_n = \frac{2\ell}{n} = \frac{2(4)}{4} = 2\text{m}$$

86. (C)

$$f_4 = 4f_1 \Rightarrow f_1 = f_4/4 = 120/4 = 30 \text{ Hz}$$

87. (D)

$$f = \frac{v}{4L} \Rightarrow L = \frac{v}{4f} = \frac{340}{4(100)} = 0.85 \text{ m} = 85 \text{ cm}$$

88. (D)

$$f = \frac{v}{2L} = \frac{340}{2(3)} = 57 \text{ Hz}$$

89. (C)

$$f_1 = \frac{v}{4L} = \frac{340}{4(0.5)} = 170 \text{ Hz}$$

$$f_3 = 3f_1 = 3(170) = 510 \text{ Hz}$$

90. (B)

Sonar is derived from sound navigation and ranging. It is a technique which is used to detect and locate the objects like submarine, antisubmarine weapons, mine hunting under water and depth measurement of sea.

91. (C)

$$f = \frac{v}{4L} \Rightarrow f \propto \frac{1}{L}$$

92. (C)

For open pipe:

$$f_1 = \frac{v}{2L} = \frac{v}{2(1.6)} = \frac{v}{3.2}$$

$$f_1 = \frac{v}{2L} = \frac{v}{2(3)} = \frac{v}{6}$$

For closed ended pipe:

$$f_1 = \frac{v}{4L} = \frac{v}{4(2.3)} = \frac{v}{9.2}$$

$$f_1 = \frac{v}{4L} = \frac{v}{2(3.3)} = \frac{v}{6.6}$$

1.6 m pipe with both ends open have highest fundamental frequency.

93. (B)

Astronomers use the Doppler effect to determine the speed of stars and galaxies by comparing the spectrum of light from stars with light from a laboratory source.

94. (D)

The interval PQ = time to complete the half wavelength = Period/2

95. (D)

$$v = \frac{\lambda}{T} \Rightarrow T = \frac{\lambda}{v} = \frac{5}{20} = 0.25 \text{ s}$$

96. (C)

Wave is basically the oscillations of the particles of the medium. Its speed will be maximum at mean position where displacement is minimum.

97. (D)

$$v = x_o\omega = x_o(2\pi f) = (0.02)(2\pi)(100) = 4\pi$$
$$= 4(3.14) = 12.56 \text{ m/s} \approx 13 \text{ m/s}$$

98. (C)

$$v = x_o\omega = x_o(2\pi f) = (0.002)(2\pi)(100) = 0.4\pi$$
$$= 0.4(3.14) = 1.256 \text{ m/s} \approx 1.3 \text{ m/s}$$

99. (D)

$$a = \omega^2 x_o = 4\pi^2 f^2 x_o = 4\pi^2(10^4)(2\times10^{-3}) = 80\pi^2$$
$$= 80(9.8) \approx 790 \text{ m}/^2 \qquad \text{because } (\pi^2 \approx g)$$

100. (D)

$$v = \sqrt{\frac{F}{m/\ell}} = \sqrt{\frac{F\times\ell}{m}}$$

101. (B)

$$v = \sqrt{\frac{F}{m/\ell}} = \sqrt{\frac{0.4}{0.1\times10^{-2}}} = \sqrt{400} = 20 \text{ m/s}$$

(linear mass density = m/ℓ)

$$f = \frac{v}{\lambda} = \frac{20}{0.2} = 100 \text{ Hz}$$

102. (D)

As the frequency of wave depends upon the frequency of oscillator. So, it remains same.

$$v = f\lambda$$
$$\lambda = \frac{v}{f} = \frac{1}{f}\times\sqrt{\frac{F}{m/\ell}}$$
$$\lambda \propto \sqrt{F}$$

If tension is doubled then λ becomes $\sqrt{2}$ times.

103. (B)

$$f = \frac{v}{4L}$$
$$v = 4fL = 4(200)(0.425) = (200)(1.7) = 340 \text{ m/s}$$

104. (D)

$$v = f\lambda$$
$$\lambda = \frac{v}{f} = \frac{1}{f}\times\sqrt{\frac{F}{m/\ell}}$$
$$\frac{\lambda_I}{\lambda_{II}} = \frac{\frac{1}{f}\times\sqrt{\frac{F}{(m/\ell)_I}}}{\frac{1}{f}\times\sqrt{\frac{F}{(m/\ell)_{II}}}} = \sqrt{\frac{(m/\ell)_{II}}{(m/\ell)_I}} = \sqrt{\frac{(m/\ell)_{II}}{4(m/\ell)_{II}}} = \frac{1}{2}$$
$$\lambda_{II} = \frac{\lambda_I}{2}$$

105. (C)

$$v_1 = \sqrt{\frac{\tau\times L}{m}}$$
$$v_2 = \sqrt{\frac{2\tau\times 2L}{m}} = 2\sqrt{\frac{\tau\times L}{m}}$$
$$v_3 = \sqrt{\frac{3\tau\times 3L}{m}} = 3\sqrt{\frac{\tau\times L}{m}}$$
$$v_3 > v_2 > v_1$$

106. (D)

$$v = \sqrt{\frac{F}{m/\ell}}$$
$$\frac{v_I}{v_{II}} = \frac{\sqrt{\frac{F}{(m/\ell)_I}}}{\sqrt{\frac{F}{(m/\ell)_{II}}}} = \sqrt{\frac{(m/\ell)_{II}}{(m/\ell)_I}} = \sqrt{\frac{(m/\ell)_{II}}{4(m/\ell)_{II}}} = \frac{1}{2}$$
$$v_{II} = \frac{v_I}{2}$$

107. (C)

$$f_A = \frac{v}{4L_A} = \frac{v}{4L}$$
$$f_B = \frac{v}{4L_B} = \frac{v}{8L} = \frac{1}{2}\left(\frac{v}{4L}\right) = \frac{1}{2}f_A \qquad (L_A=L \ \& \ L_B=2L)$$
$$f_A = 2f_B$$

108. (C)

If a transverse wave travelling in a rarer medium is incident on a denser medium then it is reflected such that it undergoes a phase change of 180° or π rad (crest as trough or trough as a crest).

109. (A)

When two waves of same frequencies move oppositely along the same line in a medium, when they combine according to the principle of superposition, at certain frequencies special kind of wave is formed called stationary wave.

110. (D)

$$\frac{3\lambda}{2} = \ell \Rightarrow \lambda = \frac{2\ell}{3} = \frac{2(6)}{3} = 4 \text{ m}$$

111. (C)

Distance b/w 2nd and 3rd node = $\frac{\lambda}{2}$

Distance b/w 3rd and 4th node = $\frac{\lambda}{2}$

Distance b/w 4th and 5th node = $\frac{\lambda}{2}$

So, Distance b/w 2nd and 5th node = $\frac{\lambda}{2}+\frac{\lambda}{2}+\frac{\lambda}{2} = \frac{3\lambda}{2}$

$$\frac{3\lambda}{2} = \ell \Rightarrow \lambda = \frac{2\ell}{3} = \frac{2(60)}{3} \text{ cm} = 40 \text{ cm}$$

112. (A)

Maximum wavelength in stretched string = 2ℓ = 200 cm

So, it can never be greater than 2ℓ = 200 cm

113. (D)

Maximum wavelength in stretched string = 2L

So, it can never be greater than 2L

114. (D)

1 complete wave forms 2 loops.

No. of nodes in stretched string = No. of loops + 1

Total no. of loops in the string of length 20 m = 8

Total no. of nodes in 8 loops = 8 + 1 = 9

No. of nodes excluding the node at the ends = 9 − 2 = 7

115. (C)

$$\frac{3\lambda}{2} = \ell \Rightarrow \lambda = \frac{2\ell}{3} = \frac{2(100)}{3}\text{ cm} = 66.7\text{ cm}$$

116. (C)

$$f_1 = \frac{1}{2\ell}\sqrt{\frac{F}{m}}$$

$$f_1 \propto \sqrt{F}$$

117. (B)

$$\frac{\lambda}{2} = \ell \Rightarrow \lambda = 2\ell = 2(40) = 80\text{ cm}$$

118. (C)

$$\lambda = \ell = 30\text{ cm}$$

119. (D)

$$f_1 = \frac{v}{2\ell} = \frac{320}{2(40)} = 4\text{ Hz}$$

120. (D)

$$S = vt = (340)(3) = 1020\text{ m} \approx 1000\text{ m}$$

121. (D)

The distance from a compression center to the adjacent rarefaction center is $= \lambda/2 = 1.5$ m

UHS PAST MDCAT (2008-2019)

1. A standing wave pattern is formed when the length of string is an integral multiple of ______ wavelength. (UHS 2008)

(A) Triple (C) Half
(B) Full (D) Double

(C)

$$\lambda_n = \frac{2\ell}{n}$$

$$\ell = n\times\frac{\lambda_n}{2} = \text{Integral multiple of half of wavelength}$$

2. Two waves of slightly different frequencies and travelling in same direction produces______. (UHS 2008, 2009)

(A) Interference (C) Stationary waves
(B) Polarization (D) Beats

(D)

Definition of beats.

3. Transverse wave cannot be setup in ______. (UHS 2008)

(A) Metals (C) Fluids
(B) Solids (D) Soil

(C)

Transverse waves are also called surface waves. They cannot propagate within the fluids.

4. A 2 m long pipe is open at both ends. What is its harmonic frequency? (Speed of sound is 340 m/s) (UHS 2008)

(A) 42.5 Hz (C) 220 Hz
(B) 85 Hz (D) None of these

(B)

$$f_1 = \frac{v}{2\ell} = \frac{340}{2(2)} = 85\text{ Hz}$$

4. What is it that we use to calculate the speeds of distant stars and galaxies? (UHS 2009)

(A) Doppler effect (C) Beats
(B) Interference (D) All of these

(A)

Doppler effect can be used to calculate the speed of distant stars and galaxies.

5. Speed of waves is equal to: (UHS 2009)

(A) $f\lambda$ (C) Both (A) and (B)
(B) $\frac{\lambda}{T}$ (D) λT

(B)

$$\text{Speed of waves} = \frac{\text{Distance}}{\text{Time}} = \frac{\lambda}{T}$$

6. Two waves of same amplitude are traveling in the same direction and are out of phase, their resultant wave is: (UHS 2010)

(A) Zero amplitude
(B) The sum of amplitudes of two waves
(C) Difference of the amplitudes of two waves
(D) Double the amplitude of either wave

(A)

The superposition of two waves of same amplitude and are out of phase, then the displacement of resultant wave will be zero (According to principle of super position).

7. An organ pipe closed at one end has a length of 25 cm. wavelength of the fundamental note is: (UHS 2010)

(A) 25cm (C) 100cm
(B) 50cm (D) 75 cm

(C)

$$\lambda_n = \frac{4\ell}{n} \qquad \text{where } n = 1,3,5,\ldots$$

For fundamental mode of vibration

$$\lambda_1 = \frac{4\ell}{1} = 4\ell = 4(25\text{ cm}) = 100\text{ cm}$$

8. A source "Y" of known frequency produces 4 beats with a source of 240 Hz and 8 beats with a sound of 252 Hz. Frequency of the source "Y" is: (UHS 2010)

(A) 244 Hz (C) 248 Hz
(B) 236 Hz (D) 246 Hz

(A)

"Y" produces 4 beats with source of 240 Hz. This shows that the frequency of "Y" will be either 236 Hz or 244 Hz.
If the frequency of "Y" is 236 Hz then it produces 16 beats with 252 Hz source while the source "Y" produces 8 beats with 252 Hz. So, the frequency of "Y" is 244 Hz.

9. A source of sound wave emits waves of frequency "f". If "v" is the speed of sound waves, then what will be the wavelength of waves: (UHS 2011)

(A) $\frac{v}{f}$ (C) $\frac{v - u_o}{f}$

(B) vf (D) $(v - u_o)f$

(A)

$$v = f\lambda \Rightarrow \lambda = \frac{v}{f}$$

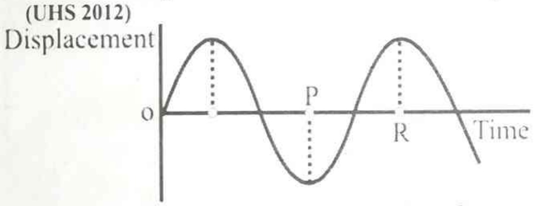
10. The spectrum of a star's light is measured and the wavelength of one of the line as the sodium's line is found to be 589 nm. The same line has the wavelength of 497 nm when observed in laboratory. This means the star is: (UHS 2011)

(A) Moving away from the Earth
(B) Moving towards the Earth
(C) Stationary
(D) Revolving around the planet

(A)

$\lambda_{real} = 497$ nm
$\lambda_{apparent} = 589$ nm
As
$\lambda_{apparent} > \lambda_{real}$
This shows that star is moving away from Earth.

11. In the diagram below, the displacement of an oscillating particle is plotted against time. What does the length "PR" on the time axis represents? (UHS 2012)



(A) Twice the frequency (C) Half the frequency
(B) Half the period (D) Twice the period

(B)

Length of "PR" = Half of wavelength = $\lambda/2$
Time for half wavelength = T/2 = half the period

12. When the source of sound moves towards the stationary observer, the value of apparent frequency "f_o" is: (UHS 2012)

(A) $f_o = \left(\frac{v + u_s}{v}\right)f$ (C) $f_o = \left(\frac{v}{v + u_s}\right)f$

(B) $f_o = \left(\frac{v}{v - u_s}\right)f$ (D) $f_o = \left(\frac{v - u_s}{v}\right)f$

(B)

$$f_o = \left(\frac{v}{v - u_s}\right)f$$

13. An observer moves with velocity "v_o" towards a stationary source, then the number of waves received in one second is: (UHS 2015)

(A) $f' = f\left(\frac{v}{v + v_o}\right)$ (C) $f' = f\left(\frac{v + v_o}{v}\right)$

(B) $f' = f\left(\frac{v}{v - v_o}\right)$ (D) $f' = f\left(\frac{v - v_o}{v}\right)$

(C)

$$f' = f\left(\frac{v + v_o}{v}\right)$$

14. The red shift measurement of Doppler effect of galaxies indicate that the universe is: (UHS 2016)

(A) Expanding (C) Stationary
(B) Contracting (D) Oscillating

(A)

Red shift in Doppler effect means that galaxies are moving away from Earth (universe is expanding).

15. A wave traveling with speed of 130 m/s having wavelength of 5 m. what is its frequency? (UHS 2017)

(A) 650 Hz (C) 26 Hz
(B) 20 Hz (D) 3.8×10^2 Hz

(C)

$$f = \frac{v}{\lambda} = \frac{130}{5} = 26 \text{ Hz}$$

16. A metallic wire of length 2 m hooked between two points has tension 10 N. if mass per unit length is 0.004 kg/m, its fundamental frequency emitted by wire on vibration is? (UHS 2017)

(A) 48 Hz (C) 12.5 Hz
(B) 24 Hz (D) 6.25 Hz

(C)

$$f_1 = \frac{1}{2\ell}\sqrt{\frac{F}{m/\ell}} = \frac{1}{2(2)}\sqrt{\frac{10}{0.004}} = \frac{1}{4}\sqrt{\frac{10}{0.004}}$$
$$= 12.5 \text{ Hz}$$

17. A shock wave is produced due to an earthquake which makes the buildings move in the direction of shock wave. Which progressive wave would this be? (UHS 2018)

(A) Transverse wave (C) Material wave
(B) Longitudinal wave (D) Particle wave

(B)

Shock waves are longitudinal in nature (Like sound wave)

18. The wavelength of the electromagnetic wave having frequency of 3 kHz will be: (UHS 2019)

(A) 80 km (C) 100 km
(B) 140 km (D) 120 km

(C)

$$\lambda = \frac{c}{f} = \frac{3 \times 10^8}{3 \times 10^3} = 100 \times 10^3 \text{ m} = 100 \text{ km}$$

19. What will be the expression for the observed frequency, if the source is moving towards the observer: (UHS 2019)

(A) $f_o = \left(\frac{v}{v - u_s}\right)f$ (C) $f_o = \left(\frac{v}{v + u_s}\right)f$

(B) $f_o = \left(\frac{v}{v \pm u_s}\right)f$ (D) $f_o = \left(\frac{v}{v - u_s}\right)f$

(D)

$$f_o = \left(\frac{v}{v - u_s}\right)f$$

UNIT 07 LIGHT

01. **Which of the following is a not necessary condition(s) to observe the phenomenon of interference of light waves clearly?**
(A) beams should be monochromatic
(B) wavelength of beams should be different
(C) amplitude of interfering beams should be small
(D) both (B) and (C)

02. **Which of the following statements must be true for two monochromatic beams of light to be coherent?**
(A) they have almost the same amplitude
(B) they produce constructive interference
(C) they have constant phase difference
(D) Different frequencies

03. **For two sources to be coherent, the waves emitted by these sources should have:**
(A) constant phase difference
(B) same wavelength
(C) same amplitude
(D) All of these

04. **The color of light is determined by its:**
(A) Wavelength (C) Velocity
(B) Frequency (D) Amplitude

05. **Young's Double slit experiment is basically used to study:**
(A) refraction of light (C) interference of light
(B) Polarization of light (D) reflection of light

06. **Destructive interference will take place if path difference between two waves is:**
(A) $m\lambda$; where m=1/2,3/2,5/2,...
(B) $m\lambda/2$; where m=1,2,3,...
(C) $m\lambda/4$; where m=1,2,3,...
(D) $m\lambda/3$; where m=1,2,3,...

07. **In Young's double slit experiment, if the screen is moved away from the slits:**
(A) fringe spacing remains unchanged
(B) fringe spacing decreases
(C) fringe spacing increases
(D) the waves never interfere

08. **In young's experiment more orders of spectra can be observed by:**
(A) increasing the wavelength of light
(B) increasing slit separation
(C) increasing the distance between screens
(D) all of these

09. **Interference can be observed in:**
(A) water waves (C) sound waves
(B) light waves (D) all of these

10. **The path difference in thin film depends upon:**
(A) angle of incidence (C) Thickness of the film
(B) nature of the film (D) all mentioned

11. **If Young's double slit apparatus is immersed in water then the fringe width:**
(A) Decreases (C) Becomes infinite
(B) Remains unchanged (D) Increases

12. **A maxima is produced at points where path difference for two monochromatic waves is:**
(A) λ (C) $\lambda/2$
(B) $\frac{\lambda}{4}$ (D) $\frac{3\lambda}{2}$

13. **The distance between two adjacent bright fringes is $\Delta y = \frac{\lambda L}{d}$. For dark fringes Δy is given by:**
(A) $\Delta y = \frac{\lambda L}{d}$ (C) $\Delta y = \left(m+\frac{1}{2}\right)\frac{L\lambda}{d}$
(B) $\Delta y = \frac{m\lambda L}{d}$ (D) $\Delta y = \frac{\lambda L}{2d}$

14. **The two sources of light are considered to be coherent if the beams emitted by them have:**
(A) same amplitudes
(B) constant phase difference
(C) equal speeds
(D) always constructive interference

15. **The colour of a light beam is not determined by its:**
(A) speed
(B) wavelength
(C) frequency
(D) both wavelength and speed

16. **A diffraction grating has 500 lines per mm. its slit spacing or grating element will be equal to:**
(A) 500 mm (C) 5×10^{-3}mm
(B) 2×10^{-5}mm (D) 2×10^{-3}mm

17. **In a Young's double slit experiment the center of a bright fringe occurs wherever waves from the slits differ in phase by a multiple of:**
(A) $\pi/4$ (C) $\pi/2$
(B) π (D) 2π

18. **The phase difference between the two waves that give rise to a dark spot in a Young's double slit experiment is (where m = integer):**
(A) $2\pi m + \pi$ (C) $2\pi m + \pi/8$
(B) $2\pi m + \pi/4$ (D) $2\pi m + \pi/2$

19. **Radio waves are readily diffracted around buildings whereas light waves are negligibly diffracted around buildings. This is because radio waves:**
(A) are plane polarized
(B) have much longer wavelengths than light waves
(C) have much shorter wavelengths than light waves
(D) are nearly monochromatic (single frequency)

20. **In Young's experiment, the fringe width of bright points as compared to that of dark points is:**
(A) small (C) large
(B) same (D) either large or small

21. **The fringe spacing in Young's experiment is:**
(A) constant throughout the pattern on the screen
(B) increased as we move away from center of the screen
(C) decreased as we move away from center of the screen
(D) independent of the colour of light

22. **If white light was used in Young's double slit experiment, the central point would be:**
(A) white fringe (C) red fringe
(B) dark fringe (D) violet fringe

23. **A maxima is produced on the screen of Young's apparatus with beams of wavelength 550nm. The path difference between the interfering beams at this point might be:**
(A) 1050 nm (C) 2050 nm
(B) 1650 nm (D) 700 nm

24. **2000 lines per centimeter have been ruled on a diffraction grating. Its grating element will be:**
(A) 5.0×10^{-6} m (C) 5.0×10^{-10} m
(B) 5.0×10^{-8} m (D) 5.0×10^{-4} m

25. **In the equation $d\sin\theta = m\lambda$ for a diffraction grating, "d" is called:**
(A) number of slits (C) slit separation
(B) grating element (D) inter planer spacing

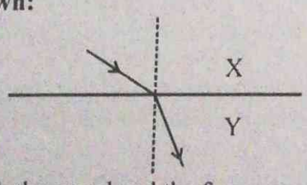
26. **A glass plate having a large number of close parallel equidistant slits mechanically ruled on it is called:**
(A) grating element (C) grating spectrometer
(B) diffraction grating (D) prism

27. **The reason there are two slits, rather than one, in a Young's experiment is:**
(A) to increase the intensity
(B) one slit is for frequency, the other for wavelength
(C) to create a path length difference
(D) one slit is for Electric fields, the other is for magnetic fields

28. **As light goes from one medium to another, it is bent away from the normal. Then:**
(A) the speed of the light has increased
(B) dispersion must occur
(C) the second medium has a higher index of refraction than the first
(D) no change in speed has occurred

29. **In a Young's double–slit experiment the center of a bright fringe occurs wherever waves from the slits differ in phase by a multiple of:**
(A) $\pi/4$ (C) $\pi/2$
(B) π (D) 2π

30. **When light travels from medium X to medium Y as shown:**



(A) both the speed and the frequency decrease
(B) both the speed and the frequency increase
(C) both the speed and the wavelength decrease
(D) both the speed and the wavelength increase

31. **When light passes from air to glass, it bends:**
(A) toward the normal without changing speed
(B) toward the normal and slows down
(C) toward the normal and speeds up
(D) away from the normal and slows down

32. **Waves from two slits are in phase at the slits and travel to a distant screen to produce the third maximum of the interference pattern. The difference in the distance traveled by the waves is:**
(A) half a wavelength (C) a wavelength
(B) two wavelengths (D) three wavelengths

33. **Light from a small region of an ordinary incandescent bulb is passed through a yellow filter and then serves as the source for a Young's double–slit experiment. Which of the following changes would cause the interference pattern to be more closely spaced?**
(A) Use slits that are closer together
(B) Use a light source of higher intensity
(C) Use a light source of lower intensity
(D) Use a blue filter instead of a yellow filter

34. **In a Young's double–slit experiment, the slit separation is doubled. To maintain the same fringe spacing on the screen, the screen–to–slit distance D must be changed to:**
(A) D/2 (C) $D/\sqrt{2}$
(B) $D\sqrt{2}$ (D) 2D

35. **In a Young's double–slit experiment, light of wavelength 500nm illuminates two slits that are separated by 1 mm. The separation between adjacent bright fringes on a screen 5m from the slits is:**
(A) 0.10 cm (C) 0.25 cm
(B) 0.50 cm (D) 1.0 cm

36. **In a Young's double slits experiment, the separation between slits is d and the screen is a distance "D" from the slits. "D" is much greater than "d" and "λ" is the wavelength of the light. The number of bright fringes per unit width on the screen is:**
(A) Dd/λ (C) $D\lambda/d$
(B) $D/d\lambda$ (D) $d/\lambda D$

37. **In a Young's experiment, it is essential that the two beams:**
(A) have exactly equal intensity
(B) travel equal distances
(C) be exactly parallel
(D) come originally from the same source

38. **To obtain an observable double–slit interference pattern:**
(A) the light must be incident normally on the slits
(B) the light must be monochromatic
(C) the light must consist of plane waves
(D) the light must be coherent

39. **The spacing between adjacent slits on a diffraction grating is 3λ. The deviation θ of the first order diffracted beam is given by:**
(A) $\sin\theta = 1/3$ (C) $\sin\theta = 2/3$
(B) $\sin\theta = 3$ (D) $\tan\theta = 1/3$

40. **Position of the m^{th} dark band be written as:**
(A) $m\frac{\lambda L}{d}$ (C) $(2m+1)\frac{\lambda}{2}$
(B) $m\lambda$ (D) $\left(\frac{2m+1}{2}\right)\frac{\lambda L}{d}$

41. **In YDSE the distance between two consecutive dark fringes will be:**

(A) $m\frac{\lambda L}{d}$ (C) $\frac{\lambda L}{d}$

(B) $(2m+1)\frac{\lambda}{2}$ (D) $m\lambda$

42. **In Young's double slit experiment, if "d" is the slits separation, "λ" is the wave length of the light used and "D" is the distance of the screen from the slits, then the separation between two successive bright fringes or dark fringes is given by:**

(A) $\frac{\lambda D}{d}$ (C) $\frac{\lambda d}{D}$

(B) $\frac{D}{\lambda d}$ (D) $\frac{d}{\lambda D}$

43. **Angle between ray of light and the corresponding wave front is:**

(A) 0° (C) 90°

(B) 60° (D) 120°

44. **A wave front means:**

(A) all particles in it, have same phase

(B) few particles are in same phase, rest are in opposite phase

(C) all particles in it, have opposite phase

(D) all particles in it, have random phases

45. **In a young's double slit experiment, the central point on the screen is:**

(A) bright

(B) first bright then dark

(C) dark

(D) first dark and then bright

46. **In young's double slit experiment the distance between the slits is gradually increased. The width of the fringe system:**

(A) increase

(B) remain same

(C) decrease

(D) first increase and then decrease

47. **In Young's double slit experiment, if "d" is the separation between the slits, "λ" is the wavelength of the light used and "D" is the distance of the screen from the slits, then the position of the mth bright fringe from the central position is given by:**

(A) $y_m = m\lambda D/d$ (C) $y_m = (m + ½)\lambda D/d$

(B) $y_m = m\lambda d/D$ (D) $y_m = (m + ½)\lambda d/D$

48. **In young's experiment, one slit is covered with a blue filter and other slit with a yellow filter, then the interference pattern:**

(A) will be blue (C) will be yellow

(B) will be green (D) will not be formed

49. **Light travels in straight lines because:**

(A) the frequency of light is very small

(B) the wavelength of light is very small

(C) Light consists of very small particles

(D) the velocity of light is different from different colour

50. **Diffraction pattern of a single slit consist of a central band which is:**

(A) wider, brighter and accompanied with alternate dark and bright bands of decreasing intensity

(B) wider, bright with alternate bright and dark bands of equal intensity

(C) narrow, bright with an alternate dark and bright bands of equal intensity

(D) dark with alternate bright and dark bands of decreasing intensity

51. **In Young's double slit experiment, if d is the separation between the slits, destructive interference will occur if:**

(A) $d \sin\theta = m\lambda$, (m = 0, 61, 6 2, . . .)

(B) $2d \sin\theta = m/\lambda$, (m = 0, 61, 6 2, . . .)

(C) $d \sin\theta = (m + ½)\lambda$, (m = 0, 61, 6 2, ...)

(D) $2d \sin\theta = m\lambda$, (m = 0, 61, 6 2, ...)

52. **If the frequency of light emitted by a source in an interference experiment is made four times, then the fringe width will become:**

(A) four times (C) one fourth

(B) three times (D) half

53. **Light of frequency 6×10^{14} Hz passes through a diffraction grating with 4×10^{3} lines per centimeter. The wavelength of the light used will be:**

(A) 2×10^{-9}m (C) 5×10^{-7}m

(B) 5×10^{-9}m (D) 6×10^{14}m

54. **In YDS experiment, if the distance between the slits and also the distance between slits and screen is doubled, the fringe width:**

(A) Becomes doubled (C) Is halved

(B) Becomes 4 times (D) Remains the same

55. **If the slits in YDS experiment are made closer, fringe spacing will:**

(A) Increase (C) Remain same

(B) Decrease (D) insufficient date

56. **Fringe spacing in YDS experiment will be maximum if we use:**

(A) Red light (C) Violet light

(B) Green light (D) Blue light

57. **In YDS experiment, data given is $\lambda = 500$ nm, d = 1 mm, L=100 cm, Δy comes out to be:**

(A) 0.5 cm (C) 0.5 nm

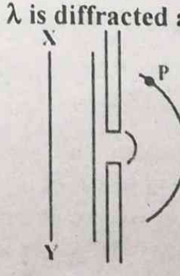
(B) 0.5 mm (D) 0.5 m

58. **The bending of light when it passes from one medium to another is known as:**

(A) Refraction (C) Polarization

(B) Interference (D) Diffraction

59. **A monochromatic plane wave of speed "c" and wavelength λ is diffracted at a small aperture:**



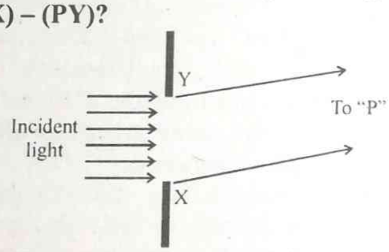
The time during which a portion of the wave front XY reaches at "P" will be:

(A) $\frac{3\lambda}{2c}$ (C) $\frac{2\lambda}{c}$
(B) $\frac{3\lambda}{c}$ (D) $\frac{4\lambda}{c}$

60. **In a Young's double–slit experiment, the slit separation is doubled. This results in:**
(A) an increase in fringe intensity
(B) a halving of the wavelength
(C) a decrease in fringe intensity
(D) a halving of the fringe spacing

61. **In an experiment to measure the wavelength of light using a double slit, it is found that the fringes are too close together to easily count them. To spread out the fringe pattern, one could:**
(A) decrease the slit separation
(B) increase the width of each slit
(C) increase the slit separation
(D) decrease the width of each slit

62. **The diagram shows a single slit with the direction to a point "P" on a distant screen shown. At "P", the pattern has its second minimum (from its central maximum). If "X" and "Y" are the edges of the slit, what is the path length difference (PX) – (PY)?**



(A) λ/2 (C) λ
(B) 3λ/2 (D) 2λ

63. **Diffraction fringes are:**
(A) Equally spaced
(B) Distance between then decreases
(C) Distance between them increases
(D) They are adjacent with no space in between

64. **In double slit experiment, if one of the two slit is covered then:**
(A) No interference fringes are observed
(B) No fringes observed
(C) No diffraction fringes are observed
(D) Interference pattern not distributed

65. **All wave fronts are concentric:**
(A) Circles (C) Spheres
(B) Squares (D) Rectangles

66. **If "N" is number of lines ruled on the grating having length "L" then grating element "d" is given by:**
(A) N/L (C) 2N/L
(B) L/N (D) N/2L

67. **Two slits of width "a" and separation "d" are illuminated by a beam of light of wavelength "λ". The separation of the interference fringes on a screen a distance "D" away is:**
(A) λa/D (C) λd/D
(B) λD/d (D) dD/λ

68. **Monochromatic light is normally incident on a diffraction grating that is 1 cm wide and has 10000 slits. The first order line is deviated at a 30° angle. What is the wavelength, in "nm", of the incident light?**
(A) 300 (C) 400
(B) 500 (D) 600

69. **The medium in which speed of light is same in all directions is called:**
(A) Homogeneous medium
(B) Non homogeneous medium
(C) Heterogeneous medium
(D) Free space

70. **In Michelson's interferometer to switch the fringe from bright to dark, the mirror should be displaced by:**
(A) λ/4 (C) λ/3
(B) λ/2 (D) λ

71. **The wave nature of the light was proposed by:**
(A) Thomas young (C) Maxwell
(B) Huygen (D) Newton

72. **The electromagnetic theory of waves was proposed by:**
(A) Thomas young (C) Maxwell
(B) Huygen (D) Newton

73. **Electromagnetic waves transport:**
(A) energy only
(B) momentum only
(C) both momentum & energy
(D) Energy only

74. **The distance between two consecutive wave fronts is called:**
(A) Time period (C) Frequency
(B) Wavelength (D) Displacement

75. **The effective path difference between two reflected beams, in X–rays diffraction by crystals is:**
(A) d sinθ (C) 2d sinθ
(B) d sin(θ/2) (D) d sin(2θ)

76. **The speed of light in vacuum depends upon:**
(A) time period
(B) wave length
(C) frequency
(D) Independent to all above options

77. **In a Young's double–slit experiment the center of a bright fringe occurs wherever waves from the slits differ in the distance they travel by a multiple of:**
(A) one fourth of a wavelength
(B) a wavelength
(C) a half a wavelength
(D) one third of a wavelength

78. **Wavelength of X–rays falling at glancing angle of 30° on a crystal with atomic spacing 2×10^{-10} for the first order diffraction is:**
(A) 4×10^{-10} m (C) 2×10^{-10} m
(B) 0.02×10^{-10}m (D) 20×10^{-10}m

79. **A diffraction grating has 500 lines per mm. Its slit spacing or grating element will be equal to:**
(A) 500 mm (C) 5×10^{-3}mm
(B) 2×10^{-5}mm (D) 2×10^{-3}mm

80. **A point source of light placed in homogeneous medium produced:**
(A) cylindrical wave front (C) elliptical wave front
(B) spherical wave front (D) plane wave front

81. **At very large distance from a point source we get:**
(A) cylindrical wave front (C) elliptical wave front
(B) spherical wave front (D) plane wave front

82. **The locus of all points in a medium having the same phase of vibration is called:**
(A) crest (C) trough
(B) wavelength (D) wavefront

83. **In an interference pattern:**
(A) Bright fringes are wider than dark fringes
(B) Dark fringes are wider than bright fringe
(C) Both dark and bright fringes are of equal width
(D) Central fringes are brighter than the outer fringes

84. **In Young's experiment, if the distance between the slits is doubled and the distance between the slits and the screen is halved, the fringe width or spacing is:**
(A) half (C) doubled
(B) four times (D) one fourth

85. **A thin layer of oil on the surface of water looks coloured due to:**
(A) polarization of light
(B) interference of light
(C) different present in the oil
(D) the transmission of light

86. **When white light is passes through a prism it:**
(A) deviated (C) diffracted
(B) dispersed (D) polarized

87. **When crest of one wave falls over the trough of the other wave, this phenomenon is known as:**
(A) Polarization
(B) Destructive interference
(C) Constructive interference
(D) Diffraction

88. **The condition for constructive interference of two coherent beams is that the path difference should be:**
(A) Integral multiple of $\lambda/2$
(B) Odd Integral multiple of $\lambda/2$
(C) Integral multiple of λ
(D) Even integral multiple of λ

89. **When a ray of light enters in glass from air:**
(A) its wavelength increases
(B) its frequency increases
(C) its wavelength decreases
(D) its frequency decreases

90. **Which one of the following is nearly monochromatic light?**
(A) Light form fluorescent tube
(B) Light form neon lamp
(C) Light form sodium lamp
(D) Light form simple lamp

91. **The blue colour of the sky is due to:**
(A) diffraction (C) reflection
(B) polarization (D) scattering

92. **When Newton's rings interference is seen from above means of transmitted light the central spot is:**
(A) red (C) blue
(B) dark (D) bright

93. **The equation for Michelson's interferometer is:**
(A) $L = 2m\lambda$ (C) $L = \frac{1}{2} m\lambda$
(B) $\lambda L = 2m$ (D) $\lambda L = \frac{1}{2} m$

94. **We get light inside a room in a day time due to:**
(A) diffraction (C) interference
(B) polarization (D) refraction

95. **Bending of light around the edges of an obstacle is called:**
(A) diffraction (C) interference
(B) polarization (D) refraction

96. **Which one of the following properties of light does not change with the nature of the medium?**
(A) Velocity (C) Wavelength
(B) Amplitude (D) Frequency

97. **Central spot of Newton's rings:**
(A) Bright
(B) Dark
(C) Dark for large wavelength
(D) Both (A) & (B)

98. **Interference and diffraction of light support the:**
(A) particle nature of light
(B) quantum nature of light
(C) wave nature of light
(D) transverse nature of light

99. **Young double slit experiment proves:**
(A) particle nature of light
(B) dual nature of light
(C) wave nature of light
(D) Both (A) and (C)

100. **Diffraction is a special type of:**
(A) reflection (C) interference
(B) polarization (D) refraction

101. **In double slit experiment, we observe:**
(A) Interference fringes only
(B) Diffraction fringes only
(C) Both interference and diffraction fringes
(D) Polarized fringes

102. **When light incident normally on thin film, the path difference depends upon:**
(A) Thickness of the film only
(B) Angle of incidence only
(C) Nature of the film only
(D) All thickness, nature and angle of incidence

103. **The equation $2d\sin\theta = n\lambda$ denotes:**
(A) Huygen's principle
(B) Bragg's equation
(C) Young's equation
(D) diffraction grating equation

104. **Which of the following is used to measure the wavelength of X–rays:**
(A) Diffraction grating
(B) Stefan's Law
(C) Bragg's Law
(D) Young's double slit experiment

105. **Bragg's law for x–ray diffraction is $2d \sin \theta = m\lambda$, where the quantity "d" is:**
(A) the height of a unit cell
(B) the distance from detector to sample
(C) the smallest inter–atomic distance
(D) the distance between planes of atoms

106. **A beam of x rays of wavelength 0.10nm is found to diffract in second order from the face of a LiF crystal at a Bragg angle of 30^o. The distance between adjacent crystal planes, in nm, is about:**
(A) 0.15 (C) 0.20
(B) 0.25 (D) 0.30

107. **A diffraction grating of width "W" produces a deviation θ in second order for light of wavelength "λ". The total number "N" of slits in the grating is given by:**
(A) $2W\lambda/ \sin\theta$ (C) $(W/\lambda) \sin\theta$
(B) $\lambda W/2 \sin\theta$ (D) $(W/2\lambda) \sin\theta$

108. **The wavelength of the X–rays is:**
(A) 1 $\mathring{A}$ (C) 10 $\mathring{A}$
(B) 100 $\mathring{A}$ (D) 1000 $\mathring{A}$

109. **A grating has 5000 lines per centimeter. Then grating element will be:**
(A) 2×10^{-6} m (C) 2×10^{-8} m
(B) 2×10^{-10} m (D) 2×10^{-4} m

110. **In Michelson's interferometer, a bright fringe will be replaced by next bright fringe if we move the movable mirror by an amount equal to:**
(A) λ (C) λ/2
(B) λ/4 (D) λ/3

111. **When mirror of Michelson Interferometer is moved a distance of 0.5 mm, 2000 fringes are observed. The wave length of light used is:**
(A) 5000 m (C) 5000 A°
(B) 500 cm (D) 2000 A°

112. **Sodium Chloride in flame gives out pure:**
(A) Blue light (C) Yellow light
(B) Red light (D) White light

113. **The phase difference between two points on wave front is:**
(A) zero (C) π/4
(B) π/2 (D) π

114. **A light spectrum is formed on a screen using a diffraction grating. The entire apparatus (source, grating and screen) is now immersed in a liquid of refractive index 1.33. As a result, the pattern on the screen:**
(A) remains the same
(B) spreads out
(C) crowds together
(D) becomes reversed, with the previously blue end becoming red

115. **Michelson Interferometer is used to:**
(A) Measure the distance with high precision
(B) Study the interference of thin film
(C) Find the speed of light
(D) Study the diffraction of light

UNIT 07 LIGHT (SOLUTIONS)

01. (D)

Conditions for detectable interference:
i. The interfering beams of light must be monochromatic.
ii. The interfering beams of light must be coherent.

02. (C)

Two or more sources will behave as coherent sources if they continuously emit light waves of the same amplitude, same time period and same frequency (or wavelength) having the same phase or constant phase difference.

03. (D)

Two or more sources will behave as coherent sources if they continuously emit light waves of the same amplitude, same time period and same frequency (or wavelength) having the same phase or constant phase difference.

04. (B)

Colours of light are primarily depends upon the frequency.

05. (C)

Young's double slit experiment basically used to study interference effect of light. However, spreading of light around the edges of the slits also produces some diffraction effects but interference plays a prominent role than the diffraction

06. (A)

Condition for destructive interference:
Path difference = Odd Integral multiple of half wavelength

07. (C)

$$\Delta y = \frac{\lambda L}{d} \Rightarrow \Delta y \propto L$$

08. (B)

$$\Delta y = \frac{\lambda L}{d}$$

To get more order of spectra, the fringe spacing should be decreased. this is only possible when slit separation is increased.

09. (D)

Two waves (any type) having same frequencies and travelling in the same direction, when they superposed interference is produced.

10. (D)

The path difference depends upon:
i. Thickness and nature of the film
ii. Angle of incidence

11. (A)

$$\Delta y = \frac{\lambda L}{d} \Rightarrow \Delta y \propto \lambda$$

When light wave enters into denser medium from rarer medium its wavelength decreases. So, fringe width also decreases.

12. (A)

Condition for constructive interference:
Path difference = Integral multiple of wavelength

13. (A)

In case of interference

$$\Delta y_B = \Delta y_D = \frac{\lambda L}{d}$$

14. (B)

The monochromatic sources of light which emit waves having constant phase difference.

15. (D)

Colours of light are primarily depends upon the frequency.

16. (D)

$$d = \frac{1}{500}\text{ mm} = 2 \times 10^{-3}\text{ mm}$$

17. (D)

Condition for constructive interference:
Path difference = Integral multiple of wavelength
= $m\lambda$
The corresponding phase difference for λ is 2π.

18. (A)

Phase difference for destructive interference is integral multiple of π ($m\pi$).

19. (B)

Because the wavelength of radio waves is much longer than light waves. So, more will be diffracted.

20. (B)

In case of interference

$$\Delta y_B = \Delta y_D = \frac{\lambda L}{d}$$

21. (A)

In case of interference

$$\Delta y_B = \Delta y_D = \frac{\lambda L}{d}$$

22. (A)

In Young's experiment, when white light is used, alternate dark and bright colour fringes will be seen with white zero order maxima (center).

23. (B)

Condition for constructive interference:
Path difference = Integral multiple of wavelength
= $m\lambda$
Path difference = (3)(550 nm) = 1650 nm
So, the only (B) is the integral multiple of "λ".

24. (A)

$$d = \frac{1}{200000}\text{ m} = 5 \times 10^{-6}\text{ m}$$

25. (B)

d = grating element = Separation between two consecutive slits on diffraction grating = $\frac{L}{N}$

26. (B)

A diffraction grating is a glass plate having a large number of close parallel equidistance slits mechanically ruled on it. The transparent spacing between the scratches on the glass plate act as slits. A typical diffraction grating has about 400 to 5000 lines per centimeter.

27. (C)

To decide the constructive or destructive interference, path difference of two interfering beams must be required.
For constructive interference:
Path difference = Integral multiple of wavelength
Path difference = $m\lambda$ Where $m = 0,1,2,3,\ldots$
For destructive interference:
Path difference = Odd Integral multiple of half wavelength

$$\text{Path difference} = \left(m + \frac{1}{2}\right)\lambda$$

Where $m = 0,1,2,3,\ldots$

28. (A)

The light bends away from the normal, this shows that the light is entering from denser to rarer medium. So, wavelength and speed both increase.

29. (D)

For constructive interference:
Path difference = Integral multiple of wavelength
Path difference = $m\lambda$ Where $m = 0,1,2,3,\ldots$
The phase difference corresponding to λ is 2π. So,
Phase difference for bright fringe = $m(2\pi)$

30. (D)

As the light bends towards the normal, this shows that the light is entering from rarer to denser medium. So, wavelength and speed both decrease.

31. (B)

As the light bends towards the normal, this shows that the light is entering from rarer to denser medium. So, wavelength and speed both decrease.

32. (D)

For constructive interference:
Path difference = Integral multiple of wavelength
Path difference = $m\lambda$ Where $m = 0,1,2,3,\ldots$
For third maxima
$m = 3$
Path difference = 3λ

33. (D)

$$\Delta y = \frac{\lambda L}{d} \Rightarrow \Delta y \propto \lambda$$

$$\lambda_{blue} < \lambda_{yellow}$$

34. (D)

$$\Delta y = \Delta y'$$

$$\frac{\lambda D}{d} = \frac{\lambda D'}{2d} \Rightarrow D' = 2D$$

35. (C)

$$\Delta y = \frac{\lambda L}{d} = \frac{(500 \times 10^{-9})(5)}{10^{-3}}$$

$$= 2.5 \times 10^{3-9+3}\text{ m} = 2.5 \times 10^{-3}\text{ m} = 0.25\text{ cm}$$

36. (D)

Number of fringes in unit width $= \frac{1}{\Delta y} = \frac{d}{\lambda D}$

37. (D)

Conditions for detectable interference:

i. The interfering beams of light must be monochromatic.

ii. The interfering beams of light must be coherent (same sources).

38. (D)

The necessary condition for interference is coherent.

39. (A)

$d\sin\theta = n\lambda$

$3\lambda\sin\theta = (1)\lambda \Rightarrow \sin\theta = 1/3$

40. (D)

$$y_m = \left(m + \frac{1}{2}\right)\frac{\lambda L}{d} = \left(\frac{2m+1}{2}\right)\frac{\lambda L}{d}$$

41. (C)

In case of interference

$$\Delta y_B = \Delta y_D = \frac{\lambda L}{d}$$

42. (A)

In case of interference

$$\Delta y_B = \Delta y_D = \frac{\lambda D}{d}$$

43. (C)

A line normal to the wave front which gives the direction of motion of the wave is called ray of light.

44. (A)

Such a surface on which all the points have the same phase of vibration is called wave front.

45. (A)

For constructive interference

Path difference = $m\lambda$

$d \sin\theta = m\lambda$ where $m = 0,1,2,3,\ldots\ldots$

The central bright fringe is obtained when $m = 0$.

46. (C)

$$\Delta y = \frac{\lambda L}{d} \Rightarrow \Delta y \propto \frac{1}{d}$$

47. (A)

For m^{th} order bright fringe, $y_m = m\frac{\lambda D}{d}$

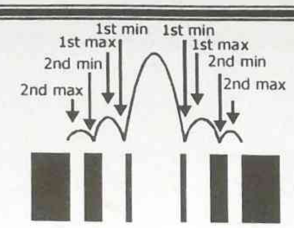
48. (D)

Blue and red lights coming out from the two slits will not be phase coherence due to different wavelengths. Interference of light will not occur. So, there will be no bright and dark fringes on the screen. Only two coloured spots will observe with constant intensity on the screen.

49. (C)

When the light is behaving as particle, it will not be diffracted. So, it travels in straight path.

50. (A)



51. (C)

Path difference = Odd Integral multiple of half wavelength

Path difference $= \left(m + \frac{1}{2}\right)\lambda$

Where $m = 0,1,2,3,\ldots.., 61,62,63,\ldots$

52. (C)

$$\Delta y = \frac{\lambda L}{d} = \frac{cL}{fd}$$

$$\Delta y' = \frac{cL}{4fd} = \frac{1}{4}\left(\frac{cL}{fd}\right) = \frac{1}{4}\Delta y$$

53. (C)

$$\lambda = \frac{c}{f} = \frac{3 \times 10^8}{6 \times 10^{14}} = 0.5 \times 10^{-6} m = 5 \times 10^{-7}\ m$$

54. (D)

$$\Delta y = \frac{\lambda L}{d}$$

$$\Delta y' = \frac{\lambda(2L)}{2d} = \frac{\lambda L}{d} = \Delta y$$

55. (A)

$$\Delta y = \frac{\lambda L}{d} \Rightarrow \Delta y \propto \frac{1}{d}$$

56. (A)

$$\Delta y = \frac{\lambda L}{d} \Rightarrow \Delta y \propto \lambda$$

The wavelength of red light is maximum. So, fringe spacing will also be maximum.

57. (B)

$$\Delta y = \frac{\lambda L}{d} = \frac{(500 \times 10^{-9})(100 \times 10^{-2})}{10^{-3}}$$

$$= 5 \times 10^{4-11+3} m = 5 \times 10^{-4} m = 0.5\ mm$$

58. (A)

When an oblique ray enters from one medium to another medium, its path will be changed. This is known as refraction.

59. (B)

$$S = ct \Rightarrow t = \frac{S}{c} = \frac{3\lambda}{c}$$

60. (D)

$$\Delta y = \frac{\lambda L}{d} \Rightarrow \Delta y \propto \frac{1}{d}$$

61. (A)

$$\Delta y = \frac{\lambda L}{d} \Rightarrow \Delta y \propto \frac{1}{d}$$

62. (B)

For destructive interference:

Path difference = Odd Integral multiple of half wavelength

Path difference $= \left(m + \frac{1}{2}\right)\lambda$

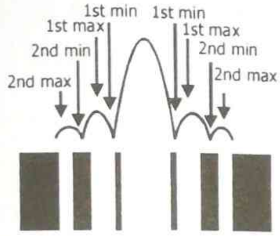
Where $m = 0,1,2,3,.....$

For 2^{nd} minima

$m = 1$

$$\text{Path difference} = PX - PY = \left(1+\frac{1}{2}\right)\lambda = \frac{3\lambda}{2}$$

63. (C)

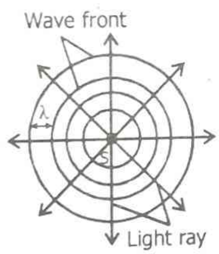


64. (A)

When two or more light waves having the same frequency and wave length, travelling in the same direction superpose each other, in such a way that they reinforce each other at some points and cancel the effect of each other at other points. This is called interference.

When one slit is covered then only one light wave is left. To produce the interference minimum two light waves of monochromatic light are necessary. That is why no interference fringes are observed.

65. (C)



66. (B)

Distance between two adjacent slits is called grating element. If "N" is the number of the lines on the grating and "L" is the length of the grating so,

$$\text{Grating element, } d = \frac{L}{N}$$

67. (B)

$$\Delta y = \frac{\lambda D}{d}$$

68. (B)

$$d\sin\theta = n\lambda$$

$$\frac{L}{N}\sin\theta = n\lambda$$

$$\lambda = \frac{L\sin\theta}{nN} = \frac{10^{-2}\sin 30^\circ}{(1)(10^4)} = 0.5 \times 10^{-6}\text{ m} = 500\text{ nm}$$

69. (A)

The medium in which speed of light is same in all directions is called homogeneous medium.

70. (A)

If movable mirror moves a distance "λ/4" then

Path difference produced = $\lambda/4 + \lambda/4 = \lambda/2$

So, instead of constructive interference, destructive interference takes place. A dark fringe takes the position of a bright fringe or bright fringe takes the position of a dark fringe.

71. (B)

In 1678, Huygen was the first scientist who proposed that light has wave nature.

72. (C)

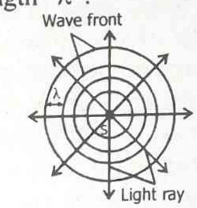
The electromagnetic theory of waves was proposed by Maxwell.

73. (C)

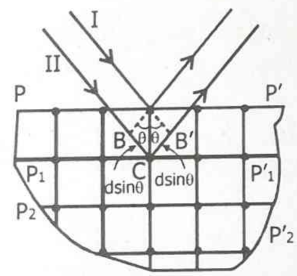
As light has dual nature. So, it will carry both energy and momentum.

74. (B)

The distance between two consecutive wave fronts is one wavelength "λ".



75. (C)



BC + BC' = Path difference between beam "I" and "II".

Path difference = BC + BC'

Path difference = $d\sin\theta + d\sin\theta = 2d\sin\theta$

76. (D)

Speed of light in vacuum is universal constant having value 3×10^8 m/s.

77. (B)

For constructive interference:

Path difference = Integral multiple of wavelength

Path difference = $m\lambda$ Where $m = 0,1,2,3,.....$

78. (C)

$$2d\sin\theta = n\lambda$$

$$2(2 \times 10^{-10})\sin 30^\circ = (1)\lambda \Rightarrow \lambda = 2 \times 10^{-10}\text{m}$$

79. (D)

$$d = \frac{1}{500}\text{ mm} = 2 \times 10^{-3}\text{ mm}$$

80. (B)

In case of point source the wave fronts are in spherical shape.

81. (D)

At very large distance from the source a small portion of the spherical wave front is nearly plane and it is called plane front.

82. (D)

Locus of all the points having the same phase or same state of vibration is called wavefront.

83. (C)

In case of interference

$$\Delta y_B = \Delta y_D = \frac{\lambda L}{d}$$

84. (D)

$$\Delta y = \frac{\lambda L}{d}$$

$$\Delta y' = \frac{\lambda(L/2)}{2d} = \frac{1}{4}\frac{\lambda L}{d} = \frac{1}{4}\Delta y$$

85. (B)

An oil film floating on water surface exhibit beautiful colours due to interference of light.

86. (B)

When white light passes through the prism it is dispersed into seven colours.

87. (B)

The two light waves meet in such a way that they cancel the effect of each other. (Crest of one wave falls on the trough of the other and the trough of one wave falls on the crest of the other) The amplitude of the resultant wave will be less than either of the individual waves and a dark band (dark fringe) is seen on the screen.

88. (C)

Path difference = Integral multiple of wavelength
Path difference = $m\lambda$ Where $m = 0,1,2,3,\ldots$

89. (C)

$$n = \frac{c}{v} = \frac{f\lambda}{f\lambda_{glass}} \Rightarrow \lambda_{glass} = \frac{\lambda}{n}$$

as $n > 1$

so,

$\lambda_{glass} < \lambda$

90. (C)

Sodium chloride in a flame gives out pure yellow light. This light is not a mixture of red and green.

91. (D)

As the scattering of blue light is more as compared to the lights of other colours. That is why the colour of sky is blue.

92. (D)

In case of transmitted light, the fringe pattern is just opposite of the reflected pattern because of no phase change of 180°. It means that the central spot of Newton's rings in this case will be bright instead of dark due to the transmitted light.

93. (C)

$$L = \frac{1}{2} m \lambda$$

94. (A)

The bending of light around obstacles and spreading of light wave into the geometrical shadow of obstacle is called diffraction.

95. (A)

The bending of light around obstacles and spreading of light wave into the geometrical shadow of obstacle is called diffraction.

96. (D)

Frequency of waves can only be changed by changing the source of waves. So, it does not change with the nature of the medium.

97. (D)

In case of reflected light the central spot of Newton's ring is dark, while in case of transmitted light the central spot is bright.

98. (C)

The phenomenon of interference and diffraction prove the wave nature of light.

99. (C)

Young's double slits experiment is used to study the interference and diffraction of light that supports the wave nature of light.

100. (C)

In diffraction the fringes on the screen are formed due to the interference.

101. (C)

Young's double slit experiment basically used to study interference effect of light. However, spreading of light around the edges of the slits also produces some diffraction effects.

102. (D)

Path difference in thin film depends upon:

i. Thickness and nature of the film.
ii. Angle of incidence.

103. (B)

X–rays diffraction is studied by the Bragg's equation given by

$2d\sin\theta = n\lambda$

104. (C)

Bragg's equation can be used to find the wavelength of x–rays.

$2d\sin\theta = n\lambda$

105. (D)

d = inter–planar spacing = the distance between planes of atoms of a crystal

106. (C)

$2d\sin\theta = n\lambda$

$2d\sin 30^\circ = 2(0.10\text{nm}) \Rightarrow d = 0.20$ nm

107. (D)

$d\sin\theta = n\lambda$

$$\frac{W}{N}\sin\theta = 2\lambda \Rightarrow N = \frac{W\sin\theta}{2\lambda}$$

108. (A)

X–rays are electromagnetic radiations of much smaller wavelength about 10^{-10}m.

109. (A)

$$d = \frac{1}{500000}\text{ m} = 2 \times 10^{-6}\text{ m}$$

110. (C)

If movable mirror is displaced through a distance of "$\lambda/2$" then

path difference produced = $\lambda/2 + \lambda/2 = \lambda$

This means that one fringe shift is seen i.e, one bright fringe will move to the position of the next bright fringe.

111. (C)

$$L = m\frac{\lambda}{2} \Rightarrow \lambda = \frac{2L}{m} = \frac{2(5 \times 10^{-4})}{2000} = 5 \times 10^{-7}\text{ m}$$

$= 5000 \times 10^{-10}$ m = 5000A°

112. (C)

Sodium chloride in a flame gives out pure yellow light. This light is not a mixture of red and green.

113. (A)

Such a surface on which all the points have the same phase (phase difference = zero) of vibration is called wave front.

114. (C)

$$n = \frac{c}{v} = \frac{f\lambda}{f\lambda_{liquid}} \Rightarrow \lambda_{liquid} = \frac{\lambda}{n}$$

as $n > 1$

so,

$\lambda_{liquid} < \lambda$

$\Delta y \propto \lambda$

On decreasing "λ" fringe spacing will be decreased. So, more numbers of fringes will form.

115. (A)

In 1881 Albert A. Michelson devised this instrument.

i. It can measure the distance with high precision.

ii. It can be used to measure the wavelength of light.

UHS PAST MDCAT (2008-2019)

1. The centre of Newton rings is dark due to: (UHS 2008)

(A) Polarization
(B) Destructive Interference
(C) Constructive Interference
(D) Reflection

(B)

At the point of contact of the lens and the glass plate, the thickness of the film is effectively zero but due to reflection at the lower surface of air film from denser medium, an additional path difference of λ/2 is introduced. Consequently the centre of Newton rings is dark due to destructive interference.

2. A yellow light of wavelength 500 nm emitted by a single source passes through two narrow slits 1mm apart. How far apart are two adjacent bright fringes when interference is observed on a screen 10 m away? (UHS 2008)

(A) 5 mm (B) 1.33 mm
(B) 0.5 mm (D) 50 mm

(A)

$$\Delta y = \frac{\lambda L}{d} = \frac{(500 \times 10^{-9})(10)}{10^{-3}}$$

$$= 5 \times 10^{3-9+3} \text{ m} = 5 \times 10^{-3} \text{ m} = 5 \text{ mm}$$

3. In Young's double slit experiment, if the distance between slits and screen is doubled, then fringe spacing becomes: (UHS 2009)

(A) zero
(B) One
(C) Double of the original value
(D) Half of the original value

(C)

$$\Delta y = \frac{\lambda L}{d} \Rightarrow \Delta y \propto L$$

4. In Michelson's interferometer 792 bright fringes pass across the field of view when its moveable mirror is displaced through 0.233 mm using equation $L = m\frac{\lambda}{2}$. The wavelength of light used is: (UHS 2009)

(A) 588 nm (C) 348 nm
(B) 620 nm (D) 400 nm

(A)

$$L = m\frac{\lambda}{2} \Rightarrow \lambda = \frac{2L}{m}$$

$$= \frac{2(0.233 \times 10^{-3})}{792} = \frac{2(233 \times 10^{-6})}{792} = \frac{446 \times 10^{-6}}{792}$$

$$\approx 0.588 \times 10^{-6} \text{ m} = 588 \times 10^{-9} \text{ m} = 588 \text{ nm}$$

5. In Newton ring apparatus, at the point of contact of the lens and glass plate, the additional path difference introduced is: (UHS 2010)

(A) λ/4 (C) λ
(B) λ/2 (D) λ/3

(B)

At the point of contact of the lens and the glass plate, the thickness of the film is effectively zero but due to reflection at the lower surface of air film from denser medium, an additional path difference of λ/2 is introduced.

6. The path difference "BD" for destructive interference is: (UHS 2010)

(A) $(m + 1/2)\lambda$ (C) $d\sin\theta$
(B) $m\lambda$ (D) 3λ

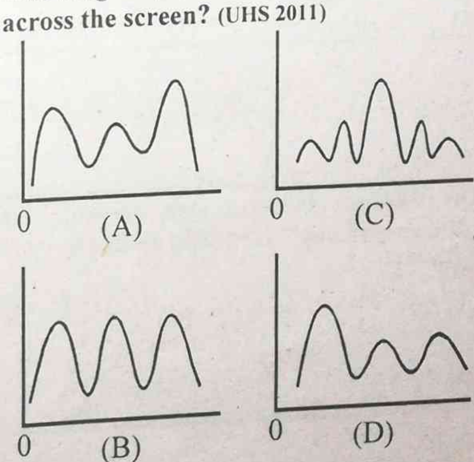
(A)

Condition for destructive interference:

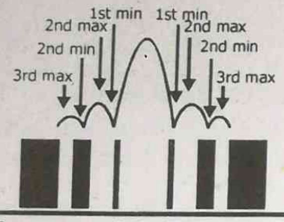
Path difference = Odd Integral multiple of half wavelength

$BD = (m + 1/2)\lambda$

7. A monochromatic light of wavelength "λ" is used to produce the diffraction pattern through a single slit of width "x". Which one of the following represents the intensity distribution across the screen? (UHS 2011)



(C)



8. For interference of light waves to take place, the required condition is: (UHS 2011)

(A) The path difference of the light waves from the source must be large
(B) The interfering waves must be non-coherent
(C) The light waves may come from different sources
(D) The light waves may come from two coherent sources

(D)

Conditions for detectable interference:

i. The interfering beams of light must be monochromatic.
ii. The interfering beams of light must be coherent.

9. The property of bending of light around an obstacle and spreading of light waves into geometric shadow of an obstacle is called: (UHS 2011)

(A) Diffraction (C) Quantization of light
(B) Polarization (D) Interference of light

(A)

Definition of diffraction.

10. An oil film floating on water surface exhibits colour pattern due to the phenomenon of: (UHS 2014)

(A) Diffraction (C) Interference
(B) Polarization (D) Surface tension

(C)

Coloured pattern will be observed in oil film due to interference of light.

11. The distance between atoms is 0.30 nm. What will be the wavelength of X-rays at angle $\theta = 30^o$ for 1st order diffraction: (UHS 2014)

(A) $\lambda = 0.60$ nm (C) $\lambda = 0.20$ nm
(B) $\lambda = 0.30$ nm (D) $\lambda = 0.90$ nm

(B)

$$2d\sin\theta = n\lambda \Rightarrow \lambda = \frac{2d\sin\theta}{n} = \frac{2(0.30\text{ nm})\sin 30^o}{1}$$

$\lambda = 0.30$ nm

12. The distance between two bright or two dark adjacent fringes is mathematically written as: (UHS 2015)

(A) $\Delta y = \frac{\lambda L}{d}$ (C) $\Delta y = \frac{\lambda d}{L}$
(B) $\Delta y = \frac{\lambda}{dL}$ (D) $\Delta y = \frac{d}{\lambda L}$

(A)

In case of interference

$$\Delta y_B = \Delta y_D = \frac{\lambda L}{d}$$

13. In Young's Double slit experiment, slit separation a = 0.05 cm, distance between screen and slit D = 200 cm, fringes separation x = 0.13 cm, then the wavelength "λ" of light ray is: (UHS 2015)

(A) $\lambda = 1.33 \times 10^{-2}$m (C) $\lambda = 4.55 \times 10^{-3}$m
(B) $\lambda = 3.25 \times 10^{-7}$m (D) $\lambda = 5.1 \times 10^{-5}$m

(B)

In case of interference

$$\Delta y = \frac{\lambda L}{d}$$

$$x = \frac{\lambda D}{a} \Rightarrow \lambda = \frac{ax}{D}$$

$$= \frac{(5 \times 10^{-4})(13 \times 10^{-4})}{2} = \frac{65}{2} \times 10^{-8}\text{ m} = 3.25 \times 10^{-7}\text{ m}$$

14. If general equation for destructive interference's is given by the relation

Optical path difference = $\left(m + \frac{1}{2}\right)\lambda$

Where "m" is an integer, then first dark fringe appear for "m" will be equal to: (UHS 2016)

(A) $\frac{2}{3}$ (C) 0
(B) $\frac{1}{2}$ (D) 1

(C)

Optical path difference = $\left(m + \frac{1}{2}\right)\lambda$

Where m = 0,1,2,3,…
For 1st dark fringe
m = 0

15. For bright fringe formation the path difference is: (UHS 2016)

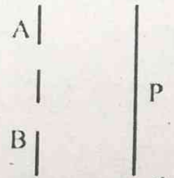
(A) $\left(n + \frac{1}{2}\right)\lambda$ where n = 0,1,2………
(B) $n\lambda$ where n = 0,1,2………
(C) $(2n + 1)\frac{\lambda}{2}$ where n = 0,1,2………
(D) $\left(\frac{n+1}{2}\right)\lambda^2$ where n = 0,1,2………

(B)

Condition for constructive interference:

Path difference = Integral multiple of wavelength
= $m\lambda$

16. Coherent light emerge from two fine parallel slit "A" and "B" as shown in the figure below:



If "P" is the position of nth dark fringe from the centre of interference pattern then the phase difference between the wave train from "A" and "B" is: (UHS 2017)

(A) $n\pi$ radian (C) $(n + 1/2)\pi$ radian
(B) $2n\pi$ radian (D) $(2n + 1)\pi$ radian

(D)

Path difference = Odd Integral multiple of half wavelength

Path difference = $(2n+1)\frac{\lambda}{2}$

The phase difference corresponds to $\frac{\lambda}{2}$ is π. So,

Phase difference = = $(2n+1)\pi$ radian

17. **Wavelength of light which produces second order spectrum on a diffraction grating on which 5000 lines/cm are ruled at an angle of 30° will be equal to:** (UHS 2017)

(A) 6×10^{-7} m (C) 5×10^{-7}m
(B) 4×10^{-6}m (D) 3×10^{-6}m

(C)

$$d\sin\theta = n\lambda \Rightarrow \frac{L}{N}\sin\theta = n\lambda \Rightarrow \lambda = \frac{L\sin\theta}{Nn}$$

$$\lambda = \frac{L\sin\theta}{Nn} = \frac{(10^{-2})\sin 30^{\circ}}{(5\times10^{3})(2)} = \frac{10^{-2}}{2\times10^{4}}$$
$$= 5\times10^{-3-4}\text{ m} = 5\times10^{-7}\text{ m}$$

18. **A diffraction grating has 500 lines per mm, its grating element "d" equal to:** (UHS 2018)

(A) 2×10^{-2} meter (C) 2×10^{-2} cm
(B) 2×10^{-6} meter (D) 2×10^{-6} cm

(B)

$$d = \frac{L}{N} = \frac{10^{-3}}{5\times10^{2}} = 2\times10^{-6}\text{ m}$$

19. **In double slits experiment, the fringe spacing of the diffracted rays increases when:** (UHS 2019)

(A) the distance between the screen and slit decreases
(B) the wavelength of the diffracted rays increases
(C) the distance from mid points of the slits to the central point of fringe on the screen increases
(D) the distance between the slits increases

(B)

In case of interference

$$\Delta y = \frac{\lambda L}{d} \Rightarrow \Delta y \propto \lambda$$

20. **Path difference for destructive interference can be written as:** (UHS 2019)

(A) $\Delta S = n\lambda$ (C) $\Delta S = 2n(\lambda)$
(B) $\Delta S = (n + 1/3)\lambda/2$ (D) $\Delta S = (2n+1)\lambda/2$

(D)

Path difference = Odd Integral multiple of half wavelength

$$\Delta S = (2n+1)\frac{\lambda}{2}$$

21. **If a light is emitted by a single source passes through two narrow slits 1.00 mm apart. The interference pattern is observed on a screen 200 cm away and the separation between the centers of adjacent bright fringes is 2.00 mm. what would be the wavelength of light?** (UHS 2019)

(A) 2 μm (C) 2 pm
(B) 1 μm (D) 2 nm

(B)

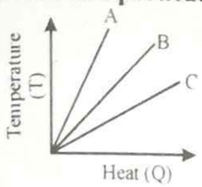
$$\Delta y = \frac{\lambda L}{d}$$

$$\lambda = \frac{\Delta y d}{L} = \frac{(2\times10^{-3})(1\times10^{-3})}{2} = 1\ \mu\text{m}$$

UNIT 08 HEAT AND THERMODYNAMICS

01. **The specific heat of a gas in an isothermal process is:**
(A) infinity (C) negative
(B) zero (D) remain constant

02. **Which of the substances A,B or C has the highest specific heat? The temperature vs heat graph is:**



(A) A
(B) B
(C) C
(D) all have equal specific heats

03. **Consider the ratios of the heat capacities $\gamma = C_p/C_v$ for the three types of ideal gases: monatomic, diatomic, and polyatomic:**
(A) γ is the greatest for monatomic gases
(B) γ is the greatest for polyatomic gases
(C) γ is the same only for diatomic and polyatomic gases
(D) γ is the same only for monatomic and diatomic gases

04. **Two gasses "A" and "B" having same number of molecules are at temperature 10^0C. A is heated at constant volume and "B" is heated at constant pressure and their temperature rises to 12°C. Increase in internal energy in:**
(A) A is greater (C) both gasses are same
(B) B is greater (D) A is slightly greater

05. **Average K.E of one mole of an ideal gas can be written as:**
(A) $\frac{2}{3kT}$ (C) $\frac{2}{3RT}$
(B) $\frac{3RT}{2}$ (D) $\frac{3kT}{2}$

06. **For an ideal gas force of attraction between molecules is:**
(A) very large (C) very small
(B) infinite (D) zero

07. **If mean square velocity of gas molecules is doubled then pressure of gas:**
(A) doubles (C) becomes four times
(B) remains same (D) one third

08. **Boltzman's constant is defined as:**
(A) N_A/R (C) N_AR
(B) R/N_A (D) $1/RN_A$

09. **Polyatomic real gas molecules have:**
(A) translational K.E (C) rotational K.E
(B) vibrational K.E (D) all of these

10. **Pressure of a gas can be written as:**
(A) $\frac{1}{3}\rho\langle v\rangle$ (C) $\frac{1}{3}\langle v^2\rangle$
(B) $\frac{1}{3}\rho\langle v^2\rangle$ (D) $\frac{1}{3}\rho^2\langle v\rangle$

11. **Which of the given statements contradicts the kinetic theory of gasses:**
(A) molecules have very small size
(B) molecules collide in–elastically
(C) molecules are far apart
(D) molecules collide elastically

12. **When water is heated from 0 C° to 10 C°, its volume:**
(A) Increase
(B) Decreases
(C) Does not change
(D) First deceases and then increases

13. **The temperature of a gas is increased from 27°C to 127°C. The ratio of its mean kinetic energies after and before heating will be:**
(A) $\frac{10}{9}$ (C) $\frac{4}{3}$
(B) $\frac{9}{16}$ (D) $\frac{3}{4}$

14. **Which one is correct relation?**
(A) $C_P + C_V = \gamma$ (C) $C_P = 1 + R/C_v$
(B) $\gamma = C_P/C_V$ (D) $C_P = 1 - R/C_V$

15. **In free expansion of a gas, the internal energy of the system:**
(A) Increase
(B) Decreases
(C) is unchanged
(D) First increases then decreases

16. **The temperature at which the reading of Fahrenheit thermometer will be double that of a centigrade thermometer is:**
(A) 160°C (C) 140°C
(B) 180°C (D) 100°C

17. **A Celsius degree rise in temperature is larger than a Fahrenheit degree rise in temperature by:**
(A) 5/9 (C) 9/10
(B) 9/5 (D) 9/8

18. **Absolute zero is considered as that temperature at which:**
(A) All liquids become gases
(B) All gases become liquids
(C) Water freezes
(D) All gasses partially liquefied

19. **At constant temperature, the graph between V and $\frac{1}{P}$ is:**
(A) Hyperbola (C) Straight line
(B) Parabola (D) Ellipse

20. **The K.E of the molecules of an ideal gas at absolute zero will be:**
(A) Infinite (C) Very high
(B) Zero (D) Below zero

21. **At constant temperature, if the volume of the given mass of gas is doubled, than the density of the gas becomes:**

(A) Double (C) $\frac{1}{2}$ of the original value

(B) $\frac{1}{4}$ of the original value (D) Remains constant

22. **At 30°C and atmospheric pressure, the volume of a given mass is 100 cm^3. Pressure remaining same, the volume will be doubled if the temperature becomes:**
(A) 15°C (C) 60°C
(B) 606°C (D) 333°C

23. **The pressure exerted on the walls of the container by a gas is due to the fact that the gas molecules:**
(A) lose their kinetic energy
(B) stick to the wall
(C) collide with the walls
(D) all of these

24. **In the equation PV = RT, 'V' stands for the volume of:**
(A) One gram of gas
(B) One liter of gas
(C) Any amount of gas
(D) One gram molecule of gas

25. **If a given mass of gas occupies a volume of 100 cm^3 at one atmospheric pressure and temperature of 100°C, what will be its volume at 4 atmospheric pressure, the temperature being the same?**
(A) 25 cm^3 (C) 104 cm^3
(B) 100 cm^3 (D) 400 cm^3

26. **The root mean square speed of the molecules of different ideal gases, maintained at the same temperature are:**
(A) Same (C) Zero
(B) Different (D) Infinity

27. **Average translational kinetic energy per molecule of an ideal gas is given by:**
(A) $\frac{3N_AT}{2R}$ (C) $\frac{2N_AT}{3}$
(B) $\frac{3RT}{2N_A}$ (D) $\frac{3N_A}{2RT}$

28. **If the pressure is increased, then the boiling point of the liquid:**
(A) Decrease
(B) Remains unchanged
(C) Increase
(D) Decrease first and then increases

29. **Assume that the masses of all the molecules of a gas are halved and speeds are doubled, the ratio of the final and initial pressure is:**
(A) 1 : 2 (C) 2 : 1
(B) 2 : 3 (D) 4 : 3

30. **When a car is drivers through some distance which of the following increases for the gas inside the tyres of car?**
(A) K.E of the gas molecules
(B) pressure of the gas
(C) temperate of the gas
(D) all of these

31. **The work done in an adiabatic change in a particular gas depends upon only:**
(A) Change in volume (C) Change in pressure
(B) Change in temperature (D) Change in specific heat

32. **The amount of heat required raising the temperature of 1 kg of a substance through 1 K is called:**
(A) specific heat (C) heat capacity
(B) calorie (D) Joule

33. **The ratio of the specific heat of an ideal gas at constant volume to its specific heat at constant pressure is:**
(A) R
(B) dependent on the temperature
(C) dependent on the pressure
(D) different for monatomic, diatomic, and polyatomic gases

34. **An ideal gas undergoes an isothermal process starting with a pressure of 2×10^5 Pa and a volume of 6 cm^3. Which of the following might be the pressure and volume of the final state?**
(A) 1×10^5 Pa and 10 cm^3 (C) 3×10^5 Pa and 6 cm^3
(B) 4×10^5 Pa and 4 cm^3 (D) 6×10^5 Pa and 2 cm^3

35. **The mass of an oxygen molecule is 16 times that of a hydrogen molecule. At room temperature, the ratio of the rms speed of an oxygen molecule to that of a hydrogen molecule is:**
(A) 16 (C) 4
(B) 1 (D) ¼

36. **The pressure of an ideal gas is doubled in an isothermal process. The root mean square speed of the molecules:**
(A) does not change
(B) decreases by a factor of $1/\sqrt{2}$
(C) increases by a factor of $\sqrt{2}$
(D) increases by a factor of 2

37. **Ideal monatomic gas "A" is composed of molecules with mass "m" while ideal monatomic gas "B" is composed of molecules with mass "4m". The average molecular speeds are the same if the ratio of the temperatures T_A/T_B is:**
(A) ¼ (C) 1/2
(B) 1 (D) 2

38. **The ratio of the specific heat of a gas at constant volume to its specific heat at constant pressure is:**
(A) 1
(B) more than 1
(C) less than 1
(D) has units of pressure/volume

39. **A real gas is changed slowly from state 1 to state 2. During this process no work is done on or by the gas. This process must be:**
(A) isothermal (C) adiabatic
(B) iscoheric (D) isobaric

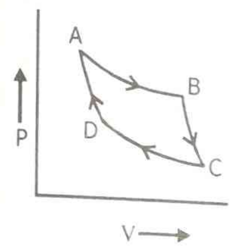
40. **Work done in expanding gas under adiabatic condition results in:**
(A) Increase in temperature
(B) Decrease in temperature
(C) change in temperature

(D) change in heat

41. A given mass of gas is enclosed in a suitable container so that it may be maintained at constant volume. Under these conditions, there can be no change in what property of the gas?
(A) Pressure
(B) Molecular kinetic energy
(C) Density
(D) Internal energy

42. Heat energy added to a system under isothermal condition appears as:
(A) Work done by the system
(B) Work done on the system
(C) Increase in internal energy
(D) Increase in temperature

43. The pressure–volume graph of an ideal gas cycle consisting of isothermal and adiabatic process is shown in the figure. The adiabatic process is described by:



(A) AB and BC (C) BC and CD
(B) AB and CD (D) AD and BC

44. If 20 J of work is done in compressing a gas adiabattically, the change in internal energy is equal to:
(A) 20 J (C) 10 J
(B) –20 J (D) 200 J

45. A gas performs the most work when it expands:
(A) Isothermally (C) Iso-barically
(B) Adiabatically (D) At non–uniform rate

46. Air is pumped into a bicycle tire at constant temperature. The pressure increases because:
(A) more molecules strike the tire wall per second
(B) the molecules are larger
(C) the molecules are farther apart
(D) each molecule is moving faster

47. The rms speed of an oxygen molecule at 0° C is 460m/s. If the molar mass of oxygen is 32 g and that of helium is 4 g, then the rms speed of a helium molecule at 0^o C is approximately:
(A) 230m/s (C) 1300m/s
(B) 650m/s (D) 920m/s

48. A system consists of "N" gas molecules, each with mass "m". Their rms speed is v_{rms}. Their total translational kinetic energy is:
(A) $(1/2)m(Nv_{rms})^2$ (C) $(1/2)N(mv_{rms})^2$
(B) $(1/2)mv^2_{rms}$ (D) $(1/2)Nmv^2_{rms}$

49. An ideal gas is allowed to expand isothermally. The root mean square velocity of its molecules:
(A) will increase (C) will remain unchanged
(B) will decrease (D) depends on other factors

50. A system does 600 J of work and at the same time has its internal energy increased by 320 J, How much heat has been supplied?
(A) 280 J (C) 600 J
(B) 920 J (D) 20 J

51. The internal energy of an ideal gas depends on:
(A) the temperature only
(B) the volume only
(C) the pressure only
(D) the temperature and pressure only

52. As the volume of an ideal gas is increased at constant pressure the average molecular speed:
(A) increases
(B) decreases
(C) same
(D) decreases at high temperature, increases at low

53. Two mono-atomic ideal gases are in thermal equilibrium with each other. Gas "A" is composed of molecules with mass "m" while gas "B" is composed of molecules with mass "4m". The ratio of the average translational kinetic energies K_A/K_B is:
(A) ¼ (C) 1/2
(B) 1 (D) 2

54. The specific heat C_v at constant volume of a mono-atomic gas at low pressure is proportional to "T^n" where the exponent "n" is:
(A) −1 (C) 0
(B) 1 (D) ½

55. Value of Boltzmann constant is:
(A) 13.8×10^{-23} J K^{-1} (C) $1.38 \times 10^{+23}$ J K^{-1}
(B) 0.138 J K^{-1} (D) 1.38×10^{-16} erg K^{-1}

56. The average kinetic energy of hydrogen molecules at 300K is 'E'. At the same temperature, the average kinetic energy of oxygen molecules will be:
(A) E /16 (C) E
(B) E / 4 (D) 4E

57. The SI unit of molar specific heat is:
(A) J mol K^{-1} (C) J mol^{-1} K^{-1}
(B) J mol^{-1} K (D) J mol^{-1}

58. The temperature of "n" moles of an ideal mono-atomic gas is increased by "ΔT" at constant volume. The energy "Q" absorbed as heat, change in internal energy "ΔE_{int}", and work "W" done by the environment are given by:
(A) $Q = (5/2)nR\,\Delta T$, $\Delta E_{int} = 0$, $W = 0$
(B) $Q = (3/2)nR\,\Delta T$, $\Delta E_{int} = (3/2)nR\,\Delta T$, $W = 0$
(C) $Q = (3/2)nR\,\Delta T$, $\Delta E_{int} = (1/2)nR\,\Delta T$, $W = -nR\,\Delta t$
(D) $Q = (5/2)nR\,\Delta T$, $\Delta E_{int} = (3/2)nR\,\Delta T$, $W = -nR\,\Delta T$

59. The expression for the absolute temperature "T" of an ideal gas is given by:
(A) $T = \frac{3}{2} < \frac{1}{2}mv^2 >$ (C) $T = \frac{3N_A}{2R} < \frac{1}{2}mv^2 >$
(B) $T = \frac{1}{3k} < mv^2 >$ (D) $\frac{2N_AR}{3T}$

60. **In an adiabatic process the quantity which remains constant is:**
(A) Internal energy (C) temperature
(B) volume (D) Heat

61. **The temperature of a gas is measure of:**
(A) The average K.E of gaseous molecules
(B) The average distance b/w the molecules
(C) The average P.E of gaseous molecules
(D) The size of the molecules of a gas

62. **The pressure on the walls of container becomes two times if:**
(A) velocity of gas molecules in the container gets doubled
(B) The number of gas molecules in the container increases four times
(C) The number of gas molecules in the container gets doubled
(D) the velocity of gas molecules in the container becomes four times

63. **The temperature of "n" moles of an ideal mono-atomic gas is increased by "ΔT" at constant pressure. The energy "Q" absorbed as heat, change in internal energy "ΔE_{int}", and work "W" done by the environment are given by:**
(A) $Q = \frac{5}{2}nR\,\Delta T, \Delta E_{int} = 0, W = -nR\Delta T$
(B) $Q = \frac{3}{2}nR\,\Delta T, \Delta E_{int} = \frac{5}{2}nR\,\Delta T, W = -\frac{3}{2}nR\,\Delta T$
(C) $Q = \frac{3}{2}nR\,\Delta T, \Delta E_{int} = 0, W = -nR\Delta T$
(D) $Q = \frac{5}{2}nR\,\Delta T, \Delta E_{int} = \frac{3}{2}nR\,\Delta T, W = -nR\,\Delta T$

64. **On the basis of kinetic theory of gases, the absolute zero is that temperature at which molecules of gas:**
(A) will shrink to points
(B) will come to stand still
(C) will become massless
(D) will start emitting light

65. **The pressure exerted by a gas on the walls of a container is measured by:**
(A) change of momentum imparted to walls per unit area per second
(B) change of momentum imparted to walls per unit area
(C) momentum imparted to walls per unit area
(D) change of momentum per unit volume

66. **The root mean square velocity of a gas molecules of mass m at a given temperature is proportional to:**
(A) m_o (C) m
(B) $m^{1/4}$ (D) $m^{-1/2}$

67. **The motion of gas molecules which determine the temperature is:**
(A) translatory (C) vibratory
(B) rotatory (D) all of these

68. **Which of the following gas possess maximum root mean square velocity at a given temperature:**
(A) hydrogen (C) nitrogen
(B) oxygen (D) helium

69. **In an isothermal process, the internal energy of the system:**
(A) Increases (C) Remains constant
(B) Decreases (D) Becomes zero

70. **First law of thermodynamics when applied to an adiabatic process becomes:**
(A) $W = \Delta U$ (C) $Q = \Delta U$
(B) $W = Q$ (D) $W = -\Delta U$

71. **In which processes the pressure of the system remains constant:**
(A) Isochoric process (C) Adiabatic process
(B) Isobaric process (D) Isothermal process

72. **Given that $P = 10^4\ N\ m^{-2}$, area of the piston is equal to $0.1\ m^2$ and distance moved by the piston is equal to 10^{-1} cm, then work done by the gas is:**
(A) 1 J (C) 104 J
(B) 105 J (D) 10 J

73. **Suppose volume of a gas in cylinder is 3 cm^3. If the piston is kept fixed and gas is heated from 5°C to 12°C, then the work done is:**
(A) 2.3 J (C) 0 J
(B) 21 J (D) 2 J

74. **KMT is likely to break at:**
(A) High pressure, low temperature
(B) Low pressure, high temperature
(C) High pressure, high temperature
(D) Low pressure, low temperature

75. **A gas expands in three different ways isothermally, adiabatically and then iso-barically. Work done is maximum in:**
(A) Isothermal process (C) Isobaric process
(B) Adiabatic process (D) Isochoric process

76. **If $C_v = \frac{5}{2}R$ then C_P in:**
(A) $\frac{2}{5}R$ (C) $\frac{2}{7}R$
(B) $\frac{7}{2}R$ (D) $\frac{5}{2}R$

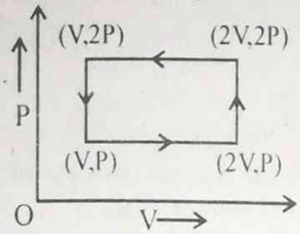
77. **Which one of the following is a correct relation:**
(A) $C_p = C_v$ (C) $C_v < C_p$
(B) $C_v > C_p$ (D) $C_v \geq C_P$

78. **Which of the following properties of molecules of gas is same for all gases at particular temperature?**
(A) Momentum (C) Mass
(B) Velocity (D) Kinetic energy

79. **Which one is not adiabatic process:**
(A) Escape of air from burst tyre
(B) Cloud formation
(C) Slow expansion
(D) Rapid expansion

80. **An ideal gas has molar specific heat "C_p" at constant pressure. When the temperature of "n" moles is increased by "ΔT" the increase in the internal energy is:**
(A) $nC_p\,\Delta T$ (C) $n(C_p + R)\,\Delta T$
(B) $n(C_p - R)\,\Delta T$ (D) $n(2C_p + R)\,\Delta T$

81. **The work done on ideal gas during the cycle is:**



(A) 1PV (C) $\frac{PV}{2}$

(B) 2PV (D) 0

82. **Three gas molecules are moving with velocities 1cm/sec, 3cm/sec and $\sqrt{2}$ cm/sec. The root mean square velocity of these gas molecule is:**

(A) 2 cm/sec (C) 4 cm/sec

(B) 3 cm/sec (D) 12 cm/sec

83. **If average velocity of gas molecules in a container is doubled, the value of pressure will be:**

(A) Doubled (C) Halved

(B) Four times (D) None of these

84. **If Q, E and W denote respectively the heat added, change in internal energy and the work done in a closed cyclic process, then**

(A) W = 0 (C) Q = W = 0

(B) E = 0 (D) Q = 0

85. **An ideal gas is heated from 20°C to 40°C under constant pressure the change in internal energy is:**

(A) Zero under constant pressure

(B) Proportional to change in volume

(C) Double the original value

(D) Proportional to change in temperature

86. **Area under a P-V diagram represents:**

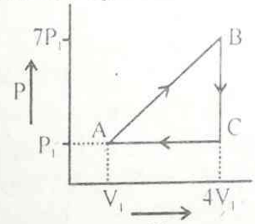
(A) Work done

(B) Heat supplied to system

(C) A thermodynamic process

(D) The state of a thermodynamic system

87. **In a cyclic process shown in figure, the work done by the gas in one cycle is:**



(A) 28 P_1V_1 (C) 14 P_1V_1

(B) 18 P_1V_1 (D) 9 P_1V_1

89. **Two different gases are enclosed in two different vessels at same pressure. If ρ_1 and ρ_2 are their densities then ratio of their rms speed $\frac{<v_1>}{<v_2>}$ is equal to:**

(A) $\frac{\rho_1^2}{\rho_2^2}$ (C) $\sqrt{\frac{\rho_1}{\rho_2}}$

(B) $\frac{\rho_2^2}{\rho_1^2}$ (D) $\sqrt{\frac{\rho_2}{\rho_1}}$

90. **The temperature of an ideal gas is increased from 120K to 480K. If at 120 K the rms velocity of the gas molecules is "v", at 480 K it becomes:**

(A) 4v (C) 2v

(B) $\frac{v}{2}$ (D) $\frac{v}{4}$

91. **For a gas obeying Boyle's law, if the pressure is doubled, the volume becomes:**

(A) Double (C) One half

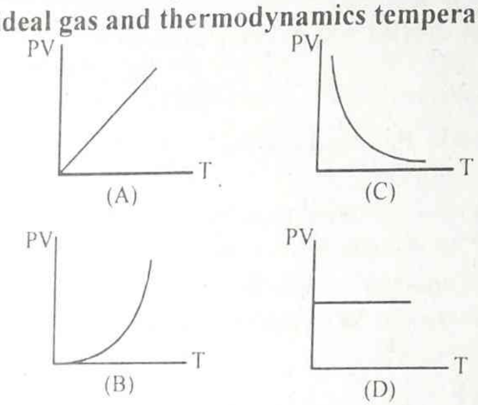
(B) Four time (D) One fourth

92. **When a hot milk is shaken in a thermo flask whose lid is closed. The temperature of the milk will:**

(A) Increase (C) Is not affected

(B) Decrease (D) Cannot be predicted

93. **Which one of the following graphs best illustrates the relationship between the product (PV) for an ideal gas and thermodynamics temperature:**



94. **Oxygen molecules in the earth's atmosphere have root mean square speed of about 500ms^{-1}. If the relative molecular mass of oxygen and helium is 32 and 4 respectively, then the approximate root mean square speed of helium molecules in the atmosphere will be:**

(A) 180ms^{-1} (C) 1000ms^{-1}

(B) 1400ms^{-1} (D) 2000ms^{-1}

95. **One mole of a gas at STP in suddenly expanded to three times its initial volume. If C_v = 2R the ratio of the initial and final pressure will be:**

(A) 5 (C) 3

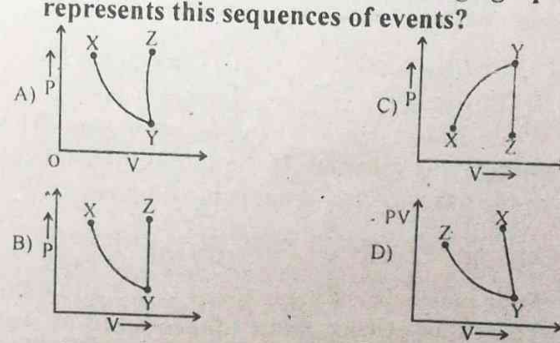
(B) 4 (D) 2

96. **Which of the following remains constant in isochoric process:**

(A) Pressure (C) Volume

(B) Temperature (D) Entropy

97. **A fixed mass of gas, initial at pressure P_1 in state X, is expanded reversibly and isothermally to state Y and then compressed reversibly and adiabatically until the pressure is again P_1 in state Z. Which one of the following graphs best represents this sequences of events?**



98. **The equation $W = P(V_2 - V_1)$ represents the work done by a gas in:**
(A) A free expansion
(B) An isothermal expansion
(C) An adiabatic expansion
(D) An expansion at constant pressure

99. **When piston is suddenly pushed in ward then:**
(A) $Q = W$ (C) $\Delta U = -W$
(B) $-\Delta U = W$ (D) $Q = \Delta U$

100. **The energy absorbed as heat by an ideal gas for an isothermal process equals:**
(A) the work done by the gas
(B) the work done on the gas
(C) the change in the internal energy of the gas
(D) the negative of the change in internal energy of the gas

101. **How much Cp is greater than Cv?**
(A) 273 (C) Both "A" & "B"
(B) 373 (D) 8.314

102. **Which thermodynamic quantity ΔU has value equal to zero?**
(A) An isothermal process (C) isochoric process
(B) An Adiabatic process (D) Isobaric Process

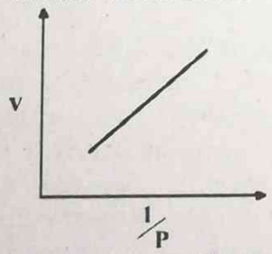
103. **At constant temperature the relation between P (Pressure), "d" density of gas:**
(A) $P \propto d^2$ (C) $P \propto d$
(B) $P \propto 1/d$ (D) $P \propto 1/d^2$

104. **In Charles law ______ is constant:**
(A) temperature (C) volume
(B) time (D) pressure

105 **1st law of thermodynamics is according to law of conservation of:**
(A) momentum (C) mass
(B) energy (D) charge

106. **The pressure of an ideal gas is doubled during a process in which the energy given up as heat by the gas equals the work done on the gas. As a result, the volume is:**
(A) doubled
(B) unchanged
(C) halved
(D) need more information to answer

107. **The graph shown below is the representation of:**



(A) Charles's law (C) General gas law
(B) Boyles law (D) Stokes law

108. **When 20J of work was done on a gas, 40J heat energy was released. If the initial internal energy of the gas was 70J. What is the final energy?**
(A) 50J (C) 90J
(B) 60J (D) 110J

109. **Four molecules of a gas speed 1, 2, 3 and 4 kms^{-1}. The value of root mean square speed of the gas molecule is:**
(A) $\frac{\sqrt{15}}{2}$ km/s (C) 2.5 kms^{-1}
(B) $\frac{\sqrt{10}}{2}$ km/s (D) $\sqrt{\frac{15}{2}}$ km/s

110. **According to kinetic theory of gases potential energy between molecules is:**
(A) small (C) zero
(B) large (D) infinite

111. **For an ideal gas pressure of gas is:**
(A) $2/3\ N_o <K.E>$ (C) $1/3\ \rho <K.E>$
(B) $2/3\ \rho <K.E>$ (D) $2/3 <K.E>$

112. **When we derive the relation of the pressure of an ideal gas, which of the following is not among the assumptions made?**
(A) in finite volume there are infinite number of molecules
(B) molecules are in constant random motion
(C) all collisions are perfectly elastic
(D) the average kinetic energy of the molecule is directly proportional to the temperature of the gas

113. **If R is the molar gas constant, P pressure, T temperature, N_A Avogadro's number, "n" number of moles, "k" Boltzmann constant and "m" mass of gas. Which of the following expressions represents the volume "V" of ideal gas?**
(A) $\frac{RT}{P}$ (C) $\frac{nRT}{P}$
(B) $\frac{N_A RT}{P}$ (D) $\frac{NkT}{P}$

114. **Speed of three molecules of a gas are 3m/s, 4m/s and 5m/s, then rms speed of these molecules is:**
(A) 4.8 (C) 4.5
(B) 4.08 (D) 4

115. **rms velocity of the molecules of a gas would be zero at:**
(A) $0^\circ C$ (C) $-273^\circ C$
(B) $273^\circ C$ (D) no atmosphere

116. **A gas molecule "x" moving with the speed 100 m/s suffers elastic collision with a molecule "y" of the same gas which is moving with speed 150m/s. Then after collision:**
(A) speed of both molecules will be 125 m/s
(B) speed of x will be 125 m/s
(C) speed of y only will be 125 m/s
(D) speed of x will be 150 m/s

117. **We can produce heat by:**
(A) Frictional process (C) Electrical processes
(B) Chemical processes (D) All of the above

118. **Which one is true for internal energy?**
(A) It is sum of all forms of energies associated with molecules of a system
(B) It is a state function of a system
(C) It is proportional to transnational K.E of the molecules
(D) All are correct

119. **Standard condition STP refer to a gas at:**
(A) 76cm Hg $0^{\circ}C$ (C) 1atm 273K
(B) 760mm Hg 273K (D) all of the above

120. **Which of the following properties of molecules is same for all gases at particular temperature?**
(A) momentum (C) velocity
(B) mass (D) kinetic energy

121. **Two ideal mono-atomic gases are in thermal equilibrium with each other. Gas A is composed of molecules with mass m while gas B is composed of molecules with mass 4m. The ratio of the average molecular speeds v_A/v_B is:**
(A) ¼ (C) 1/2
(B) 1 (D) 2

122. **As the pressure in an ideal gas is increased isothermally the average molecular speed:**
(A) increases
(B) decreases
(C) increases at high temperature, decreases at low
(D) remains the same

123. **What will be the density of the gas if its volume is doubled but temperature is constant?**
(A) equal to original density
(B) half of original density
(C) quarter of original density
(D) double of original density

124. **A sample of argon gas (molar mass 40 g) is at four times the absolute temperature of a sample of hydrogen gas (molar mass 2 g). The ratio of the rms speed of the argon molecules to that of the hydrogen is:**
(A) 5 (C) $1/\sqrt{5}$
(B) 1/5 (D) $\sqrt{5}$

125. **The pressures P and volumes V of five ideal gases, with the same number of molecules, are given below. Which has the highest temperature?**
(A) $P = 1 \times 10^5$ Pa and $V = 10cm^3$
(B) $P = 4 \times 10^5$ Pa and $V = 4cm^3$
(C) $P = 3 \times 10^5$ Pa and $V = 6cm^3$
(D) $P = 6 \times 10^5$ Pa and $V = 2cm^3$

126. **If the pressure of a given gas is held constant its density is inversely proportional to its absolute temperature. We can refer it as another statement of:**
(A) Boyle's law (C) Charles law
(B) Ideal gas law (D) Avagadro's law

127. **Gas molecules of different masses in the same container have the same average transnational kinetic energy, which is directly proportional to:**
(A) Volume (C) Pressure
(B) Absolute temperature (D) Time

128. **Given: sample of 1 ml hydrogen and 1 ml of oxygen, both at S.T.P. which sample has higher number of molecules?**
(A) Oxygen
(B) Hydrogen
(C) It depends upon their internal energies
(D) Both will have the same number of molecules

129. **Assume that the masses of all the molecules of a gas are halved and speeds are doubled, the ratio of the final and initial pressure is :**
(A) 1 : 2 (C) 2 : 1
(B) 2 : 3 (D) 4 : 3

130. **The work done in an adiabatic change in a particular gas depends upon only:**
(A) Change in volume
(B) Change in temperature
(C) Change in pressure
(D) Change in specific heat

131. **According to KMT, the collisions of gas molecules with themselves and with the walls of container are assumed to be:**
(A) perfectly elastic (C) inelastic
(B) partially elastic (D) fair

132. **The pressure exerted by a gas is directly proportional to:**
(A) average translational K.E. of its molecules
(B) average vibrational K.E. of its molecules
(C) average rotational K.E. of its molecules
(D) all of the above

133. **The ideal gas equation in terms of Boltzmann constant can be written as:**
(A) $PV = N_AkT$ (C) $T = \frac{nk}{PV}$
(B) $\frac{PkT}{V} = N$ (D) $\frac{P}{kT} = \frac{N}{V}$

134. **Two identical rooms in a house are connected by an open doorway. The temperatures in the two rooms are maintained at different values. Which room contains more air?**
(A) the room with higher temperature
(B) the room with higher pressure
(C) the room with lower temperature
(D) neither because both have the same pressure

135. **Work done in expanding gas under adiabatic condition results in:**
(A) Increase in temperature
(B) Decrease in temperature
(C) change in temperature
(D) Volume remains constant

136. **Heat energy added to a system under isothermal condition appears as:**
(A) Work done by the system
(B) Work done on the system
(C) Increase in internal energy
(D) Increase in temperature

137. **273 cm^3 of an ideal gas is at $0^{\circ}C$. It is heated at constant pressure to 10° C. It will now occupy:**
(A) 263 cm^3 (C) 273 cm^3
(B) 283 cm^3 (D) 278 cm^3

138. **If the volume of a gas is held constant and we increase its temperature then:**
(A) its pressure is constant (C) its pressure rises
(B) its pressure falls (D) any of above

139. **Hydrogen is 16 times lighter than Oxygen. If at S.T.P. the average K.E. of H_2 molecules is E, the average K.E. of O_2 molecules will be:**
(A) 16E (C) 4E

(B) E/16 (D) E

140. If "k" is the Boltzmann constant, the translational kinetic energy of nitrogen molecules at 400K will be:
(A) 400k (C) 800k
(B) 600k (D) (800/3)k

141. A 100 cm^3 gas tank is filled with a certain amount of an ideal gas at 400K. If the gas is heated to 500K, the new volume of the gas will be:
(A) 100 cm^3 (C) 150 cm^3
(B) 125 cm^3 (D) 250 cm^3

142. Air enters a hot-air furnace at 7° C and leaves at 77° C. If the pressure does not change each entering cubic meter of air expands to:
(A) 0.80m^3 (C) 1.25m^3
(B) 1.9m^3 (D) 7.0m^3

143. If the pressure is doubled and kelvin temperature is halved, the volume of the gas will:
(A) become half (C) become double
(B) become quarter (D) remain unchanged

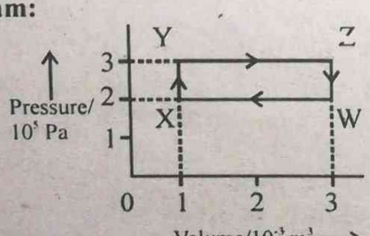
144. Heat Q is supplied to one mole of a gas which does an amount of work W. The rise in temperature of the gas is:
(A) Q/C_V (C) $(Q-W)/C_P$
(B) $(Q-W)/C_V$ (D) $(Q-W)C_V$

145. In an adiabatic process:
(A) the energy absorbed as heat equals the work done by the system on its environment
(B) the energy absorbed as heat equals the work done by the environment on the system
(C) the absorbed as heat equals the change in internal energy
(D) the work done by the environment on the system equals the change in internal energy

146. The internal energy of a gas at 35°C is 100J. If the gas expands adiabatically and does an external work of 20J, its internal energy will be:
(A) 100 J (C) 120 J
(B) 80 J (D) 115 J

147. In a system of N gas molecules, the individual speeds are $v_1, v_2, ..., v_n$. The rms speed of these molecules is:
(A) $\sqrt{\frac{v_1^2 + v_2^2 + \ldots + v_N^2}{N}}$ (C) $\frac{\sqrt{v_1^2 + v_2^2 + \ldots + v_N^2}}{N}$
(B) $\frac{\sqrt{v_1 + v_2 + \ldots + v_N}}{N}$ (D) $\frac{\sqrt{v_1^2 + v_2^2 + \ldots + v_N^2}}{N^2}$

148. A gas undergoes the cycle of pressure and volume changes. W → X → Y → Z shown in the diagram:



What is the net work done by the gas?
(A) –600 J (C) 200 J
(B) 0 J (D) –200 J

149. A system undergoes an adiabatic process in which its internal energy increases by 20 J. Which of the following statements is true?
(A) 20 J of work was done on the system
(B) the system lost 20 J of energy as heat
(C) 20 J of work was done by the system
(D) the system received 20 J of energy as heat

150. Two different samples have the same mass and temperature. Equal quantities of energy are absorbed as heat by each. Their final temperatures may be different because the samples have different:
(A) heat capacities
(B) thermal conductivities
(C) volumes
(D) coefficients of expansion

151. The first law of thermodynamics may be expressed as shown.

$$\Delta U = Q + W$$

Where ΔU is the change in internal energy, Q is the heating of the system, W is the work done on the system. A fixed mass of ideal gas at high pressure is contained in a balloon. The balloon suddenly bursts, causing the gas to expand and cool. In this situation, which row describes the values of ΔU, Q and W?

	ΔU	Q	W
(A)	Negative	Negative	Positive
(B)	Negative	Zero	Positive
(C)	Positive	Zero	Negative
(D)	Positive	negative	Positive

152. The rms speed of gas molecules is
(A) $\sqrt{\frac{m}{3kT}}$ (C) $\frac{m}{3kT}$
(B) $\sqrt{\frac{3kT}{m}}$ (D) $\left(\frac{3kT}{m}\right)^2$

153. According to Pascal's law the pressure of gas in a vessel is:
(A) Different in different direction
(B) Same only along opposite directions
(C) Same in all direction
(D) Same only along normal directions

154. Starting with same initial conditions, an ideal gas expands from volume V_1 to V_2 in three different ways. The work done by the gas is W_1, if process is purely isothermal, W_2 if purely isobaric and W_3 if purely adiabatic. Then
(A) $W_1 > W_2 > W_3$ (C) $W_2 > W_1 > W_3$
(B) $W_2 > W_3 > W_1$ (D) $W_1 > W_3 > W_2$

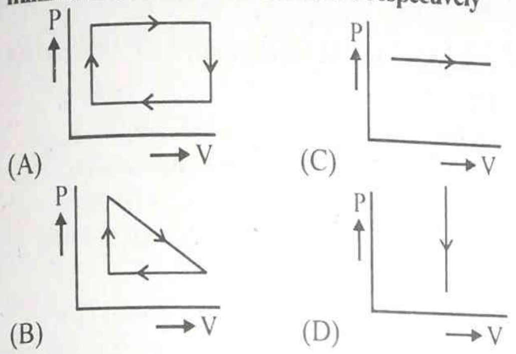
155. A gas expands 0.25 m^3 at constant pressure 10^3 N/m^2. The work done is:
(A) 2.5 erg (B) 250 J
(B) 2500 J (D) 2.5 J

156. Which of the following is not a thermodynamic function:
(A) Work (C) Entropy

(B) Internal Energy (D) Temperature

157. **The pressure (P) of an ideal gas and mean K.E per unit volume (E) are related as:**
(A) P = NE (C) P = NE/2
(B) $P = \frac{2NE}{3}$ (D) $P = \frac{3NE}{2}$

158. **The indicator diagrams representing maximum and minimum amount of work done are respectively**



(A) A and B (C) B and D
(B) B and C (D) C and D

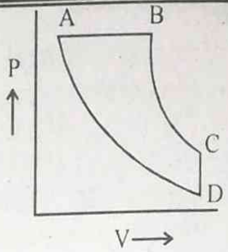
159. **An ideal gas undergoes an expansion in volume from 1.3×10^{-4} m^3 to 3.6×10^{-4} m^3 at a constant pressure of 1.3×10^5 Pa. During this expansion, 24 J of heat is supplied to the gas. What is the overall change in the internal energy of the gas?**
(A) Decrease of 54 J (C) Increase of 6 J
(B) Decrease of 6 J (D) Increase of 54 J

160. **The size of one degree of celsius is equal to:**
(A) One degree of Fahrenheit scale
(B) 3.2 degrees of Fahrenheit scale
(C) 1.8 degrees of Fahrenheit scale
(D) 2.12 degrees of Fahrenheit scale

161. **If, while the pressure is kept constant, the temperature of a mono atomic ideal gas is doubled the average speed of the atoms:**
(A) Increases by a factor 4
(B) Decreases by a factor of 4
(C) Increases by a factor of 2
(D) Increase by a factor of $\sqrt{2}$

162. **The simple kinetic theory of gases may be used to derive the expression relating the pressure "P" to the density ρ of a gas. $P = \frac{1}{3}\rho\langle c^2\rangle$ in this expression, what does $\langle c^2\rangle$ represents?**
(A) The average of the squares of the speeds of the gas molecules
(B) The most probable value of the squares of the speeds of the gas molecules
(C) The root means squares speed of the gas molecules
(D) The square of average speed of the gas molecules

163. **In the pressure–volume diagram given below, isochoric, isothermal, isobaric and adiabatic path respectively are:**



(A) BA, AD, DC, CB (C) DC, CB, BA, AD
(B) AB, BC, CD, DA (D) CD, DA, AB, BC

164. **A monochromatic gas is suddenly compressed to 1/8th of the initial volume adiabatically. The ratio of the final pressure to initial pressure is $\left(\frac{C_P}{C_V} = \frac{5}{3}\right)$**
(A) 32 (C) 40/3
(B) 24/3 (D) 8

165. **A graph between T and V of a gas at constant pressure is:**
(A) Hyperbola (C) Parabola
(B) Straight line (D) Exponentional curve

166. **Two points on a same body having the same temperature will have no heat transfer between them. This is the condition of:**
(A) Dynamic equilibrium
(B) Hydrostatic equilibrium
(C) Thermal equilibrium
(D) Unstable equilibrium

167. **We consider a thermodynamic system. If ΔU represents the increase in internal energy and W the work done by the system, which of the following statements is true?**
(A) ΔU = –W in an adiabatic process
(B) ΔU = –W in an isothermal process
(C) ΔU = W in an isothermal process
(D) ΔU = W in an adiabatic process

168. **A surface is bombarded by particles, each of mass small "m", which has velocity "v" normal to the surface. On average, "n" particles strike unit area of the surface each second and rebound elastically. What is the pressure on the surface?**
(A) nmv (C) $\frac{1}{2}$ nmv^2
(B) 2nmv (D) nmv^2

169. **According to the first law of thermodynamics, applied to a gas, the increase in the internal energy during any process:**
(A) equals the heat input minus the work done on the gas
(B) equals the heat input plus the work done on the gas
(C) equals the work done on the gas minus the heat input
(D) is independent of the heat input

170. **Kinetic molecular theory assumes that:**
(A) Volume of the gas molecules is negligible as compared to the total volume of the gas
(B) Collisions among gas molecules are elastic
(C) Both "A" and "B"
(D) There are attractive forces between the

molecules

171. **If C_v is the molar specific heat at constant volume and ΔT is the temperature then $C_v\Delta T$ gives:**
(A) Area (C) Energy
(B) Volume (D) Density

172. **The same energy Q enters four different substances. Which substance has the greatest specific heat?**
(A) The temperature of 3 g of substance A increases by 10K
(B) The temperature of 4 g of substance B increases by 4K
(C) The temperature of 6 g of substance C increases by 15K
(D) The temperature of 8 g of substance D increases by 6K

173. **If a given mass of gas occupies a volume of 100 cm^3 at one atmospheric pressure and temperature of 100°C (373.15K), what will be its volume at 4 atmospheric pressure, the temperature being the same?**
(A) 25 cm^3 (C) 104 cm^3
(B) 100 cm^3 (D) 400 cm^3

174. **The initial volume of an ideal gas is 10cm^3 at a pressure of 20Pa. Its volume and pressure in the final state might be:**
(A) 5 cm^3, and 10 Pa (C) 20 cm^3, and 40 Pa
(B) 2.5 cm^3, and 10 Pa (D) 40 cm^3, and 5 Pa

175. **Fahrenheit and centigrade thermometer have the same reading at:**
(A) – 100°C (C) 60°C
(B) 40°C (D) – 40°C

176. **Absolute zero is considered as that temperature at which:**
(A) all liquids become gases
(B) water freezes
(C) all gases become liquids
(D) all substances remain solids

177. **The total sum of all energies of all the molecules in a system is called:**
(A) potential energy (C) kinetic energy
(B) internal energy (D) elastic P.E

179. **The pressure exerted by a column of mercury 76 cm high and 0°C is called:**
(A) 1 atm (C) 1 Nm^{-2}
(B) 1 Pa (D) 1 torr

180. **PV^γ = constant holds good for:**
(A) Isothermal process (C) Isochoric process
(B) Isobaric process (D) Adiabatic process

181. **The process in which no heat enters or leaves the system is called:**
(A) Isothermal process (C) Isochoric process
(B) Isobaric process (D) Adiabatic process

182. **Which is called internal energy of an ideal gas:**
(A) Translational K.E. (C) Vibrational K.E.
(B) Rotational K.E. (D) P.E.

183. **A system does 600 J of work and at the same time has its internal energy increased by 320 J. How much heat has been supplied:**
(A) 280 J (C) 920 J
(B) 600 J (D) 200 J

184. **Pressure of gas depends:**
(A) Only on molecular speed
(B) Only on mass of molecules
(C) Only on number of molecules in unit volume
(D) Number of molecules in unit volume, mass and speed of molecules

185. **Absolute zero corresponds to:**
(A) –460°F (C) –360°F
(B) 0°F (D) 460°F

186. **Expression for isothermal process is:**
(A) $Q = \Delta U$ (C) $Q = W$
(B) $\Delta U = W$ (D) $\Delta U = -W$

187. **Which is isothermal process:**
(A) Rapid escape of air from a burst tyre
(B) Slow expansion of gas at in cylinder at constant temperature
(C) Rapid expansion of gas in cylinder
(D) Cloud formation

188. **For an ideal gas $C_P - C_V$ is equal to:**
(A) Plank's constant
(B) Joule's constant
(C) Universal gas constant
(D) Boltzmann constant

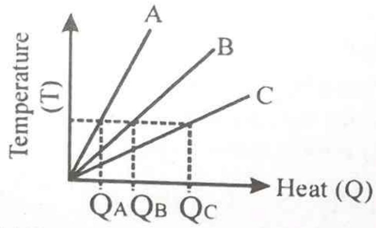
UNIT 08 HEAT AND THERMODYNAMICS (SOLUTIONS)

01. (A)

$$\Delta T = 0$$

$$c = \frac{\Delta Q}{n\Delta T} = \frac{\Delta Q}{n(0)} = \infty$$

02. (C)



$$Q = nC\Delta T \Rightarrow C \propto Q$$
$$Q_C > Q_B > Q_A$$

03. (A)

Values of constant	
Types of gas	γ
Mono-atomic	1.67
Diatomic	1.40
Polyatomic	1.29

04. (C)

As the temperature of system is defined as the average translational K.E. of its molecules, so for an ideal gas system the internal energy is directly proportional to its temperature.

$$Q \propto T$$

05. (B)

$K.E = \frac{3}{2}kT$

For 1 mole

K.E for one mole $= \frac{3}{2}kT\,(N_A) = \frac{3}{2}\frac{R}{N_A}T\,(N_A) = \frac{3}{2}RT$

06. (D)

The molecules of an ideal gas are mere mass points which exert no force on one another.

07. (C)

$P = \frac{1}{3}\rho\langle v^2\rangle \Rightarrow P \propto \langle v^2\rangle$

08. (B)

$k = \frac{R}{N_A} = 1.38 \times 10^{-23}\ JK^{-1}$

09. (D)

A polyatomic gas molecule has both translational and rotational energy. It also has vibrational energy associated with spring like bond between its atoms.

10. (B)

$P = \frac{1}{3}\rho\langle v^2\rangle$

11. (B)

Collisions between the gas molecules themselves and with the walls of the container are perfectly elastic.

12. (D)

From 0°C to 4°C the volume of water decreases and after 4°C volume increases.

13. (D)

$T_1 = 27 + 273 = 300\ K$

$T_2 = 127 + 273 = 400\ K$

$$\frac{(K.E)_1}{(K.E)_2} = \frac{\frac{3}{2}kT_1}{\frac{3}{2}kT_2} = \frac{T_1}{T_2} = \frac{300}{400} = \frac{3}{4}$$

14. (B)

$\gamma = \frac{C_P}{C_V}$

15. (B)

As

$\Delta U \propto \Delta T$

In free expansion the temperature of gas decreases, so its internal energy decreases.

16. (A)

$T_F = 2T_C$

$\frac{9}{5}T_C + 32 = 2T_C$

$32 = 2T_C - \frac{9}{5}T_C$

$\frac{10T_C - 9T_C}{5} = 32°$

$T_C = 160°C$

17. (B)

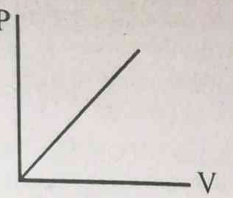
$\Delta T_F = 1.8\Delta T_C = \frac{9}{5}T_C$

18. (B)

Absolute zero is considered as that temperature at which all gases become liquids.

Volume = 0

19. (C)



20. (B)

$K.E. = \frac{3}{2}kT = \frac{3}{2}k(0) = 0$

21. (C)

$\rho = \frac{m}{V} \Rightarrow \rho \propto \frac{1}{V}$

22. (D)

$T_1 = 30°C = 303\ K$

$\frac{V_2}{T_2} = \frac{V_1}{T_1} \Rightarrow T_2 = V_2 \times \frac{T_1}{V_1}$

$= (200) \times \frac{303}{100} = 606\ K = 606 - 273 = 333°C$

$(V_2 = 2V_1 = 200\ cm^3)$

23. (C)

Pressure exerted by a gas is the momentum transferred to the walls of container per unit time per unit area due to continuous collisions of gas molecules.

24. (D)

$PV = nRT$

n = number of mole

"V" is the volume of one mole or one gram molecule of gas.

25. (A)

$P_2V_2 = P_1V_1 \Rightarrow V_2 = \frac{P_1V_1}{P_2} = \frac{(1)100}{4} = 25\ cm^3$

26. (B)

$v_{rms} = \sqrt{\frac{3RT}{m}} \Rightarrow v_{rms} \propto \frac{1}{\sqrt{m}}$ if T = constant

27. (B)

$K.E = \frac{3}{2}kT$

$K.E = \frac{3}{2}\frac{R}{N_A}T$

28. (C)

If the pressure is increased, then the boiling point of the liquid increase.

29. (C)

$$\frac{P_2}{P_1} = \frac{\frac{1}{3}N_o m_2 v_2^2}{\frac{1}{3}N_o m_1 v_1^2} = \frac{m_2v_2^2}{m_1v_1^2} = \frac{m_1(4v_1^2)}{2m_1v_1^2} = 2:1$$

30. (D)

Friction between the tyre and the road heats up the gas in the tyre and its temperature increases. So, this increases the average K.E. of the gas molecules increases.

$T \propto \langle K.E\rangle$

and $P \propto \langle K.E\rangle$

31. (B)

Adiabatic Expansion:

In adiabatic expansion of the system, the temperature decreases as the work is done in expanding the system at the cost of internal energy.

$$-\Delta U = +W$$

Adiabatic Compression:

In adiabatic compression, the work has done on the system increases the temperature of the system.

$$+\Delta U = -W$$

$$\Delta U \propto \Delta T$$

32. (A)

The amount of heat required raising the temperature of 1 kg of a substance through 1 K is called specific heat.

33. (D)

$$\gamma = \frac{C_P}{C_V} \Rightarrow \frac{1}{\gamma} = \frac{C_V}{C_P}$$

Values of constant Types of gas	γ
Mono-atomic	1.67
Diatomic	1.40
Polyatomic	1.29

34. (D)

For isothermal process

PV = constant

$P_1V_1 = P_2V_2$

$(2 \times 10^5 \text{ Pa})(6 \text{ cm}^3) = (6 \times 10^5 \text{ Pa})(2 \text{ cm}^3)$

35. (D)

$$v = \sqrt{\frac{3RT}{m}}$$

$$\frac{v_O}{v_H} = \frac{\sqrt{\frac{3RT}{m_O}}}{\sqrt{\frac{3RT}{m_H}}} = \sqrt{\frac{m_H}{m_O}} = \sqrt{\frac{m_H}{16m_H}} = \sqrt{\frac{1}{16}} = \frac{1}{4}$$

36. (A)

$$v_{rms} = \sqrt{\frac{3RT}{m}}$$

In isothermal process temperature remains same. So, v_{rms} = constant

37. (A)

$$v_{rms} = \sqrt{\frac{3RT}{m}}$$

for same average molecular speed

$T \propto m$

$$\frac{T_A}{T_B} = \frac{m_A}{m_B} = \frac{m}{4m} = \frac{1}{4}$$

38. (C)

As we know that

$$C_V < C_P$$

$$\frac{C_V}{C_P} < 1$$

39. (B)

$W = P\Delta V$

In isocoheric process (constant volume) $\Delta V = 0$

$W = P(0) = 0$

40. (B)

In adiabatic expansion

$$+W = -\Delta U$$

+W shows that work is done by the gas at the cost of its internal energy. Internal energy decreases and hence temperature also decreases.

41. (C)

As mass and volume of gas are constant. So, its density remains same.

42. (A)

By 1st law of thermodynamics

$Q = \Delta U + W = 0 + W = W$

This shows that the total energy supplied is used to do external work. To keep the temperature constant the compression and expansion must done very slowly.

43. (D)

As adiabat is more steeper than isotherm. So, "DA" and "BC" represent the adiabatic processes.

44. (A)

In adiabatic compression, the work has done on the system increases the temperature of the system.

$$-W = +\Delta U$$

Work done on the gas = increase in its internal energy = + 20 J

45. (C)

$$W_{isobaric} > W_{isothermal} > W_{adiabatic} > W_{isocoheric}$$

46. (A)

$$P = \frac{2N}{3V} \langle K.E. \rangle$$

For same temperature means same <K.E>

$P \propto N$

47. (C)

$$v = \sqrt{\frac{3RT}{m}}$$

$$\frac{v_{He}}{v_O} = \frac{\sqrt{\frac{3RT}{m_{He}}}}{\sqrt{\frac{3RT}{m_O}}} = \sqrt{\frac{m_O}{m_{He}}} = \sqrt{\frac{32}{4}} = 2\sqrt{2} \Rightarrow v_{He} = 2\sqrt{2}$$

$v_O = 920\sqrt{2} = 920(1.4) \approx 1300$ m/s

48. (D)

Total translational K.E $= \frac{1}{2}Nmv^2_{rms}$

49. (C)

$$v_{rms} = \sqrt{\frac{3RT}{m}}$$

In isothermal process temperature remains same. So, v_{rms} = constant

50. (B)

$Q = \Delta U + W$

$Q = 320 + 600 = 920$ J

51. (A)

For an ideal gas system the internal energy is directly proportional to its temperature.

52. (A)

$$v_{rms} = \sqrt{\frac{3RT}{m}}$$

at constant pressure

$V \propto T$

And

$v_{rms} \propto \sqrt{T}$

53. (B)

$$K.E = \frac{3}{2}kT$$

$K.E \propto T$

$$\frac{K_A}{K_B} = \frac{T_A}{T_B} = 1 \qquad (T_A = T_B)$$

54. (A)

It is the amount of heat required to raise the temperature of one mole of substance through 1 K at constant volume.

$$Q_v = C_v\Delta T \Rightarrow C_v = \frac{Q_v}{\Delta T} \Rightarrow C_v = Q_v\Delta T^{-1}$$

55. (D)

$$k = \frac{R}{N_A} = 1.38 \times 10^{-23}\ JK^{-1}$$
$$= 1.38 \times 10^{-23}\ (10^7\ erg)K^{-1} = 1.38 \times 10^{-16}\ erg\ K^{-1}$$

56. (C)

$$E = \frac{3}{2}kT \Rightarrow E \propto T$$

57. (C)

$$C = \frac{Q}{n\Delta T}$$

Its units are "$J\ mol^{-1}K^{-1}$".

58. (B)

$Q_V = nC_V\Delta T$

For mono-atomic gas $C_V = \frac{3}{2}R$

$$Q_V = \frac{3}{2}nR\Delta T$$

At constant volume $\Delta V = 0$

$W = 0$

$$Q_V = \Delta E_{int} + W = \Delta E_{int} = \frac{3}{2}nR\Delta T$$

59. (B)

$$T = \frac{2}{3k}<K.E> = \frac{2}{3k}<\frac{1}{2}mv^2> = \frac{1}{3k}<mv^2>$$

60. (D)

Adiabatic is the process in which no heat enters or leaves the system.

$$Q = 0$$

61. (A)

The temperature of system is defined as the average translational K.E. of its molecules

$$T = \frac{2}{3k}<K.E.>$$

62. (C)

$$P = \frac{2N}{3V}<\frac{1}{2}mv^2>$$

$P \propto N$

63. (D)

$Q_P = nC_P\Delta T$

For mono-atomic gas $C_P = \frac{5}{2}R$

$$Q_P = \frac{5}{2}nR\Delta T$$
$$Q_P = \Delta E_{int} + W$$
$$\frac{5}{2}nR\Delta T = \frac{3}{2}nR\Delta T - nR\Delta T$$

$$(Q_v = \Delta E_{int} = \frac{3}{2}nR\Delta T)$$

64. (B)

$$<K.E> = \frac{3}{2}kT$$

If

$T = 0\ K$

$$<K.E> = \frac{3}{2}k(0) = 0$$

65. (A)

Pressure exerted by a gas is the momentum transferred to the walls of container per unit time per unit area due to continuous collisions of gas molecules.

66. (D)

$$T = \frac{2}{3k}<\frac{1}{2}mv^2>$$

$$<v^2> = \frac{3kT}{m} \Rightarrow v_{rms} = \sqrt{\frac{3kT}{m}} \Rightarrow v_{rms} \propto \frac{1}{\sqrt{m}}$$

$v_{rms} \propto m^{-1/2}$

67. (A)

The temperature of system is defined as the average translational K.E. of its molecules

$$T = \frac{2}{3k}<K.E.>$$

68. (A)

$$T = \frac{2}{3k}<\frac{1}{2}mv^2>$$

$$<v^2> = \frac{3kT}{m} \Rightarrow v_{rms} = \sqrt{\frac{3kT}{m}} \Rightarrow v_{rms} \propto \frac{1}{\sqrt{m}}$$

As the mass of hydrogen is least. So, its root mean square velocity is maximum at a given temperature.

69. (C)

The temperature of system is defined as the average translational K.E. of its molecules, so for an ideal gas system the internal energy is directly proportional to its temperature.

$$U \propto T$$

As the temperature remains same in isothermal process. So, internal energy also remain same.

70. (D)

In adiabatic expansion

$$+W = -\Delta U$$

+W shows that work is done by the gas at the cost of its internal energy. Internal energy decreases and hence temperature also decreases.

71. (B)

The thermodynamic process in which pressure remains same is called isobaric process.

72. (A)

$W = P\Delta V = PA\Delta y = (10^4)(0.1)(10^{-3}) = 1$ J

73. (C)

$W = P\Delta V$

As the piston is fixed. So, $\Delta V = 0$

$W = 0$

74. (B)

Gases show ideal behaviour at high temperature and low pressure.

75. (C)

$W_{isobaric} > W_{isothermal} > W_{adiabatic} > W_{isocoheri}$

76. (B)

For diatomic gases

$C_V = \frac{5}{2}R$ and $C_P = \frac{7}{2}R$

77. (C)

As for every gas

$\gamma > 1 \Rightarrow \frac{C_P}{C_V} > 1$

$C_P > C_V \Rightarrow C_V < C_P$

78. (D)

$<K.E> = \frac{3}{2}kT$

T = constant

<K.E> = constant

79. (C)

All the sudden changes are adiabatic.

i. Rapid escape of air from a burst tire.

ii. The rapid expansion and compression of air when sound waves pass through it.

iii. Cloud formation in the atmosphere.

80. (B)

Using 1st law of thermodynamics

$Q_P = \Delta U + W$

$\Delta U = Q_P - W$

$\Delta U = C_P\Delta T - R\Delta T$ $\quad (P\Delta V = R\Delta T)$

Internal energy for "n" moles = $n\Delta U$

$= n(C_P\Delta T - R\Delta T) = n(C_P - R)\Delta T$

81. (A)

Work done = Area of PV diagram (closed shape)

= (length)(width)

Work done = (P)(V) = PV

82. (A)

$$v_{rms} = \sqrt{\frac{v_1^2 + v_2^2 + \ldots + v_N^2}{N}}$$

$$= \sqrt{\frac{1+9+2}{3}} = \sqrt{\frac{12}{3}} = 2 \text{ cm/s}$$

83. (B)

$P = \frac{1}{3}\rho <v^2>$

$P \propto <v^2>$

84. (C)

A process which brings the system back to its initial condition is called a cycle. In the reversible cycle all the changes are reversible.

In cyclic the final and initial position of the system is same.

E = constant $\Rightarrow \Delta E = 0$

V = constant $\Rightarrow \Delta V = 0 \quad \Rightarrow W = 0$

By 1st law of thermodynamics

$Q = E + W = 0$

85. (D)

As

$U \propto T$

$\Delta U \propto \Delta T$

86. (A)

Work done = Area of PV diagram

87. (D)

Work done = Area of PV diagram (closed shape)

$= \text{Area of triangle} = \frac{1}{2}(3V_1)(6P_1) = 9P_1V_1$

89. (D)

$P = \frac{1}{3}\rho_1 <v_1^2>$

$P = \frac{1}{3}\rho_2 <v_2^2>$

$\rho_1 <v_1^2> = \rho_2 <v_2^2>$

$$\frac{<v_1^2>}{<v_2^2>} = \frac{\rho_2}{\rho_1} \Rightarrow \frac{<v_1>}{<v_2>} = \sqrt{\frac{\rho_2}{\rho_1}}$$

90. (C)

$v_{rms} \propto \sqrt{T}$

As the temperature increases 4 times (4×120K = 480 K), v_{rms} becomes 2times (2v).

91. (C)

$V \propto \frac{1}{P}$

92. (A)

When milk in the thermos flask is shaken rapidly, work is done in shaking it. This work is converted into K.E. of molecules of the milk.

As

$T \propto <K.E>$

So, temperature of the milk increases.

93. (A)

By ideal gas equation

$PV = nRT$

$PV \propto T$ $\quad$ (n = constant)

94. (B)

$$v = \sqrt{\frac{3RT}{m}}$$

$$\frac{v_{He}}{v_O} = \frac{\sqrt{\frac{3RT}{m_{He}}}}{\sqrt{\frac{3RT}{m_O}}} = \sqrt{\frac{m_O}{m_{He}}} = \sqrt{\frac{32}{4}} = 2\sqrt{2} \Rightarrow v_{He} = 2\sqrt{2}$$

$v_O = 1000\sqrt{2} = 1400$ m/s

95. (A)

$P1V_1^\gamma = P_2V_2^\gamma$

$$\frac{P_1}{P_2} = \left(\frac{V_2}{V_1}\right)^\gamma$$

$$\frac{P_1}{P_2} = \left(\frac{(3V_1)}{(V_1)}\right)^\gamma$$

$$\frac{P_1}{P_2} = 3^{\gamma}$$

As

$$C_P - C_V = R \Rightarrow \quad C_P - 2R = R \Rightarrow C_P = 3R$$

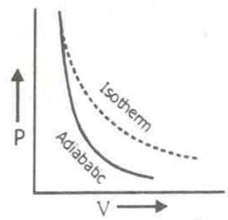
$$\gamma = \frac{C_P}{C_V} = \frac{3R}{2R} = 3/2$$

$$\frac{P_1}{P_2} = 3^{3/2} \approx 5$$

96. (C)

The thermodynamic process in volume remains constant is called isochoric process.

97. (A)



As adiabat is more steeper than isotherm. In option "A" curve "X" to "Y" represents the isotherm and "Y" to "Z" represents adiabat.

98. (D)

The work done in thermodynamic process at constant pressure is

$W = P\Delta V = P\,(V_2 - V_1)$

99. (C)

In adiabatic compression

$$-W = +\Delta U$$

In adiabatic compression work done on the gas increases its internal energy and hence its temperature also increases.

100. (A)

By 1st law of thermodynamics

$Q = \Delta U + W = 0 + W = W$

This shows that the total energy supplied is used to do external work. To keep the temperature constant the compression and expansion must done very slowly.

101. (D)

As we know that

$C_P - C_V = R = 8.314\ \text{J mol}^{-1}\text{K}^{-1}$

102. (A)

The temperature of system is defined as the average translational K.E. of its molecules, so for an ideal gas system the internal energy is directly proportional to its temperature.

$U \propto T$

As the temperature remains same in isothermal process. So, internal energy also remain same.

103. (C)

$$P = \frac{1}{3}\rho\langle v^2\rangle$$

As

$$T \propto \langle\frac{1}{2}mv^2\rangle$$

Constant temperature means constant K.E. So,

$P \propto \rho$

104. (D)

Volume of a gas is directly proportional to the absolute temperature at constant pressure." This is the statement of the Charles law.

$V \propto T$

105. (B)

$Q = \Delta U + W$

This is according to law of conservation of energy.

106. (C)

In isothermal process

$Q = W$

As Boyle's law is applicable in isothermal process. So,

$$V \propto \frac{1}{P}$$

107. (B)

As Boyle's law is applicable in isothermal process. So,

$$P \propto \frac{1}{V}$$

$$PV = \text{constant}$$

108. (A)

$Q = \Delta U + W$

$Q = (U_f - U_i) + W$

$-40 = (U_f - 70) - 20$

$-40 = U_f - 90$

$U_f = -40 + 90 = 50\text{J}$

109. (D)

$$v_{rms} = \sqrt{\frac{v_1^2 + v_2^2 + \ldots + v_N^2}{N}}$$

$$= \sqrt{\frac{1+4+9+16}{4}} = \sqrt{\frac{30}{4}} = \sqrt{\frac{15}{2}}\ \text{km/s}$$

110. (C)

The molecules of an ideal gas are mere mass points which exert no force on one another. So, potential energy between the molecules is zero.

111. (A)

$$P = \frac{1}{3}\rho\langle v^2\rangle$$

As $\quad \rho = \dfrac{mN}{V}$

$$P = \frac{1}{3}\frac{mN}{V}\langle v^2\rangle = \frac{2}{3}\frac{N}{V}\langle\frac{1}{2}mv^2\rangle = \frac{2}{3}N_o\langle K.E\rangle$$

where $\dfrac{N}{V} = N_o$

112. (A)

A finite volume of a gas consists of very large number of molecules (not infinite).

113. (D)

$PV = nRT$

$$PV = \frac{N}{N_A}RT \Rightarrow V = \frac{NRT}{N_A P} = \frac{NkT}{P} \quad (k = R/N_A)$$

114. (B)

$$v_{rms} = \sqrt{\frac{v_1^2 + v_2^2 + \ldots + v_N^2}{N}}$$

$$= \sqrt{\frac{9+16+25}{3}} = \sqrt{\frac{50}{3}} = 4.08\ \text{m/s}$$

115. (C)

$$v_{rms} = \sqrt{\frac{3RT}{m}}$$

$$0 = \sqrt{\frac{3RT}{m}}$$

$T = 0\,K = -273°C$

116. (D)

In elastic collision, the velocities of bodies having same masses are inter changed after collision.

So, velocity of "x" = 150 m/s

velocity of "y" = 100 m/s

117. (D)

All energy transfers result in heating of environment and energy is wasted.

118. (D)

All are the properties of internal energy.

119. (D)

At STP

P = 1atm = 76 cm of Hg

= 760 mm Hg = 760 torr = 101325 Pa

T = 0°C = 273 K

120. (D)

As

$$<K.E> = \frac{3}{2}kT$$

For a particular temperature

$$\frac{3}{2}kT = \text{constant} = <K.E>$$

121. (D)

$$v = \sqrt{\frac{3RT}{m}}$$

$$\frac{v_A}{v_B} = \frac{\sqrt{\frac{3RT}{m_A}}}{\sqrt{\frac{3RT}{m_B}}} = \sqrt{\frac{m_B}{m_A}} = \sqrt{\frac{4m}{m}} = 2$$

122. (D)

$$v = \sqrt{\frac{3RT}{m}}$$

If T = constant

v = constant

123. (B)

$$\rho = \frac{m}{V} \Rightarrow \rho \propto \frac{1}{V}$$

124. (C)

$$v = \sqrt{\frac{3RT}{m}}$$

$$\frac{v_{Ar}}{v_H} = \frac{\sqrt{\frac{3RT_{Ar}}{m_{Ar}}}}{\sqrt{\frac{3RT_H}{m_H}}} = \sqrt{\frac{m_H \times T_{Ar}}{m_{Ar} \times T_H}} = \sqrt{\frac{2 \times 4T_H}{40 \times T_H}} = \frac{1}{\sqrt{5}}$$

$(T_{Ar} = 4T_H)$

125. (C)

PV = nRT

PV = T (n, R are constant)

Option (C) gives the maximum product of PV this means it has maximum temperature.

126. (C)

$$\rho = \frac{m}{V} \Rightarrow \rho \propto \frac{1}{V}$$

$$V \propto T$$

$$\rho \propto \frac{1}{T}$$

127. (B)

The molecules of an ideal gas are mere mass points which exert no force on one another. So, the internal energy of an ideal gas system is generally the translational K.E. of the gas molecules.

128. (D)

At same condition (STP)

If volume of two different gases is same, then they have same number of molecules.

129. (A)

$$P = \frac{2}{3}N_o<\frac{1}{2}mv^2>$$

$$P \propto <mv^2>$$

$$\frac{P_2}{P_1} = \frac{m_1v_1^2}{m_2v_2^2} = \frac{m_1v_1^2}{(m_1/2)(2v_1)^2} = \frac{1}{2} = 1:2$$

If T = constant

130. (B)

In adiabatic expansion

$+W = -\Delta U$

+W shows that work is done by the gas at the cost of its internal energy. Internal energy decreases and hence temperature also decreases.

131. (A)

According to KMT Collisions between the gas molecules themselves and with the walls of the container are perfectly elastic.

132. (A)

$P \propto <K.E>$

Pressure is directly proportional to the average translational kinetic energy of the gas molecules.

133. (D)

PV = nRT

$$PV = \frac{N}{N_A}RT \Rightarrow V = \frac{NRT}{N_AP} = \frac{NkT}{P} \quad \Rightarrow \frac{P}{kT} = \frac{N}{V}$$

134. (C)

At same temperature, If volume of two different gases is same, then they have same number of molecules.

But in this case the temperatures of both rooms are maintained at different values, it means that both the rooms have different number of molecules of air. Which room contain more have less temperature and vice versa.

135. (B)

In adiabatic expansion

$+W = -\Delta U$

+W shows that work is done by the gas at the cost of its internal energy. Internal energy decreases and hence temperature also decreases.

136. (B)

$Q = \Delta U + W$

At isothermal condition $\Delta U = 0$

137. (B)

At constant pressure

$V \propto T$

$$\frac{V_2}{V_1} = \frac{T_2}{T_1} = \frac{283}{273}$$

$$V_2 = \frac{283}{273} \times V_1 = \frac{283}{273} \times (273) = 283 \text{ cm}^3$$

138. (C)

At constant volume

$P \propto <K.E>$

And

$T \propto <K.E>$

139. (D)

$$<K.E> = E = \frac{3}{2}kT$$

As

T = constant (STP)

E = constant

140. (B)

$$<K.E> = \frac{3}{2}kT = \frac{3}{2}k(400) = 600 \text{ k}$$

141. (B)

At constant pressure

$V \propto T$

$$\frac{V_2}{V_1} = \frac{T_2}{T_1} = \frac{500}{400}$$

$$V_2 = \frac{500}{400} \times V_1 = \frac{500}{400} \times (100) = 125 \text{ cm}^3$$

142. (C)

At constant pressure

$V \propto T$

$$\frac{V_2}{V_1} = \frac{T_2}{T_1} = \frac{350}{280}$$

$$V_2 = \frac{350}{280} \times V_1 = \frac{350}{280} \times (1) = 1.25 \text{ m}^3$$

143. (B)

$PV = nRT$

$PV = T$ (n, R are constant)

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2} \Rightarrow V_2 = \frac{P_1V_1}{T_1} \times \frac{T_2}{P_2} = \frac{P_1V_1}{T_1} \times \frac{T_1/2}{2P_1} = \frac{V_1}{4}$$

144. (B)

$Q = \Delta U + W$

$Q = C_V\Delta T + W$

$$\frac{Q - W}{C_V} = \Delta T$$

145. (D)

In adiabatic compression work done on the gas increases its internal energy and hence its temperature also increases.

$- W = + \Delta U$

146. (B)

$+ W = - \Delta U$

+W shows that work is done by the gas at the cost of its internal energy. Internal energy decreases and hence temperature also decreases.

As 20 J of work is being done by using 20 J of internal energy. So, remaining internal energy will be 80 J.

147. (A)

$$\left(\frac{v_1^2 + v_2^2 + v_3^2 + \ldots + v_N^2}{N}\right) = \text{Mean square velocity}$$

$= <v^2>$

$$v_{rms} = \sqrt{<v^2>} = \sqrt{\left(\frac{v_1^2 + v_2^2 + v_3^2 + \ldots + v_N^2}{N}\right)}$$

148. (C)

Work done = Area of PV diagram (closed shape)

= Area of rectangle = $(2 \times 10^{-3})(1 \times 10^5) = 200$ J

149. (A)

$- W = + \Delta U$

In adiabatic compression work done on the gas increases its internal energy. So, 20 J of work was done by the system.

150. (A)

Two different samples have different heat capacities even their masses and temperatures are same

151. (B)

It is the process in which no heat enters or leaves the system.

$Q = 0$

In Adiabatic expansion

$+ W = - \Delta U$

+W shows that work is done by the gas at the cost of its internal energy. Internal energy decreases and hence temperature also decreases.

152. (B)

$$K.E = \frac{3}{2}kT$$

$$\frac{1}{2}m<v^2> = \frac{3}{2}kT$$

$$m<v^2> \;\; 3kT \Rightarrow <v^2> = \frac{3kT}{m} \Rightarrow v_{rms} = \sqrt{\frac{3kT}{m}}$$

153. (C)

Pressure on each side of the container and everywhere in the container is same provided the density of the gas is uniform.

154. (C)

$W_{isobaric} > W_{isothermal} > W_{adiabatic} > W_{isocoheric}$

$W_2 > W_1 > W_3$

155. (B)

$W = P\Delta V = (0.25)(10^3) = 250$ J

156. (A)

Work is the technique to transfer energy into the system. It is not a thermodynamics function.

157. (B)

$$P = \frac{2N}{3}\left(\frac{<K.E>}{V}\right) = \frac{2N}{3}E$$

158. (C)

Work done = Area of PV diagram

$W_D = 0$ $(\Delta V = 0)$

W_B = Maximum $(P\Delta V = \text{max})$

159. (B)

$W = P\Delta V = (1.3 \times 10^5)(2.3 \times 10^{-4}) \approx 30$ J

$Q = \Delta U + W$

$\Delta U = Q - W = 24 - 30 = -6$ J (Decrease)

160. (C)

$1^\circ C = 1.8^\circ F$

161. (D)

$v_{rms} = \sqrt{\frac{3RT}{m}}$

$v_{rms} \propto \sqrt{T}$

162. (A)

By comparing the given equation with

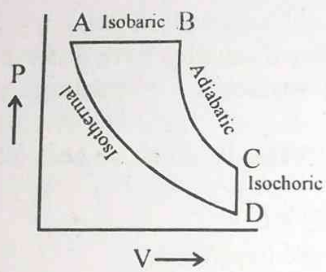
$P = \frac{1}{3}\rho<v^2>$

P = pressure of gas

ρ = density of gas

$<c^2> = <v^2>$ = The average of the squares of the speeds of the gas molecules

163. (D)



164. (A)

$P_1V_1^\gamma = P_2V_2^\gamma$

$\frac{P_2}{P_1} = \left(\frac{V_1}{V_2}\right)^\gamma$

$\frac{P_2}{P_1} = \left(\frac{V_1}{V_1/8}\right)^\gamma$

$\frac{P_2}{P_1} = 8^\gamma = 8^{5/3} = (2^3)^{5/3} = (2)^5 = 32$

$(C_P/C_V = \gamma = 5/3)$

165. (C)

$V \propto T$ straight line (P = constant)

166. (C)

Two points on a same body having the same temperature will have no heat transfer between them. This is the condition of thermal equilibrium.

167. (A)

In adiabatic compression work done on the gas increases its internal energy and hence its temperature also increases.

$-W = +\Delta U$

168. (B)

$P = \frac{F}{A} = \frac{\Delta P}{A\Delta t} = \frac{2nmv}{(1)(1)} = 2nmv$ (nm= total mass)

169. (B)

$Q = \Delta U + W$

$\Delta U = Q - W = Q + (-W)$ = heat input plus the work done on the gas

170. (C)

According to KMT

i. A finite volume of a gas consists of very large number of molecules.

ii. Collisions between the gas molecules themselves and with the walls of the container are perfectly elastic.

171. (C)

$C_V\Delta T = Q_V$ = Energy

172. (B)

$C = \frac{Q}{m\Delta T} \Rightarrow C \propto \frac{1}{m\Delta T}$

In (B) the product "mΔT" gives minimum value. So, have greatest specific heat.

173. (A)

$P_1V_1 = P_2V_2 \Rightarrow V_2 = \frac{P_1V_1}{P_2} = \frac{(1)(100)}{(4)} = 25\ cm^3$

174. (D)

$P_1V_1 = P_2V_2$

$(10cm^3)(20\ Pa) = (5\ Pa)(40\ cm^3) = 200\ Pa\ cm^3$

175. (D)

$T_C = T_F = 1.8T_C + 32$

$-32 = 0.8T_C$

$T_C = -\frac{32}{0.8} = -40^\circ C$

176. (C)

Absolute zero is considered as that temperature at which all gases become liquids.

177. (B)

The sum of all forms of molecular energies (K.E. and P.E.) of a substance is called internal energy.

179. (A)

The pressure exerted by a column of mercury 76 cm high and 0°C is called1 atm.

180. (D)

For an adiabatic process

PV^γ = constant

181. (D)

Adiabatic process is the process in which no heat enters or leaves the system.

$Q = 0$

182. (A)

The molecules of an ideal gas are mere mass points which exert no force on one another. So, the internal energy of an ideal gas system is generally the translational K.E. of the gas molecules.

183. (C)

$Q = \Delta U + W = 320 + 600 = 920\ J$

184. (D)

$P = \frac{2N}{3V}<\frac{1}{2}mv^2>$

185. (A)

$T_F = 1.8T_C + 32 = 1.8(-273) + 32$

$= -492 + 32 = -460^\circ F$

186. (C)

$Q = \Delta U + W$

In isothermal process $\Delta U = 0$

$Q = W$

187. (B)

To keep the temperature constant the compression and expansion must done very slowly.

188. (C)

$C_P - C_V = R$

UHS PAST MDCAT (2008-2019)

1. **The pressure on the other sides and everywhere inside the vessel will be same according to the: (UHS 2009)**

(A) Pascal's law (C) Boyle's law
(B) Hook's law (D) Charles law

> **(A)**
> By Pascal's law "Pressure on each side of the container and everywhere in the container is same provided the density of the gas is uniform."

2. **The value of universal gas constant is: (UHS 2009,2010,2013)**

(A) $8.314\ J\ mol^{-1}K^{-1}$ (C) $100\ J\ mol^{-1}K^{-1}$
(B) $8.32\ J\ mol^{-1}K^{-1}$ (D) $1.38\times10^{-23}\ J\ mol^{-1}K^{-1}$

> **(A)**
> $R = 8.314\ J\ mol^{-1}K^{-1}$

3. **For adiabatic process, the first law of thermodynamics is: (UHS 2009,2012)**

(A) $W = \Delta U + Q$ (C) $Q = W$
(B) $Q = -W$ (D) $W = -\Delta U$

> **(D)**
> $Q = \Delta U + W$
> $0 = \Delta U + W \Rightarrow W = -\Delta U$

4. **Which of the following is a postulate of kinetic theory of gases: (UHS 2010)**

(A) A finite volume of a gas consists of a small number of molecules
(B) The size of the molecules is much larger than the separating between them
(C) Molecules do not exert force on each other except during a collision
(D) The gas molecules are in no-random motion

> **(C)**
> Only (C) is the postulate of KMT.

5. **Which one is not an irreversible process? (UHS 2010)**

(A) Slow compression of a gas into a cylinder
(B) Changes due to friction
(C) Explosion
(D) Dissipation of energy

> **(C)**
> Explosion is an irreversible process.

6. **Which of the following is expression of mean square speed of "N" gas molecules contained in a cylinder? (UHS 2011,2012)**

(A) $\sqrt{\dfrac{v_1^2 + v_2^2 + \ldots + v_n^2}{N}}$ (C) $\sqrt{\dfrac{v_1 + v_2 + \ldots + v_n}{N}}$
(B) $\dfrac{v_1^2 + v_2^2 + \ldots + v_n^2}{N}$ (D) $\dfrac{v_1 + v_2 + \ldots + v_n}{N}$

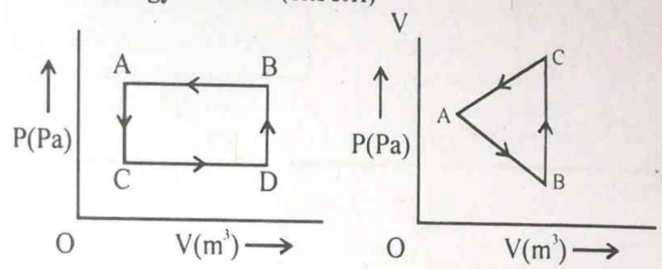
> **(B)**
> Mean square speed $= \dfrac{v_1^2 + v_2^2 + \ldots + v_n^2}{N}$

7. **For a gas of volume "V" in its equilibrium state, if the pressure does changes with time then total kinetic energy of gas is constant because: (UHS 2011)**

(A) Collision between gas molecules occur
(B) Collision between gas molecules occur linearly
(C) Collision must be elastic
(D) Collision must be inelastic

> **(C)**
> In elastic collision the K.E remains constant.

8. **In which of the following, the change in internal energy is more: (UHS 2011)**

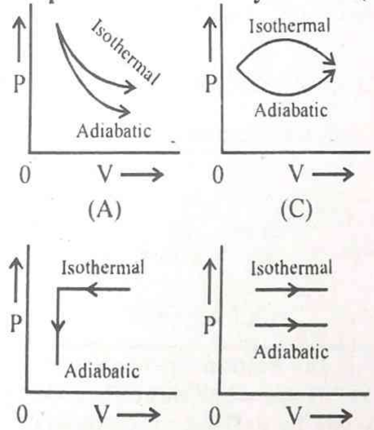


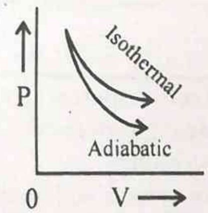
System A System B

(A) In system A
(B) In system B
(C) Cannot be predicted
(D) Change is zero in both

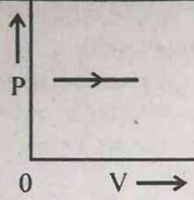
> **(D)**
> System "A" and "B" both are cyclic process. In any cyclic process
> $\Delta U = 0$

9. **Pressure-Volume graph of two systems "A" and "B" are plotted under isothermal and adiabatic conditions. Which of the following observation of graph represents the two systems?: (UHS 2011)**

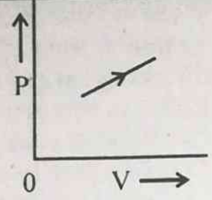


> **(A)**
> 
>
> Adiabat is steeper than isotherm.

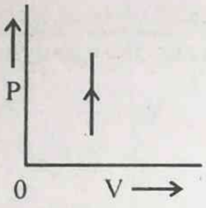
10. **Which of the following curve is an isotherm? (UHS 2011)**



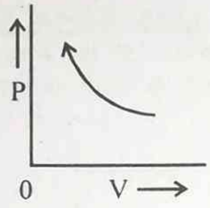
(A)



(C)

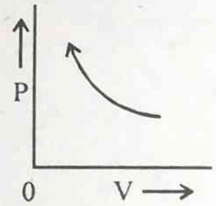


(B)



(D)

(D)



$V \propto \frac{1}{P}$ (T = constant)

11. **H_2 and O_2 both are at thermal equilibrium at temperature 300 K, Oxygen molecule is 16 times massive than hydrogen, Root mean square speed of hydrogen is: (UHS 2012)**

(A) 4 times root mean square of oxygen

(B) $\frac{1}{4}$ root mean square of oxygen

(C) $\frac{1}{16}$ root mean square of oxygen

(D) 16 root mean square of oxygen

(A)

$$v = \sqrt{\frac{3RT}{m}} \Rightarrow v \propto \frac{1}{\sqrt{m}}$$

$$\frac{v_H}{v_O} = \sqrt{\frac{m_O}{m_H}} = \sqrt{\frac{32}{2}} = 4 \Rightarrow v_H = 4\ v_O$$

12. **If "Q" is the amount of heat supplied to a system and "W" is the work done then change in internal energy can be defined as: (UHS 2012)**

(A) Q/W (C) W/Q

(B) Q – W (D) 1 + Q/W

(B)

$$Q = \Delta U + W \Rightarrow \Delta U = Q - W$$

13. **What is the factor upon which change in internal energy and ideal gas depends? (UHS 2013)**

(A) Change in volume

(B) Changed in volume and temperature

(C) Change in temperature

(D) Path followed to change internal energy

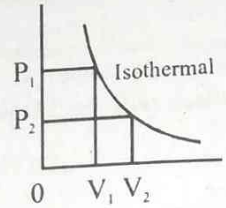
(C)

For an ideal gas system the internal energy is directly proportional to its temperature.

$$U \propto T$$

$$\Delta U \propto \Delta T$$

14. **What will be the mathematical form of first law of thermodynamics for a system whose variation of volume by pressure is shown? (UHS 2013)**



(A) Q = U (C) Q = U/W

(B) U = W (D) Q = W

(D)

$Q = \Delta U + W$

In isothermal process

$\Delta U = 0$

$Q = 0 + W = W$

15. **A gas sample contains three molecules each having speeds 1m/s, 2m/s and 3m/s. What is the mean square speed? (UHS 2013)**

(A) 14/3 m^2/s^2 (C) 2 m^2/s^2

(B) 6 m^2/s^2 (D) $\sqrt{14/3}$ m/s

(A)

$$\text{Mean square speed} = \frac{1^2 + 2^2 + 3^2}{3} = \frac{14}{3}\ m^2/s^2$$

16. **A gas containing "N" number of molecules having mass of each molecule "m" is in a cubic container having length of each side "a". What is the density of gas contained in cube? (UHS 2014)**

(A) N/a^2 (C) Nm/a^3

(B) m/a^3 (D) Na^3/m

(C)

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}} = \frac{Nm}{a^3}$$

17. **In general gas equation PV = nRT, n represents the number of moles of gas. Which of the following represents the relation of "n"? (UHS 2014)**

(A) $n = NN_A$ (C) $n = N_A/N$

(B) $n = N/N_A$ (D) $n = N+N_A$

(B)

$$\text{No. of moles, } n = \frac{N}{N_A}$$

18. **The relation between Celsius and Fahrenheit scales is:**

$$\frac{C}{100} = \frac{F - 32}{180}$$

At what temperature both scales give the same reading? (UHS 2014)

(A) –100° (C) –180°

(B) –40° (D) –173°

(B)

$$T_C = T_F$$

$$T_C = \frac{9}{5}T_C + 32° \Rightarrow T_C - \frac{9}{5}T_C = 32°$$

$$\frac{5TC - 9TC}{5} = 32^\circ \Rightarrow -\frac{4}{5}T_C = 32^\circ$$

$$T_C = -\frac{32^\circ \times 5}{4} = -40^\circ C$$

19. **Two samples of gasses "1" & "2" are taken at same temperature and pressure but the ratio of number their volume is $V_1:V_2 = 2:3$, what is the ratio of number of moles of the gas samples? (UHS 2015)**

(A) 3 :2 (C) 4:9
(B) $\sqrt{2}:\sqrt{3}$ (D) 2:3

(D)

$$PV = nRT \Rightarrow n = \frac{PV}{RT} \Rightarrow n \propto V$$

$$\frac{n_1}{n_2} = \frac{V_1}{V_2} \Rightarrow n_1 : n_2 = V_1 : V_2 = 2:3$$

20. **Root mean square velocity of a gas having pressure "P" and density "ρ" is given by: (UHS 2015)**

(A) $\sqrt{\frac{3P}{\rho}}$ (C) $\sqrt{\frac{3\rho}{P}}$
(B) $\frac{3P}{\rho}$ (D) $\sqrt{\frac{3\rho}{P}}$

(A)

$$v_{rms} = \sqrt{\frac{3PV}{M}} = \sqrt{\frac{3P}{M/V}} = \sqrt{\frac{3P}{\rho}}$$

21. **When the state of gas change without change in temperature, the gas is said to undergo: (UHS 2015)**

(A) Isothermal process (C) Isochoric process
(B) Adiabatic process (D) Isobaric Process

(A)

The process during which temperature remains same is called isothermal process.

22. **The relation $\frac{R}{N_A} = 1.38 \times 10^{-23}\ JK^{-1}$ in gas law is known as: (UHS 2016)**

(A) Avogadro's law (C) Newton's constant
(B) Cahrles constant (D) Boltzmann's constant

(D)

$$\frac{R}{N_A} = k = 1.38 \times 10^{-23}\ JK^{-1} = \text{Boltzmann's constant}$$

23. **The relation "PV=nRT" shows which law of physics? (UHS 2016)**

(A) Charles' law (C) Newton's constant
(B) Avogadro's law (D) Ideal gas law

(D)

"PV = nRT" is the Ideal gas law.

24. **The rabid escape of air from a burs tyre is an example of: (UHS 2016)**

(A) Adiabatic processes
(B) Isothermal process
(C) cooling process
(D) First law of thermodynamics

(A)

It is an example of adiabatic process.

25. **Which relation exactly described the isothermal process: (UHS 2016)**

(A) Q = W (C) $Q = -\Delta U$
(B) $W = -\Delta U$ (D) $Q = \Delta U + W$

(A)

$Q = \Delta U + W$
In isothermal process
$\Delta U = 0$
$Q = 0 + W = W$

26. **Estimate pressure of air molecules at 273K, if the mean square speed is $\langle v^2 \rangle = 500 m^2/s^2$ and density of air under these conditions is $6 kg/m^3$: (UHS 2017)**

(A) 2.5×10^2 Pa (C) 1×10^2 Pa
(B) 1×10^3 Pa (D) 2.7×10^3 Pa

(B)

$$P = \frac{1}{3}\rho\langle v^2 \rangle = \frac{1}{3}(6)(500) = 1000\ Pa$$

27. **One mole of a gas occupies volume $1 \times 10^{-2}\ m^3$ in cylinder whose pressure is 2.5×10^5 Pa. The temperature of cylinder will be equal to: (UHS 2017)**

(A) 300K (C) 370K
(B) 227K (D) 390K

(A)

$PV = nRT$

$$T = \frac{PV}{nR} = \frac{(2.5 \times 10^5)(1 \times 10^{-2})}{(8.314)(1)} K \approx 300\ K$$

28. **If $C_V = \frac{5}{2}R$, C_P will be: (UHS 2018)**

(A) $\frac{2}{7}R$ (C) $\frac{2}{5}R$
(B) $\frac{7}{2}R$ (D) $\frac{5}{2}R$

(B)

$$C_P = C_V + R = \frac{5}{2}R + R = \frac{7}{2}R$$

29. **If one mole of an ideal gas is heated at constant pressure, then the first law of thermodynamics can be written as: (UHS 2018)**

(A) $C_P\Delta T = C_V\Delta T + P\Delta V$
(B) $\Delta C_P T = \Delta C_V T + P\Delta V$
(C) $C_P\Delta T = C_V\Delta T + \Delta PV$
(D) $C_V\Delta T = C_P\Delta T + P\Delta V$

(A)

At constant pressure:
$Q_P = \Delta U + W$
$C_P\Delta T = \Delta U + P\Delta V$ .....(i)
At constant volume:
$Q_V = \Delta U + W = \Delta U + 0 = \Delta U$
$C_V\Delta T = \Delta U$
Put in (i)
$C_P\Delta T = C_V\Delta T + P\Delta V$

30. **Find the mean translational kinetic energy of ideal hydrogen gas at 17°C: (UHS 2018)**

(A) 5×10^{-21} J (C) 6.21×10^{-12} J
(B) 6×10^{-21} J (D) 6.21×10^{-21} J

(B)

$$<K.E> = \frac{3}{2}kT = \frac{3}{2}(1.38\times10^{-23})(290) = 6\times10^{-21}\ J$$

31. **Molecules of a gas at constant pressure for a fixed amount of gas have average kinetic energy "X". increasing temperature from 27°C to 327°C, average K.E of molecules will become: (UHS 2019)**

(A) 200X (C) 300X
(B) 20X (D) 2X

(D)

$T_1 = 27^{\circ}C = 300\ K$

$T_2 = 327^{\circ}C = 600\ K = 2T_1$

$<K.E> = \frac{3}{2}kT$

$<K.E> \propto T$

As temperature double so, kinetic energy also double (2X).

32. **The sum of all forms of molecular energies (kinetic and potential) of a substances is termed as: (UHS 2019)**

(A) Internal energy (C) Heat energy
(B) Elastic energy (D) Absolute energy

(A)

Sum of all forms of molecular energies (K.E. and P.E.) of a substance is called internal energy.