Classwork: Questions: 16.2, 16.3, 16.4, 16.6 (Pg. 133), Problems: 16.1, 16.2, 16.5, 16.8, 16.10 (Pg. 133, 134)

Homework: Questions: 16.1, 16.5 (Pg. 132, 133), Problems: 16.3, 16.4, 16.6, 16.7, 16.9 (Pg. 133, 134)

CHAPTER 17: PHYSICS OF SOLIDS

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Homework: Questions: 17.2, 17.3, 17.7, 17.9, 17.10 (Pg. 152), Problem: 17.1 (Pg. 153)

CHAPTER 18: ELECTRONICS

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Classwork: Questions: 18.3, 18.6, 18.7, 18.9, 18.10, 18.12 (i-iii,v), (Pg. 172, 173), Problems: 18.1, 18.4 (Pg. 174)

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CHAPTER 19: DAWN OF MODERN PHYSICS

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Homework: Questions: 19.7, 19.14, 19.19, 19.23, 19.25, 19.26 (Pg. 200), Problem: 19.3, 19.4, 19.7, 19.9 (Pg. 201)

CHAPTER 20: ATOMIC SPECTRA

Bohr's Model of the Hydrogen Atom (Pg. 204-208), Inner Shell Transitions and Characteristic X-Rays (Pg. 208-212), Uncertainty with the Atom (Pg. 212, 213), Laser (Pg. 213-216), Example: 20.1(Pg. 208)

Classwork: Questions: 20.1, 20.3, 20.8, 20.10, (Pg. 217), Problems: 20.3, 20.7, 20.8, 20.10 (Pg. 217,218)

Homework: Questions: 20.5, 20.7, 20.9 (Pg. 217), Problems: 20.2, 20.9 (Pg. 218)

CHAPTER 21: NUCLEAR PHYSICS

Mass Defect and Binding Energy (Pg. 223-226), Radioactivity (Pg. 226-229), Half Life (Pg. 229-231), Interaction of Radiation with Matter (Pg. 232-234), Radiation Detectors (Pg. 234-238), Nuclear Reactors (Pg. 238-240), Nuclear Fission (Pg. 240-243), Fusion Reaction (Pg. 246-249), Radiation Exposure (Pg. 249,250), Basic Forces of Nature (Pg. 254, 255), Building Blocks of Matter (Pg. 255, 256), Examples: 21.1, 21.2 (Pg. 224, 231, 232)

Classwork: Questions: 21.3, 21.5, 21.6, 21.7, 21.9, 21.10, 21.11, 21.15, 21.17 (Pg. 258), Problems: 21.1, 21.3, 21.4, 21.6, 21.7, 21.8 (Pg. 259)

Homework: Questions: 21.2, 21.4, 21.8, 21.12, 21.13, 21.14, 21.16 (pg. 258), Problems: 21.2, 21.5 (Pg. 259)

OBJECTIVES (MCQ'S) OF CHAPTER-12 ACCORDING TO ALP SMART SYLLABUS-2020

Topic III: Electric Field Lines:

1. The SI unit of electric intensity is:
(A) NC^{-1} (B) Tesla (C) N/m (D) Coul/meter

2. Electric lines of forces are parallel and equally spaced, then electric field is:(2 times)
(A) Weak (B) Strong (C) Non-uniform (D) Uniform

3. The force experienced by unit positive charge placed at a point in an electric field is called:
(A) Coulomb's force (B) Faraday's force (C) Lorentz's force (D)Electric field intensity

4. A charge of $1\mu C$ experience a force of 10^{-6} N at a point then the electric intensity at that point is:
(A) $10^{6}NC^{-1}$ (B) $10^{-6}NC^{-1}$ (C) $10^{-12}NC^{-1}$ (D) $1NC^{-1}$

5. The lines which provide information about the electric force exerted on charged particles are:
(A) Magnetic field lines (B) Electric field lines (C) Tangent lines (D)Curved lines

6. The electric field lines are closer where the field is:
(A) Strong (B) Weak (C) Uniform (D) Variable

7. IF a charged body is moved against the electric field, it will gain: (2 times)
(A) P.E (B) K.E (C) Mechanical energy (D) Electrical potential energy

8. Special organ called Ampullae of lorenzini that are very sensitive to electric field are found in:
(A) Bats (B) Cats (C) Dogs (D) Sharks

9. The electric field created by positive charge is:- (2 times)
(a) Radially inward (b) Zero (c) Circular (d) radially outward

10. The unit of Electric intensity other than NC^{-1} is:- (2 times)
(a) V/A (b) V/m (c) V/C (d) N/V

11. Which one of the following can be taken as measure of electric field intensity :
(a) $\frac{F}{A}$ (b) $\frac{\phi_e}{A}$ (c) $\frac{qA}{\varepsilon_0}$ (d) $\frac{\phi\varepsilon_0}{A}$

12. The unit of Electric intensity other than NC^{-1}
(A) VA^{-1} (B) Vm^{-1} (C) VC^{-1} (D) NC

13. The idea for electric field lines was proposed
(A) Henry (B) Michael Faraday (C) Ampere (D) Ohm

14. The electric field intensity due to an infinite sheet of charge is:
(A) $\overline{E}=\frac{\sigma}{2\varepsilon_o}\hat{r}$ (B) $\overline{E}=\frac{2\sigma}{E_o}\hat{r}$ (C) $\overline{E}=\frac{1}{2\sigma E_o}\hat{r}$ (D) $\overline{E}=\frac{\sigma}{E_o}\hat{r}$

15. S.I unit of strength of electric field is:
(A) J/C (B) C/V (C) N/C (D) J/N

16. Closeness of the electric field lines is the measure of.
(A) Circection of field (B) Strength of field (C) Potential difference (D) Uniformly of field

17. The direction of field lines around an isolated negative charge '-q' is.
(A) Radially inward (B) Radially outward (C) Elliptical (D) Circular

18. NC^{-1} is the SI unit of:
(A) Force (B) Charge (C) Current (D) Electric Intensity

Topic V: Electric Flux and Electric flux through a surface enclosing a charge:

19. If $\Phi_e=\vec{E}.\vec{A}$ then maximum value of flux is obtained if angle between $\vec{E}$ and $\vec{A}$ is:
(A) 90° (B) 180° (C) [illegible] (D) 0°

20. SI unit of electric flux is: (4 Time)
(A) NC^{-1} (B) Nm^2C^{-1} (C) Tesla (D) Weber

21. Unit of energy density of electric field is:
(A) JC^{-1} (B) JV^{-1} (C) Jm^{-3} (D) Jl^{-3}

22. When an area is held perpendicular to the field lines, then the magnitude of electric flux is:
(A) Negative (B) Maximum (C) Minimum (D) Zero

23. Electric flux through a closed surface does not depend upon:
(A) Its shape (B) Medium (C) Charge (D) None

24. Energy density in case of a capacitor is always proportional to:
(A) ε_o (B) C (C) V^2 (D) E^2

25. For computation of electric flux, the surface area should be:
(A) Parallel (B) curved (C) spherical (D) flat

26. Total flux through a closed surface depends on:
(a) Shape of surface (b) Charge enclosed only
(c) Medium only (d) charge and medium

27. Electric intensity inside the hollow sphere is:
(a) $\frac{\sigma}{\varepsilon_0}$ (b) $\frac{\sigma}{2\varepsilon_0}$ (c) $\frac{1}{\varepsilon_0}$ (d) Zero

Topic IX: Electric Potential:

28. The unit of electric charge is:
(A) Volt (B) Henry (C) Coulomb (D) Weber

29. Farad is the unit of:
(A) Charge (B) Current (C) Electric flux (D) Capacitance

30. A particle having 2e charge falls through a potential difference by 5v. Energy acquired by it is:
(A) 2.5 eV (B) 20 eV (C) 0.4 eV (D) 10 eV

31. Absolute potential difference due to point change of 1C at a distance of 1m is given by:
(A) 9×10^6 volts (B) 9×10^7 V (C) 9×10^8 V (D) 9×10^9 V

32. Two equal and opposite point charges separated by a distance 2m. The electric potential at the midway between them is:
(A) Zero (B) High (C) Low (D) constant

33. The relation "$\frac{\Delta V}{\Delta r}$" represents:
(A) Gauss's Law (B) Electrical flux (C) Electric intensity (D) Potential difference

34. If potential difference across two plates of a parallel plates capacitor is doubled then the energy stored in it will be:
(A) 2-times (B) 4-times (C) 8-times (D) remain same

35. The absolute Electric Potential at a point distant 20 cm from a charge of 2 μ c is:
(A) 9 x 10^2V (B) 9 x 10^3V (C) 9 x 10^4V (D) 9 x 10^5V

Topic X: Electron Volt:

36. Solid bodies are charged due to the transfer of:
(A) Electrons (B) Protons (C) Neutrons (D) All of these

37. 1 Joule=______: **(2 Time)**
(A) 6.25×10^{18} eV (B) 6.25×10^{-18} eV (C) 1.6×10^{-19} eV (D) 9.1×10^{-31} eV

38. The electron volt is the unit of: **(2 times)**
(A) Electric current (B) Electric energy (C) Potential (D) Potential difference

39. One electron volt is equal to:
(A) 1.6 x 10^{-19}Joul (B) 1.6 x 10^{19} Coulomb (C) 1.6 x 10^{-19} N (D) 1.6 x 10^{18}Joul

Topic XIII: Capacitor:

40. If potential difference across the two plates of a parallel plate capacitor is doubled, then the energy stored in it will be:
(A) 2 times (B) 8 times (C) 4 times (D) Remains constant

41. In R-C series circuit the correct relation for the time constant is:

(A) R.t = C (B) C.t = R (C) R.C = t (D) C.V = Q

42. The term 'RC' has same unit as that of:
(A) Potential (B) Capacitance (C) Energy (D) Time

43. Product of resistance and capacitance is called: **(2 times)**
(A) Gas constant (B) Resistivity (C) Boltzmann constant (D) Time constant

44. The amount of energy equal to 1.6×10^{-19} J is called: **(2 times)**
(A) One volt (B) One millivolt (C) One electron volt (D) One mega electron volt

45. The charging time of capacitor depends upon:
(A) R/C (B) C/R (C) RC (D) $\sqrt{RC}$

46. Farad is defined as:
(A) Coulomb/volt (B) Ampere/volt (C) Coulomb/joule (D) Volt/coulomb

47. A capacitor stores energy in the form of:
(A) Magnetic field (B) Heat energy (C) Electrical energy (D) Mechanical energy

48. The capacitance of a parallel plate capacitor in vacuum is:
(A) $C_{vac}=\frac{A\varepsilon_0}{d}$ (B) $C_{vac}=\frac{A\varepsilon_0\varepsilon_r}{d}$ (C) $C_{vac}=\frac{d\varepsilon_0}{A}$ (D) $C_{vac}=\frac{d\varepsilon_0\varepsilon_r}{A}$

49. The increase in capacitance of a capacitor due to presence of dielectric is due to _____ of dielectric:
(A) Electric polarization (B) Electrification (C) Ionization (D) Electrolysis

50. Capacitance of a capacitor does not depend upon:
(A) Distance between plates (B) Area of plates
(C) Electric field between plates (D) medium between plates

51. When dielectric is placed between the plates of capacitor, the value of E between the plates:
(A) Increases (B) Zero (C) Decreases (D) Infinite

52. If the separation between the plates of a capacitor is doubled then its capacitance becomes:
(A) Double (B) Half (C) One fourth (D) Three times

53. The product of resistance and capacitance is: **(2 times)**
(a) Velocity (b) Force (c) Acceleration (d) Time

54. A capacitor is perfect insulator for
(A) Alternating current (B) Sparking current (C) Eddy current (D) Direct current

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55. The electric potential at a mid-point in an electric dipole is:
(a) 0 V (b) 0.5 V (c) 1 V (d) 1.5 V

56. Coulomb per volt is called:
(a) Farad (b) Ampere (c) Joule (d) Henry

57. If time constant is RC Circuit is small, than the capacitor is charged or discharged. **(3 times)**
(a) Slowly (b) Rapidly (c) at constant rate (d) intermittently

58. Gauss's law can only be applied to:
(a) A curved surface (b) A flat surface (c) A surface of any shape (d) A closed surface

59. Two oppositely charged balls A and B attract the third ball C, when placed near them turn by turn. The third ball C must be: **(2 times)**
(a) Positively charged (b) Negatively charged
(c) electrically neutral (d) Positively and negatively charged

60. In Millikan's oil drop experiment a charged particle of mass 'm' is in equilibrium in an applied electric field $\vec{E}$.If the direction of electric field is reversed then acceleration of the particle will be:
(A) zero (B) g/2 (C) g (D) 2g

61. Which material should be inserted between the plates of a capacitor in-order to increase its capacitance?
(A) copper (B) mica (C) iron (D) tin

62. The net charge on a capacitor (each plate having magnitude of charge q) is:
(A) infinity (B) 2 q (C) q/2 (D) zero

63. If electric and gravitational forces on an electron balance each other, then electric intensity will be:

(A) $E=\frac{mg}{q}$ (B) $E=\frac{q}{mg}$ (C) $E=\frac{F_e}{q}$ (D) $E=\frac{1}{4\pi\epsilon_0}\frac{q}{r^2}$

64. The capacitance of capacitor depends upon:

(A) Thickness of plates (B) Charges on the plates
(C) Voltage applied (D) Geometry of the capacitor

65. A billion electrons are added to pith ball. It s charge is:

(A) -1.6×10^{-10}C (B) -1.6×10^{-12}C (C) -1.6×10^{-14}C (D) -1.6×10^{-7}C

66. Electric Flux is expressed as:

(A) $\phi_e=\vec{E}\times\vec{A}$ (B) $\phi_e=\vec{E}.\vec{Q}$ (C) $\phi_e=\vec{E}.\vec{A}$ (D) $\phi_e=EA^2$

67. Intensity of field inside a hollow charged sphere will be:

(A) Negative (B) unaffected (C) zero (D) maximum

68. When some dielectric is inserted between the plates of a capacitor, then capacitance: (2 times)

(A) decreases (B) increases (C) becomes zero (D) becomes infinity

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69. Equation Ø = $\overline{E}.\overline{A}$ is applicatble to the surface.

(A) Cylindrical (B) Conical (C) Flat (D) Spherical

70. Due to polarization, electric field E in a capacitor:

(A) increases (B) decreases
(C) first increases then decreases (D) remains same

71. The charge on the Droplet in Millikan Experiment is calculated by using formula:

(A) $q=\frac{mg}{vd}$ (B) $q=\frac{v}{mgd}$ (C) $q=\frac{mgd}{v}$ (D) $q=\frac{d}{mgd}$

72. 1 Ohm x 1 Farad is equal to:

(A) 1 Ampere (B) 1 Coulomb (C) 1 Joule (D) 1 Second

73. The study of electric charges at rest under the action of electric forces is known as:

(A) Electromagnetism (B) Electronstatics (C) Magnetic Induction (D) Electric field

ANSWERS OF THE MULTIPLE CHOICE QUESTIONS

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
A	D	D	D	B	A	D	D	D	B	B	B	B	A	C
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
B	A	D	D	B	B	B	B	D	D	D	D	C	D	D
31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
D	A	C	B	C	A	A	B	A	C	C	D	D	C	C
46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
A	C	A	A	C	C	B	D	D	A	A	B	D	C	D
61	62	63	64	65	66	67	68	69	70	71	72	73		
B	D	A	D	A	C	C	B	C	B	C	D	B		

SHORT QUESTIONS OF CHAPTER-12
ACCORDING TO ALP SMART SYLLABUS-2020

Topic III: Electric Field Lines:

1. Write characteristics of electric field lines.
OR Write two properties of electric field lines. (7 Times)

Ans: i. Electric field lines originate from positive charges and end on negative charges.

ii. The tangent to a field line at any point gives the direction of the electric field intensity at that point.

iii. The lines are closer where the field is strong, the lines are farther apart where the field is weak.

iv. No two lines cross each other.

2. Electric lines of force never cross why? (24 times)
OR Comment on the uni-direction of electric lines of force.

Ans: Electric lines of force never cross each other. This is because that electric field line has only one direction at any given point. If the lines cross, electric Field lines could have more than one direction which is not possible.

3. If a point charge q of mass m is released in a non-uniform electric field with field lines pointing in the same directions, will it make a rectilinear motion? OR A point charge moves rectilinear path in an electric field. Explain. (7 Times) (C.W)

Ans: If a point charge q of mass m is placed at any point in the field, it will follow straight or rectilinear path along the field line due to repulsive force.

4. Describe the force or forces on a positive point charge when placed between parallel plates, with similar and equal charges. (6 times)

Ans: When a positive point charge is placed between parallel plates with similar and equal charges, then the electric field intensity due to one plate is equal in magnitude but opposite in direction of electric intensity due to other plate. So the value of resultant electric field intensity E is zero. Hence the net force on the positive point charge is zero. Thus it will remain at rest.

5. Define electric intensity and give its unit.

Ans: The electrostatic force per unit test charge, at a specific point in the electric field, is called electric field intensity.

$$\vec{E}=\frac{\vec{F}}{q_0}$$

Its unit is NC^{-1}.

6. Distinguish between electric field and field intensity. (2 times)

Ans: <u>**Electric field:**</u>The space or region around the charge in which it exerts its eclectic force on other charges is called electric field.

<u>**Electric field intensity:**</u>At any point in electric field the force experienced by a point charge q is termed as electric intensity or strength at that point.

7. Define electric field intensity. What is its unit and direction? (2 times)

Ans: Electric force applied per unit charge is called electric field intensity.
It SI unit is N/C.
Its direction is along the electric field i.e. from positive to negative plate.

8. How sharks locate their prey? Explain briefly.

Ans: Sharks have special organs, called the ampullae of Lorenzini, that are very sensitive to electric field and can detect potential difference of the order of nano volt and can locate their prey very precisely.

Topic V: Electric Flux:

9. Define electric flux. Write its SI units.

Ans: The number of the field lines passing through a certain element of area is known as electric flux through that area.

$$\Phi_e=\vec{E}.\vec{A}$$

Its SI unit is Nm^2C^{-1}.

10. Is E necessary zero inside a charged rubber balloon if balloon is spherical? (7 Times) (C.W)

Ans: Yes, $\vec{E}$ is necessarily zero inside a charged rubber balloon if balloon is spherical.

Since $\Phi_e=\frac{1}{\epsilon_0}\times Q$

If the Gaussian's surface is imagined inside charged balloon, then

$$Q=0$$

It gives $\Phi_e=0$

$$\vec{E}.\vec{A}=0$$

Since $\vec{A}\neq0$

So $\vec{E}=0$

11. Does the total flux depend upon the shape or geometry of the closed surface?

Ans: No, the total flux does not depend upon the shape or geometry of the closed surface. It depends upon medium and charge enclosed.

12. What is the orientation of the surface in an electric field to get maximum flux through it?

Ans: When the surface area is held perpendicular to electric intensity the electric flux will be maximum.

In this case the electric field $\vec{E}$ and area vector $\vec{A}$ will be parallel. i.e. $\theta = 0°$.

$$\Phi_e = \vec{E}.\vec{A}$$
$$= EA\cos\theta$$
$$= EA\cos 0° = EA\,(1) = EA$$

13. Mention two situations of vector area in electric flux.

Ans: (i) If the electric field $\vec{E}$ and area vector $\vec{A}$ are parallel i.e. $\theta = 0°$ then the electric flux will be maximum.

$$\Phi_e = \vec{E}.\vec{A} = EA\cos\theta = EA\cos 0°$$
$$= EA\,(1) = EA$$

(ii) If the electric field $\vec{E}$ and area vector $\vec{A}$ are perpendicular i.e. $\theta = 90°$ then the electric flux will be zero.

$$\Phi_e = \vec{E}.\vec{A} = EA\cos\theta = EA\cos 90°$$
$$= EA\,(0) = 0$$

14. Define electric flux. Mention the factors upon which it depends.

Ans: The number of the field lines passing through a certain element of area is known as **electric flux** through that area.

Electric flux depends upon the nature of medium and the charge enclosed.

15 What are the factors upon which the electric flux depend?

Ans: As

$$\phi_e = \vec{E}.\vec{A} = EA\cos\theta$$

Thus electric flux depends upon

(i) Electric field intensity 'E'.
(ii) Area of flat surface 'A'.
(iii) The angle between the field lines and the normal to the area 'θ'.

Topic VII: Electric Flux through Closed surface and Gauss's Law:

16. Give the statement of Gauss's law. Write down its mathematical form. (5 Times)

Ans: It states that the total electric flux through any closed surface is equal to $\frac{1}{\epsilon_0}$ times the total charge enclosed in it.

Mathematically,

$$\Phi_e = \frac{1}{\epsilon_0} \times Q$$

17. Suggest a method 'shield' an apparatus from electric field even when it is to be kept in the region where electric field is present.

Ans: An apparatus will be shielded from electric field when it is kept inside the metallic box, so that the charges will only reside on the outer surface of the container. It is in accordance with Gauss' law.

18. Is it true that Gauss's law states that the total number of lines of forces crossing any closed surface in the outward direction is proportional to the net positive charge enclosed within surface? (3 times) (H.W)

Ans: Yes, the above statement is true. The total number of lines of force crossing any closed surface in the outward direction means electric flux.

Since
$$\Phi_e = \frac{1}{\epsilon_0} \times Q$$
$$\Phi_e = cosntant \times Q$$
$$\Phi_e \propto Q$$
$$electric\ flux \propto total\ positive\ charge$$

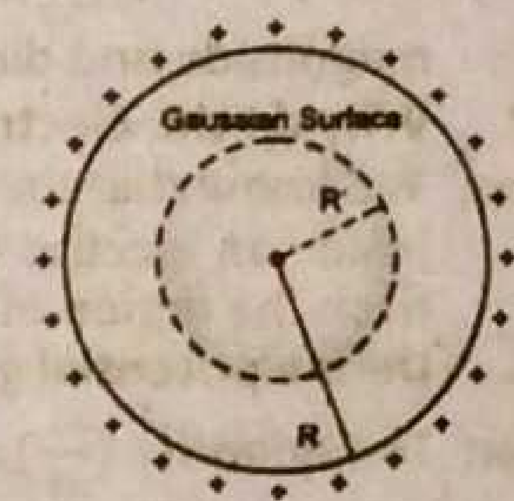
19. Define electric flux, Gaussian surface.

Ans: The number of electric field lines passing through a certain element of area is known as **electric flux** through that surface.

To apply Gauss's law, an imaginary closed surface is considered which passes through the point at which the electric intensity is to be evaluated. This closed surface is known as **Gaussian surface.**

20 Find electric intensity of field inside a hollow charged sphere.

Ans: Consider a spherical Gaussian surface inside the hollow charged sphere as shown in figure.



Applying Gauss's law

$$\phi_e = \frac{q}{\varepsilon_0} = \frac{0}{\varepsilon} = 0$$

Since

$$\phi_e = \vec{E}.\vec{A} = 0$$

As $\vec{A} \neq 0$

So $\vec{E} = 0$

Topic VIII: Applications of Gauss's Law:

21. What is strength of electric field inside a hollow charged sphere and why?

Ans: The strength of electric field inside a hollow charged sphere is zero.

Since $\Phi_e = \frac{q}{\epsilon_0}$

$$\vec{E}.\vec{A} = \frac{q}{\epsilon_0}$$

Inside a hollow charged sphere $q = 0$

So $\vec{E}.\vec{A} = 0$, As $\vec{A} \neq 0$, Thus $\vec{E} = 0$

Topic IX: Electric Potential:

22. Do electrons tends to go to region of high potential or low potential? (20 Times) (H.W)

Ans: Electrons tend to go to a region of high potential from low potential because electrons are negatively charged.

23. The potential is constant throughout a given region of space. Is electric field zero or non-zero in this region. (12 times)

OR Comment on electric field in region of constant potential.

Ans: The electric field will be zero in this region.

We know that electric field is equal to the negative of potential gradient i.e

$$E = -\frac{\Delta V}{\Delta r}$$

Here in a present case

V= constant

So, $\Delta V = 0$

Hence $E = -\frac{0}{\Delta r} = 0$

24. Define electric potential and give its SI unit. (2 times)

Ans: The electric potential at any point in an electric field is equal to work done in bringing a unit positive charge from infinity to that point keeping it in equilibrium.

Its SI unit is volt (V).

Volt:

A potential difference of 1 volt exists between two points if work done in moving a unit positive charge from one point to other keeping equilibrium is 1 joule.

$$1\ volt = 1\frac{Joule}{1\ Coulomb}$$

25. What is difference between electrical potential energy and electrical potential difference? (3 times)

Ans: __**Electrical potential energy:**__ The energy acquired by a unit positive charge in carrying it from one point to the other against the electric field keeping it in electrostatic equilibrium is called as potential energy.

It is the energy stored in the charge 'q' because of its position in an electric field. It is measured in joules.

Electrical potential difference: The electrical potential difference between two points is defined as the work done in carrying a unit positive charge from one point to the other point while keeping the charge in electrostatic equilibrium.
It is measured in volts.

26. What is Potential Gradient? OR Define Potential Gradient? (4 times)

Ans: The quantity $(\frac{\Delta V}{\Delta r})$ gives the maximum value of rate of change of electric potential in magnitude and direction with respect to distance. It is known as potential gradient.

27. Why do the electrons tend to go to region of high potential?

Ans: We know that the electrons are negatively charged particles. So, when they are put inside an electric field they tend to go to the region of high potential (positive end) from the region of low potential (negative end).

28. Define potential gradient. Give its unit. (2 times)

Ans: The quantity $(\frac{\Delta V}{\Delta r})$ gives the maximum value of rate of change of electric potential in magnitude and direction with respect to distance. It is known as potential gradient.
Its unit is Vm^{-1}.

29. What is meant by EEG and ERG? (3 times)

Ans: **Electroencephalography (EEG)** is usually applied over human brain to check its abnormal behaviour by the use of electrical energy. For this electrodes are connected to the selected portion of the head and the corresponding response is seen graphically through the screen of a recording device.

Electrocardiography (ECG) records the voltage between points on human skin generated by the electrical process in the heart. It is made in running position providing information about hearts performance under stress.

30. Define electric potential difference with units.

Ans: **Electrical potential difference:** The electrical potential difference between two points is defined as the work done in carrying a unit positive charge from one point to the other point while keeping the charge in electrostatic equilibrium.
Its SI unit is volt (V).

Volt: A potential difference of 1 volt exists between two points if work done in moving a unit positive charge from one point to other keeping equilibrium is 1 joule.

$$1 \text{ volt} = \frac{1 \text{ joule}}{1 \text{ coulomb}}$$

31. Suppose that you follow an electric line due to a positive point charge. Do electric field intensity and the potential increase or decrease? (8 Times)

Ans: Since $E \propto \frac{1}{r^2}$

and $V \propto \frac{1}{r}$

So due to a positive point charge, both electric field and potential will decrease.

32. Show that $1\frac{volt}{metre} = 1\frac{newton}{coulomb}$ (6 times)

Ans: Since

$$1\frac{Volt}{meter} = 1\frac{Joule/Coulomb}{meter}$$

$$= 1\frac{Joule}{Coulomb \times meter}$$

$$= 1\frac{Newton \times meter}{Coulomb \times meter}$$

$$1\frac{volt}{metre} = 1\frac{newton}{coulomb}$$

Hence proved

33. Derive relation for potential gradient. / Show that $E = \frac{\Delta V}{\Delta r}$ (2 times)

Ans: The potential difference between two oppositely charged plates A and B is given as:

$$V_B - V_A = \frac{W_{AB}}{q_o}$$

Where $W_{AB} = Fd = -q_o Ed$

(negative sign shows that F is opposite to q_oE.)

So, $$V_B - V_A = \frac{-q_o Ed}{q_o}$$

Or $$\Delta V = -Ed$$

Or $$E = -\frac{\Delta V}{d}$$

If distance between the plates is infinitesimally small then

$$E = -\frac{\Delta V}{\Delta r}$$

The quantity $\frac{\Delta V}{\Delta r}$ is known as potential gradient.

34. A particle carrying a charge of 5e falls through a potential difference of 10.0V. What will be the energy acquired by it.

Ans: $q = 5e$

$\Delta V = 10.0V$

$\Delta U = ?$

As we know that

$$\Delta U = q\Delta V$$
$$= 5e \times 10.0V$$
$$= 50eV$$

35 Differentiate between electrical potential difference and electric potential at a point.

Ans: The **electrical potential difference** between two points is defined as the work done in bringing a unit positive charge from one point to the other point while keeping the charge in equilibrium.

The **electric potential** at any point in an electric field is equal to **work done** in bringing a unit positive charge from infinity to that point while keeping the charge in equilibrium.

Topic X: Electron Volt

36. Show that $1\,eV = 1.6 \times 10^{-19} J$ (5 times)

Ans: Since electron volt is the amount of the energy gained or lost by an electron as it traverses a 1 volt potential difference.

As $$\Delta K.E. = q\Delta V$$

$$q = e = 1.6 \times 10^{-19} C$$

$$\Delta V = 1V$$

So, $$\Delta K.E. = (1.6 \times 10^{-19} C)(1\,V)$$

$$1\,eV = 1.6 \times 10^{-19} CV$$

$$1\,eV = 1.6 \times 10^{-19} J$$

Hence proved

37. Define electron volt, give its mathematical form. (6 times)

Ans: The amount of energy acquired or lost by an electron as it us traversed by a potential difference of one volt.

As $$\Delta K.E. = q\Delta V$$

So, $$\because \; (1\,eV = 1.6 \times 10^{-19} J)$$

38. Convert 1 Joule into electron-volt. (3 Times)

Ans: As

$$\Delta K.E. = q\Delta V$$

$\because$ (q=e=1.6×10^{-19} C)

$$\Delta V = 1V$$

So,

$$\Delta K.E. = (1.6 \times 10^{-19} C)(1\,V)$$
$$1\,eV = 1.6 \times 10^{-19} CV$$
$$1\,eV = 1.6 \times 10^{-19} J$$

Now,

$$1\,J = \frac{1}{1.6 \times 10^{-19}}\ eV$$
$$1\,J = 0.625 \times 10^{19}\ eV = 6.25 \times 10^{18}\ eV$$

39. A particle carrying a charge of 2e falls through a potential difference of 3.0V. Calculate the energy acquired by it. **(2 Times)**

Ans: It is given that

$$q = 2e$$
$$\Delta V = 3.0\,V$$

The energy acquired by the particle is

$$\Delta(K.E.) = q\Delta V$$
$$\Delta(K.E.) = (2e)(3V)$$
$$\Delta(K.E.) = 6\,eV$$
$$\Delta(K.E.) = 6 \times 1.6 \times 10^{-19}\,J$$
$$\Delta(K.E.) = 9.6 \times 10^{-19}\,J$$

40. When the electrons fall through a P.D of 1.0 Volt. Find its energy in electron volts.

Ans: As

$$\Delta K.E. = q\Delta V$$

q=e=1.6×10^{-19} C

$$\Delta V = 1V$$

So,

$$\Delta K.E. = (1.6 \times 10^{-19} C)(1\,V)$$
$$1\,eV = 1.6 \times 10^{-19} CV$$
$$1\,eV = 1.6 \times 10^{-19} J$$

Topic XI: Electric and Gravitational Forces:

41. Give similarity and difference between Coulomb and Gravitational forces. (4 times)

OR Write any two differences between electric and gravitational force. (2 Times)

Ans: **Similarities**

i. Both forces are the conservative forces.

ii. Both forces obey the inverse square law.

Differences

i. Electrical force is might be attractive as well as repulsive while the gravitational force is only attractive.

ii. Electrostatic force is medium dependent while the gravitational force is not.

42. How the orbit of planets will be modified if planets were electrically charged?

Ans: It would add or subtract the gravitational force if the charge was large enough and the sun was charged. So the radius of the orbits would be changed.

43. Center of planetary system is oppositely charged to the rest of planets. How orbits of planets would be modified?

Ans: It would add the gravitational force if the charge was large enough and the sun was charged. So the radius of the orbits would be changed.

Topic XIII: Capacitor:

44. How can you identify that which plate of a capacitor is positively charged? **(20 Times)** **(C.W)**

Ans: Gold leaf electroscope is used.

To check the polarity, disc of positively charged electroscope is brought close to the capacitor plate. If the divergence of gold leaves increases, the plate is positively charged and vice versa.

45. Define capacitance of a capacitor.

Ans: Capacitance is a measure of the ability of capacitor to store charge. OR

Capacitance of a capacitor can be defined as the amount of charge on one plate necessary to raise the potential of that plate by one volt with respect to the other.

The S.I unit of capacitance is Farad (F).

46. What is capacitor? Define the capacitance.

Ans: Capacitor is a device used to store charge.

Capacitance is a measure of ability of capacitor to store charge.

47 Define capacitance and its unit farad.

Ans: **Capacitance** is a measure of the ability of capacitor to store charge.

The capacitance of a capacitor is **one farad.** If a charge of one coulomb, given to one of the plates of a parallel plate capacitor, produces a potential difference of one volt between them.

Topic XIV: Capcitance of parallel plate Capacitor:

48. Why does capacitance of a capacitor increase when a dielectric material is inserted between its plates? **(2 Times)**

Ans: When a dielectric material is inserted between the plates of a capacitor, the molecules of the dielectric under the action of electric force become dipoles and the dielectric is said to be polarized. It effectively decreases the surface density of charge(σ) on the plates due to which electric intensity between the plates ($E = \sigma/\varepsilon_o$) decreases and as a result potential difference($E = \frac{V}{d}$) decreases.

Capacitance of a capacitor is given by

$$C_{Vac} = \frac{Q}{V}$$

Which clearly shows that with the decrease in potential difference, capacitance of a capacitor will increase.

49. How will capacitance of a parallel plate capacitor be affected if area of plates is doubled and separation between them is halved?

Ans: Since

$$C = \frac{A\varepsilon_0\varepsilon_r}{d}$$

By applying given condition

$$C_{new} = \frac{(2A)\varepsilon_0\varepsilon_r}{\frac{d}{2}}$$
$$C_{new} = 4\frac{A\varepsilon_0\varepsilon_r}{d}$$
$$C_{new} = 4C$$

So, the capacitance will increase four times.

50. Define dielectric constant and write its formula.

Ans: Dielectric constant is defined as the ratio of the capacitance of a parallel plate capacitor with an insulating substance as medium between the plates to its capacitance with vacuum or air as medium between them.

$$\varepsilon_r = C_{med}/C_{vac}$$

Topic XV: Electric Polarization:

51. What is polarization and how dipoles are formed in dielectric?

Ans: The atoms and molecules in a dielectric (insulator) material are electrically neutral. The centers of positive (nucleus) and negative (electrons) charges coincide with each other.

When dielectric is placed between the plates of capacitor, positive and negative charges in the molecules of dielectric are displaced under the effect field. As a result, one end of molecules show a negative charge and the other end an equal amount of positive charge.

Thus the molecules become dipoles, the dielectric is said to be polarized and the process is called polarization.

52. What is Dipole?

Ans: Two equal and opposite charges separated by a small distance form a dipole.

When a dipole is inserted between the plates of a capacitor, its molecules become dipoles under the effect of electric field.

53. What change takes place when polarization of dielectric occurs?

Ans: When a dielectric is placed in an external electric field, the charge arises as the result of redistribution of positive and negative charges within the dielectric.

54. Define electric polarization and electric dipole.

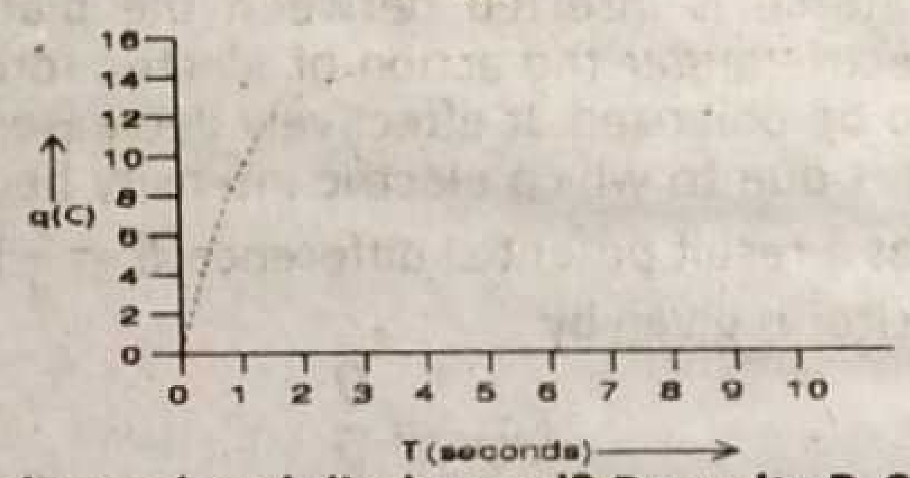
Ans: When dielectric is placed between the plates of capacitor, positive and negative charges of its molecules displace from their position. Positive charges are attracted towards negative plates and negative charges towards positive plate, dipoles are formed. This process is called **polarization**.
Two equal and opposite charges separated by a small distance is called a **dipole**.

Topic XVII: Charging and discharging of capacitor:

55. Define Time Constant for RC Circuit. Also draw (q-t) graph for charging of a capacitor in RC Circuit.

Ans: The time required by the capacitor to deposit 0.63 times the equilibrium charge q_o is called time constant. The product of R and C has the dimensions of time. So, this product is known as time constant.

t = RC

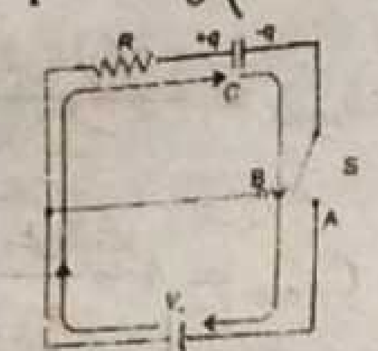


56. How a capacitor is charged and discharged? Draw its R-C circuit.
OR Draw a graph between (q-t) for charging and discharging of a capacitor in case of R-C circuit.

Ans: __Charging of a Capacitor__

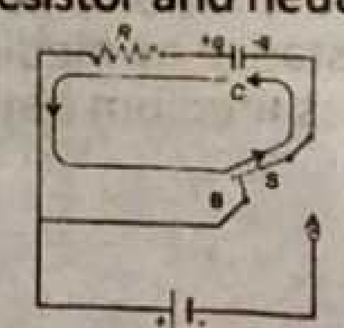
When switch is set at point A, battery starts charging the capacitor through resistor.

$$q = CV_o\left(1 - e^{-\frac{t}{RC}}\right)$$



__Discharging of a Capacitor__

When switch is set at point B then charge $+q$ on the left plate can flow in anti-clockwise direction through the resistor and neutralize the charge $-q$ on the right plate.



How fast or how slow the capacitor is charging or discharging depends on the product RC, called time constant. Capacitor charges or discharges sooner when the time constant is small.

57. Verify that an ohm times Farad is equivalent to second. (2 Times)
OR Show that t = RC.
OR Prove that unit of series RC circuit is second.

Ans: Since $V = IR$

By putting $I = \frac{q}{t}$, we get $V = \frac{q}{t}R$

$$R = \frac{Vt}{q}$$

Since $q = CV$

So $R = \frac{Vt}{CV}$

$$R = \frac{t}{C}\quad,\quad RC = t$$

In terms of units $ohm \times farad = second$
Hence it is proved that ohm times farad equals second.

58. What depend on the slow or fast charging and discharging of a capacitor?

Ans: How fast or how slow the capacitor is charging or discharging, depends upon the product of the resistance and the capacitance called time constant. $RC = t$
Capacitor is charged or discharged rapidly when RC is small.

59. What is time constant? (3 Times)

Ans: The time required by the capacitor to deposit 0.63 times the equilibrium charge q_o is called time constant.
The product of R and C has the dimensions of time. So, this product is known as time constant. t = RC
If the time constant is small then the capacitor will be charged rapidly.

60. How much is the amount of charge at start of discharging of capacitor and start of charging of a capacitor.

Ans: Discharging begins at t = 0 when $q_o = cv_o$ and decreases gradually to zero.
At the start of charging q = 0 at t = 0 and increases gradually with time till it reaches its equilibrium value $q_o = cv_o$.

61. Define charging and discharging of a capacitor.

Ans: **Charging:** The R-C combination is connected to a battery which starts charging the capacitor through the resistor. The charges build up gradually to the equilibrium value.
Discharging: When battery is removed and R-C circuit is closed charge +q on one plate flows through the resistor and neutralize the charge −q on the other plate. Discharging begins and charge decreases gradually to zero.

LONG QUESTIONS OF CHAPTER-12 ACCORDING TO ALP SMART SYLLABUS-2020

Topic V: Electric Flux:

1. Calculate the electric flux through a closed surface enclosing a charge 'q' in it.
2. Define electric flux. Show that electric flux due to point charge 'q' placed at the center of a sphere is equal to $\frac{q}{\varepsilon_o}$. **(2 times)**
3. Define electric flux. Find electric flux through a surface enclosing charge. **(3 times)** What is electric flux? Explain

Topic VIII: Gauss's Law:

4. State Gauss's Law and find electric intensity between two oppositely charged parallel plates. **(2 Times)**
5. State Gauss's law. Derive relation for electric intensity at a point near an in infinite sheet of charge. **(4 times)**

Topic IX: Electric Potential:

6. Define electric potential. Calculate the electric potential at the point due to a point charge. **(5 times)**
7. Define electric potential. Derive on equation for electric potential at a point due to a point charge.
8. What is electric potential? Find the electric potential at a point due to a point charge.

Topic XII: Charge on an Electron by Millikan's Method:

9. Describe Millikan's Oil drop method for determination of charge on an electron.

Topic XIV: Capacitance of parallel plate Capacitor:

10. Define capacitance. Derive the expression for capacitance of a parallel plate capacitor
11. What is capacitor? Find the capacitance of parallel plate capacitor.
12. Define capacitor and capacitance. Find an expression for the capacitance of a parallel plate capacitor when a dielectric material is inserted between the plates. **(5 times)**

13. Derive the relation for capacitance of a parallel plate capacitor and hence define Dielectric Constant. **(2 times)**

14. Define capacitor and capacitance. Derive the formula for energy stored in a capacitor.

15. Define capacitor and capacitance. Find an expression for the capacitance of a parallel plate capacitor when vacuum is present between the plates of capacitor.

Topic XVI: Energy store in a capacitor:

16. What is the capacitor? Show that energy density for a capacitor which has electric field strength E is given by $\frac{1}{2}\varepsilon_r\varepsilon_0E^2$. **(2 times)**

17. Define capacitor and capacitance. Derive the formula for energy stored in a capacitor. **(4 times)**

18. Define capacitor and capacitance. Find an expression for the capacitance of a parallel plate capacitor when vacuum is present between the plates of capacitor.

19. What is capacitor? Show that energy density for a capacitor which has electric field strength E is given by $\frac{1}{2}\varepsilon_r\varepsilon_o E^2$.

Numerical Problems OF CHAPTER-12 ACCORDING TO ALP SMART SYLLABUS-2020

1. **Two opposite points charges each of magnitude q are separated by a distance $2d$. What is the electric potential at a point P midway between them?** (Example No. 12.3)

Ans: According to the given conditions

$$V_+ = \frac{1}{4\pi\varepsilon_0}\frac{q}{d}$$

And $$V_- = -\frac{1}{4\pi\varepsilon_0}\frac{q}{d}$$

Thus $$V = V_+ + V_-$$

$$V = \frac{1}{4\pi\varepsilon_0}\frac{q}{d} - \frac{1}{4\pi\varepsilon_0}\frac{q}{d}$$

$$\boxed{V = 0}$$

So potential at P due to opposite charges is zero.

2. **A particle having a charge of 20 electrons on it falls through a potential difference of 100 $volt$. Calculate the energy by it in electron volts. (6 times)** (H.W)

Ans: It is given that

$$n = 20\ eletrons$$
$$e = 1.6 \times 10^{-19}\ C$$
$$q = ne = 20 \times 1.6 \times 10^{-19}$$
$$\Delta V = 100\ V$$
$$\Delta(K.E.) = ?$$

Since $$\Delta(K.E.) = q\Delta V$$

$$\Delta(K.E.) = (20 \times 1.6 \times 10^{-19})(100)$$

In electron volts $$\Delta(K.E.) = \frac{(20\times1.6\times10^{-19})(100)}{1.6\times10^{-19}}$$

$$\Delta(K.E.) = 2000\ eV \boxed{= 2.0 \times 10^3\ eV}$$

3. **A particle carrying a charge of $2e$ falls through a p.d of $3.0\ V$. Calculate the energy acquired by it.** **(3 Times)** (Example No. 12.4)

Ans: It is given that

$$q = 2e$$
$$\Delta V = 3.0\ V$$

The energy acquired by the particle is

$$\Delta(K.E.) = q\Delta V$$
$$\Delta(K.E.) = (2e)(3V)$$
$$\Delta(K.E.) = 6\ eV$$
$$\Delta(K.E.) = 6 \times 1.6 \times 10^{-19}\ J \boxed{= 9.6 \times 10^{-19}\ J}$$

Topic XIII: Capacitor:

4. **A capacitor has a capacitance of $2.5 \times 10^{-8}F$. In charging process, electrons are removed from one plate and placed on the other one. When a potential difference between the plates is $450\ V$, how many electrons have been transferred?** (C.W)

Ans: Given that

$$C = 2.5 \times 10^{-8}F$$
$$V = 450\ V$$
$$e = 1.6 \times 10^{-19}C$$
$$n = ?$$

Since $$Q = ne$$

$$number\ of\ electron = n = \frac{Q}{e}$$

But $Q = CV$

So $$n = \frac{CV}{e}$$

$$n = \frac{2.5 \times 10^{-8} \times 450}{1.6 \times 10^{-19}}$$

$$\boxed{n = 7.03 \times 10^{13}\ electrons}$$

Topic XVI: Energy store in a capacitor:

5. **The electronic flash attachment for a camera contains a capacitor for storing the energy used to produce the flash. In one such unit, potential difference between the plates of a 750 uF capacitor is 330V. Determine the energy which is used to produce the flash.** (C.W)

Ans: It is given that

$$C = 750\ uF = 750 \times 10^{-6}F$$
$$V = 330\ V$$
$$Energy = E = ?$$

Energy stored in a capacitor is given as,

$$E = \frac{1}{2}CV^2$$

Putting the values we get,

$$E = \frac{1}{2} \times 750 \times 10^{-6} \times (330)^2$$

$$E = \frac{1}{2} \times 750 \times 10^{-6} \times 330 \times 330 \boxed{= 40.8\ J}$$

ALP SMART SYLLABUS 2020

1. In Millikan oil drop experiment, an oil drop of mass $4.9\times10^{-15}\,kg$ is balanced and held stationary by the electric field between two parallel plates. If the potential difference between the plates is 750 V and the spacing between them is 5.0 mm, calculate the charge on the droplet. Assume $g = 9.8\,ms^{-2}$. Example 12.5

Sol:

Mass of the drop $= 4.9\times10^{-15}$ kg

Potential difference $= V = 750\,V$

Spacing between plates = d = 5.0 mm = $5.0\times10^{-3}\,m$

Charge on the droplet = q= ?

Calculations:

When charge is stationary, then

$F_e = F_g$

qE=mg

$q\times\frac{V}{d} = mg \quad \left[As\ E = \frac{V}{d}\right]$

$q = \frac{mdg}{V}$

Putting the values, we get

$q = \frac{4.9\times10^{-15}\times9.8\times5\times10^{-3}}{750} = \frac{240.1}{750}\times10^{-15-3}$

$q = 0.32\times10^{-18}$

$q = 3.2\times10^{-19}\,C$

2. The time constant of a series RC circuit is t = RC, Verify that an ohm times farad is equivalent to second. Example 12.6

Sol:

The time constant of a series circuit = t=RC

To prove:

$1\ ohm\times1\ farad = 1\,second$

Proof:

According to Ohm's law

V=IR

Putting $I = \frac{q}{t}$, we have

$V = \frac{q}{t}R$

Or $R = \frac{Vt}{q}$ ...(1)

According to equation

$q = CV$

Or $C = \frac{q}{v}$ ...(2)

Multiplying equation (1) and (2), we get

$RC = \frac{Vt}{q}\times\frac{q}{V}$

Or $RC = t$

Hence, $1\ ohm\times1\ farad = 1\,second$

Where ohm is the unit of resistance R.

3. Compare magnitudes of electrical and gravitational forces exerted on an object (mass = 10.0 g. charge = $20.0\,\mu C$) by an identiacal object that is placed 10.0 cm from the first. (G= $6.67\times10^{-11}\,Nm^2\,kg^{-2}$) (C.W)

Sol:

As the two objects are identical, therefore their masses and charges are equal to each other, thus $m_1 = m_2 = 10g = \frac{10}{1000}kg = 0.01\,kg$

$q_1 = q_2 = 20\,\mu C = 20\times10^{-6}\,C$

Distance between charges = r= 10cm= 0.1 m

Gravitational constant = G= $6.67\times10^{-11}\,Nm^2kg^{-2}$

and $K = \frac{1}{4\pi\epsilon_0} = 9\times10^9\,Nm^2C^{-1}$

$\frac{Electrical\ force}{Gravitational\ force} = \frac{F_e}{F_g} = ?$

Using Columbus's law

$F_e = \frac{1}{4\pi\varepsilon_o}\frac{q_1q_2}{r^2}$

Putting the values, we get

$F_e = 9\times10^9\times\frac{20\times10^{-6}\times20\times10^{-6}}{(0.1)^2}$

$F_e = \frac{9\times400\times10^{-3}}{0.01}$

$F_e = 360\,N$ ...(1)

Using Newtown's law of gravitation

$F_g = G\frac{m_1m_2}{r^2}$

Putting values, we get

$F_g = 6.67\times10^{-11}\times\frac{0.01\times0.01}{(0.1)^2}$

$F_g = 6.67\times10^{-11}\times\frac{10^{-4}}{0.01}$

$F_g = 6.67\times10^{-13}\,N$ ...(2)

Dividng eq. (1) by eq. (2) we get

$\frac{F_e}{F_g} = \frac{360}{6.67\times10^{-13}} = 53.9\times10^{13}$

or $\frac{F_e}{F_g} = 5.4\times10^{14}$

OBJECTIVES (MCQ'S) OF CHAPTER-13 ACCORDING TO ALP SMART SYLLABUS-2020

Topic III: Resistivity and its dependence upon temperature:

1. $mho\ m^{-1}$ is the SI unit of: (3 times)
(A) Conductivity (B) Conductance (C) Resistance (D) Capacitance
2. Reciprocal of resistance is called: (2 times)
(A) Conductance (B) Resistor (C) Conductivity (D) Resistivity
3. Material having positive temperature co-efficient is:
(A) Carbon (B) Copper (C) Silicone (D) Germanium
4. A battery of 50 volts is attached to a series combination of $5\Omega, 0\Omega$ and 10Ω. The current in the circuit is:
(A) 2 amp (B) 3.34 amp (C) 10 amp (D) 20 amp
5. Conductors have conductivities of the order of:
(A) $10^3(\Omega m)^{-1}$ (B) $10^7(\Omega m)^{-1}$ (C) $10^{-7}(\Omega m)^{-1}$ (D) $10^{-6}\Omega$
6. A wire of uniform area of cross section 'A' and length 'L' is cut into two equal parts. The resistivity of each part is: (2 times)
(A) Doubled (B) Half (C) Remains the same (D) Increases three times
7. Temperature co-efficient of resistivity is measured in: (3 Times)
(A) Ωk (B) Ωm (C) K^{-1} (D) K
8. A certain wire has a resistance R, the resistivity of another wire of an identical material with the first, except for twice its diameter is:
(A) $\frac{1}{4}$R (B) 4R (C) 2R (D) Same as R
9. Temperature coefficient of resistance (α) is equal to:
(A) $\frac{R_t+R_0}{R_0\Delta t}$ (B) $\frac{R_0-R_t}{R_0\Delta t}$ (C) $\frac{R_t-R_0}{R_0\Delta t}$ (D) None of these
10. The SI unit of resistivity is:
(A) Ohm-m^{-1} (B) Ohm-m^{0} (C) Ohm-m^{1} (D) Ohm-m^{2}
11. Specific resistance of a material depends upon:
(a) Length (b) Area (c) Temperature (d) Both A & B
12. A substance having the negative temperature coefficient of resistivity out of the following is:
(A) Iron (B) Tungsten (C) Carbon (D) Gold
13. By increasing the temperature of conductor, the flow rate of charges)
(A) Increases (B) Remains constant (C) Changes exponentially (D) Decrease

Topic IV: Colour Code for Carbon Resistances:

14. The color code for carbon resistance usually consists of:
(A) 3 bands (B) 4 bands (C) 2 bands (D) 7 bands
15. If fourth band on a carbon resistor is of silver colour then its tolerance is: (2 Times)
(A) ±1% (B) ±5% (C) ±10% (D) ±20%
16. The numerical value of violet colour in colour code resistors is:
(A) 0 (B) 06 (C) 05 (D) 07
17. The numerical value of green colour in colour code carbon resistor is:
(A) 0 (B) 3 (C) 5 (D) 8
18. The color of strips on a carbon resistor from extreme left is yellow, black and red respectively. Its resistance is:
(A) 4 $k\Omega$ (B) 400 Ω (C) 40 Ω (D) 40 $k\Omega$
19. In colour code of resistance orange colour represents:
(A) 0 (B) 1 (C) 2 (D) 3

20. IF fourth band is missing on resistance, its tolerance is: (2 Times)
(A) ± 5 % (B) ± 10 % (C) ± 15 % (D) ± 20 %
21. Colour code of yellow colour is:
(A) 2 (B) 3 (C) 4 (D) 5
22. Resistance tolerance for gold colour is:-
(a) ± 50% (b) ± 30 % (c) ± 20 % (d) ± 5 %
23. The numerical value of balck colour in carbon resistors is:
(A) 0 (B) 1 (C) 2 (D) 3

Topic V: Rheostate:

24. A rheostat can be used as: (2 times)
(A) Potential divider (B) Rectifier (C) Amplifier (D) Oscillator

Topic VI: Electric Power and Power dissipation in Resistor:

25. Power output is given by:
(A) $\frac{E^2R}{(R+r)^2}$ (B) $\frac{E^2R}{(R+r)+4Rr}$ (C) I^2R (D) All of these
26. If a resistor of resistance R is connected across a battery of internal resistance 'r' then output power will be maximum when: (2 times)
(A) R = ¼ r (B) R = r (C) R = 2r (D) R = 4r

Topic VII: Electromotive force and Potential Difference:

27. If a resistor is transversed in the opposite direction of current then the change in potential is:
(A) Zero (B) Negative (C) Positive (D) Constant
28. Terminal potential difference of a battery of internal resistance 'r' & emf ε is:
(A) $V = \varepsilon + Ir$ (B) $V = \varepsilon - Ir$ (C) $V = \frac{\varepsilon - r}{I}$ (D) $V = \frac{I}{\varepsilon - r}$
29. The relation of emf of two cells $\frac{E_1}{E_2}$ is =:
(A) $\frac{l_2}{l_1}$ (B) $\frac{l_1}{l_2}$ (C) $\frac{1}{l_1 l_2}$ (D) $l_1 \times l_2$
30. The potential difference between the head and tail of an electric eel is:
(a) 600 volts (b) 700 volts (c) 800 volts (d) 900 volts
31. The product of charge and potential difference is:
(A) Flux (B) Current (C) Engery (D) Power

Topic VIII: Kirchhoof's Rules:

32. Kirchhoff's first rule is based on conservation of:
(A) Energy (B) Voltage (C) Charge (D) Mass

2018

33. What is the resistance of a carbon resistor which has bands brown, black and brown:
(a) 100 Ohm (b) 1000 Ohm (c) 10 Ohm (d) 1.0 Ohm
34. The current flowing through each resistor of equal resistance in parallel combination is:
(a) Same (b) Different (c) zero (d) infinite
35. The maximum power is delivered to a load resistance 'R' when the internal resistance of the source is:
(a) Zero (b) Infinite (c) Equal to 'R' (d) Equal to $\frac{R}{2}$
36. Kirchhoff's second rule is based on: (2 Times)
(A) Energy conservation (B) Mass conservation
(C) Charge conservation (D) Momentum conservation
37. What is the colour code for 52MΩ±5% resistance:
(A) Red Green Blue Gold (B) Green Red Blue Gold
(C) Yellow Red Blue Gold (D) Green Red Violet Gold
38. The resistance of a conductor of length L, cross-sectional area 'A' and resistivity 'ρ' is given by:

(A) $R=\frac{\rho}{AL}$ (B) $R=\rho AL$ (C) $R=\rho\frac{L}{A}$ (D) $R=\rho\frac{A}{L}$

2019

39. A resistor of resistance 'R' is cut into two equal parts of resistance R/2, its resistivity becomes:
(A) half (B) remains same (C) double (D) four times

40. Siemen is the unit of:
(A) Resistivity (B) Resistance (C) Conductivity (D) Conductance

41. In carbon resistors, which colour band indicates the tolerance of ±10%?
(A) White (B) Silver (C) Gold (D) Violet

42. For an open circuit, terminal potential difference 'V_t' is:
(A) V_t=2emf (B) V_t=emf (C) V_t>emf (D) V_t<emf

ANSWERS OF THE MULTIPLE CHOICE QUESTIONS

1	2	3	4	5	6	7	8	9	10	11
A	A	B	B	B	C	C	D	C	C	C
12	13	14	15	16	17	18	19	20	21	22
C	D	B	C	D	C	A	D	D	C	D
23	24	25	26	27	28	29	30	31	32	33
A	A	A	B	C	B	B	A	C	C	A
34	35	36	37	38	39	40	41	42		
A	C	A	B	C	B	D	B	B		

SHORT QUESTIONS OF CHAPTER-13 ACCORDING TO ALP SMART SYLLABUS-2020

Topic III: Resistivity and its dependence upon temperature:

1. Why does the resistance of a conductor rise with a temperature? (11 times) (C.W)

Ans: As the temperature of the conductor rises, the amplitude of vibration of atoms increases and hence the probability of their collision with free electrons also increases which results in increase of resistance of conductor.

2. Do bends in a wire effect its electrical resistance? (10 times) (C.W)

Ans: No, bends in a wire do not affect its electrical resistance.
Electrical resistance is given as

$$R=\rho\frac{L}{A}$$

It shows that resistance depends upon length of the wire L and area of cross-section A. Thus the bends in a wire do not affect its electrical resistance.

3. Is the filament resistance lower or higher in a 500 watt, 220 volt light bulb than in a 100 watt, 220 volt bulb? (14 times) (C.W)

Ans: Since

$$P=\frac{V^2}{R}$$
$$R=\frac{V^2}{P}$$

For $P=500\ W$ and $V=220\ V$, we get

$$R=\frac{(220)^2}{500}$$
$$R=96.8\ \Omega$$

And
For $P=100\ W$ and $V=220\ V$, we get

$$R=\frac{(220)^2}{100}$$
$$R=484\ \Omega$$

Thus
It is clear that the filament resistance is loweredin a$500\ W, 220\ V$ bulb than in a $100\ W, 220\ V$.

4. Write down the value of equivalent resistance for three resistors R_1, R_2 and R_3 when joined in: (a) series (b) parallel

Ans: In a series combination

$$R_{eq}=R_1+R_2+R_3$$

and
In a parallel combination

$$\frac{1}{R_{eq}}=\frac{1}{R_1}+\frac{1}{R_2}+\frac{1}{R_3}$$

5. What is the negative co-efficient of temperature?

Ans: If the resistance of a substance decrease with an increase in temperature, then it is termed as negative coefficient of temperature.
For example, silicon and germanium have negative coefficient of temperature.

6. What is thermistor? Describe its two uses. (2 times)
OR What is thermistor? Give its two applications. (2 Times)
OR What are thermistors? How they are used?

Ans: Thermistors are heat sensitive resistors. Thermistors with positive temperature coefficient of resistance as well as negative temperature coefficient of resistance are available.
They are used for accurate measuring of temperature up to $10\ K$. They are used as temperature sensors.

7. Differentiate between resistance and resistivity. Give their unit.

Ans: **Resistance:** The opposition against the flow of current is known as resistance. The SI unit of resistance is Ohm.

$$R=\frac{V}{I}$$

Resistivity: The resistance of a meter cube of a material is called resistivity.

$$\rho=\frac{RA}{L}$$

Its unit is ohm-meter.

8. A wire of length 10m has resistance 100Ω. If the wire is stretched to increase its length three times. What will be its new resistance?

Ans: As we know that $R=\rho\frac{L}{A}$
It shows that the resistance R is directly related to the length L, so if a wire of 100Ω is stretched three times then its resistance will also increase three times. Thus new resistance in stretched wire of 30m will be 300Ω.

9. What is thermistor? Write its principle.

Ans: It is a heat sensitive resistor which is made up of metal oxides semiconductor materials which operates when exposed to heat thus converting changes of temperature into electrical voltage which is duly processed.
The resistance of thermistor changes with the change in temperature is its working principle.

10. Define temperature coefficient of resistivity.

Ans: The temperature coefficient of resistivity is defined as fractional change in resistivity per kelvin rise in temperature. Its unit is K^{-1}.

$$\alpha=\frac{\rho_t-\rho_o}{\rho_o t}$$

11. Define Resistance. Also define its unit.

Ans: **Resistance:** The opposition against the flow of current is known as resistance.
The SI unit of resistance is Ohm.

Ohm: If a current of 1A flows through a conductor when a potential difference of 1V is applied across its ends then the resistance of conductor will be 1Ω (Ohm).

12. Define temperature coefficient of resistance. Give its unit.
OR
What is temperature co-efficient of resistance?
OR
Define temperature co-efficient of resistance and write its formula. (3 times)

Ans: The temperature coefficient of resistance is defined as fractional change in resistance per kelvin rise in temperature. Its unit is K^{-1}.
Mathematically,

$$\alpha = \frac{R_t - R_o}{R_o t}$$

13. Give two substances having negative temperature co-efficient. Also define temperature co-efficient.

Ans: The temperature coefficient of a resistance is defined as fractional change in resistance per kelvin rise in temperature. Its unit is K^{-1}.
Substances like Ge and Si have negative temperature coefficients.

14. Define resistivity and electrolysis.

Ans: The resistance of a meter cube of a material is called **resistivity.**
Certain liquids such as dilute sulphuric acid or copper sulphate solution conduct electricity due to some chemical reactions that take place within them. The study of this process is known as **electrolysis.**

15. Differentiate between resistivity and conductivity.

Ans: The resistance of a meter cube of a material is called resistivity. It is denoted by ρ. It is measured in Ωm.
Conductivity is the reciprocal of resistivity. It is denoted by σ.

$$\sigma = 1/\rho$$

It is measured in $\Omega^{-1}m^{-1}$.

Topic IV: Colour Code for Carbon Resistances:

16. Find the resistance and tolerance of a resistor having color bands starting with brown, green, red and finisher with gold

Ans: The color codes are as follows

Brown	1	*1st digit*
Green	5	*2nd digit*
Red	2	*number of zeros*

Therefore *Resistance* = 1500 Ω
and *Tolerance* = ± 5 %

17. What is the resistance of colour code resister having colours yellow, white, orange and silver respectively? What is its tolerance? (C.W)

Ans: The color codes are as follows

Yellow	4	*1st digit*
White	9	*2nd digit*
Orange	3	*Number of zeros*

Therefore *Resistance* = 49000 Ω
and *Tolerance* = ± 10 %

18. Give the color code.

Ans: Color code is

Black	0
Brown	1
Red	2
Orange	3
Yellow	4
Green	5
Blue	6
Violet	7

Grey	8
White	9

19. What is meant by Tolerance'? Also give one example.
OR What is meant by tolerance of a resistor?
OR What do you meant by tolerance of a resistor? How is it expressed by different colours? (3 times)

Ans: Tolerance means the possible variation in the value of resistance of a carbon resistor from a marked value. In case of silver and gold band its value is ±10% and ±5%, respectively.
For example, for a silver band resistor of 1000 Ω, its actual value may be anyone between 900 Ω and 1100 Ω which means ±10% tolerance.

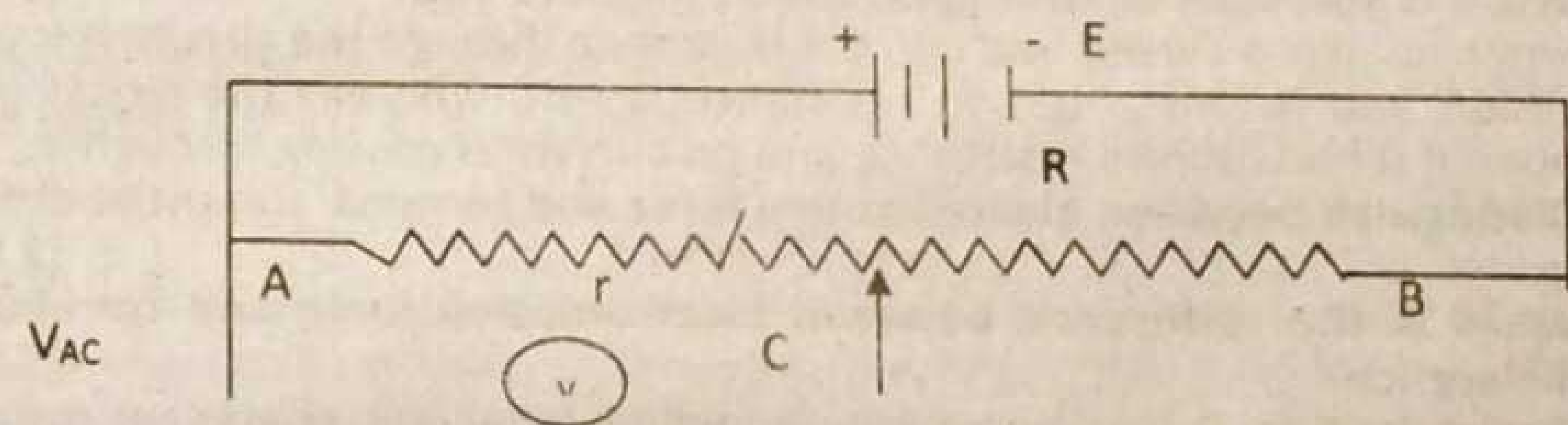
20. What is meant by tolerance? Find the resistance of a resistor with red, green, orange and gold respective bands.

Ans: Tolerance means the possible variation from the marked value.
For silver band tolerance is ±10% and for gold band is ±5%.
The resistance of given resistor is = (25000 ± 5%) Ω

Topic V: Rheostate:

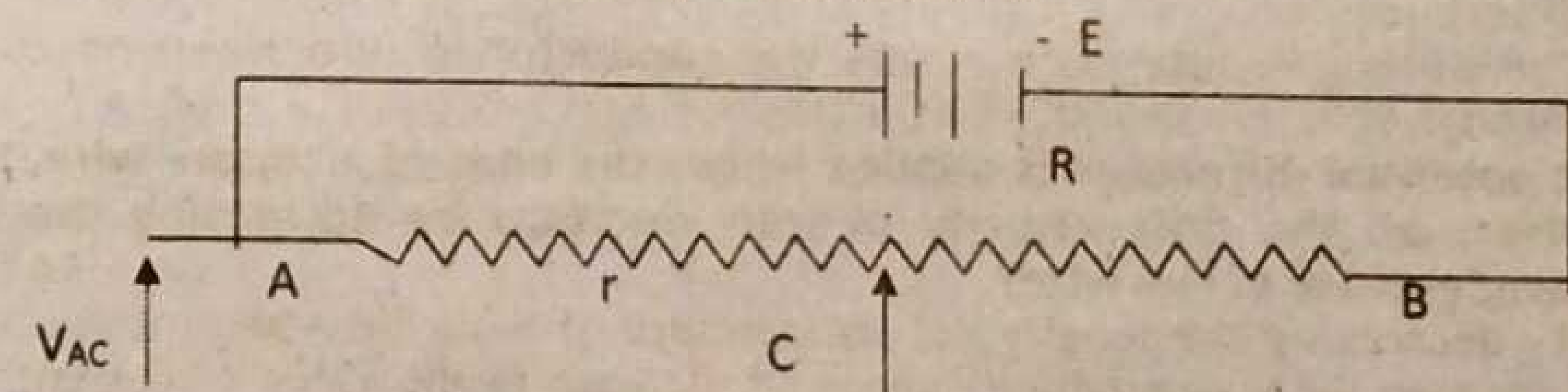
21. Describe a circuit that will give continuously varying potential. (8 times) (C.W)

Ans: A potential divider or potentiometer is a circuit that will give continuously varying potential. A potentiometer is a three-terminal resistor with a sliding contact that forms an adjustable voltage divider. Potentiometers are made from Rheostates.



22. How can a rheostat be used as potential divider?

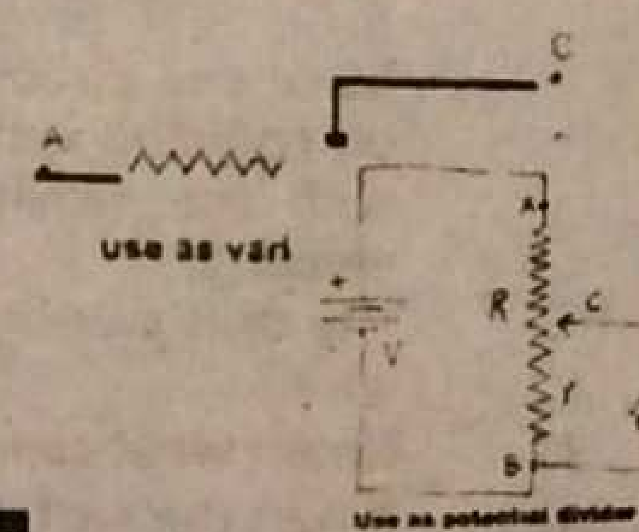
Ans: By adjusting the sliding contact resistance of the rheostat can be altered which in turn would regulate the potential offered by the cell E to the main circuit. And thus a rheostat can be used as a potential divider.



23. Write two uses of rheostat and draw their diagrams. (2 times)
OR What are the uses of rheostat?

Ans: (i) Rheostat can be used as a variable resistor.

(ii) Rheostat can be used as a potential divider circuit.



$$V_{BC} = \frac{r}{R} V$$

Topic VII: Electromotive force and Potential Difference:

24. What is effect on drift velocity of free electrons by increasing potential difference? (2 times)

Ans: By an increase in potential difference, drift velocity will also increase. Because by increasing potential difference, the current also increases i.e. $V \propto I$

25. A potential difference is applied across the ends of a copper wire. What is the effect on the drift velocity of the free electrons by increasing the potential difference? **(3 times) (C.W)**

Ans: Drift velocity is $v_d = \frac{\Delta V}{nepL}$

Clearly $v_d \propto \Delta V$

Thus, drift velocity of electron increases with increase in potential difference.

26. Why the terminal potential difference of a battery decreases when the current drawn from it is increased? **(5 times) (C.W)**

Ans: The terminal potential difference is $V_t = \varepsilon - Ir$

Clearly

When I is large, the factor Ir becomes large and V_t becomes small. Hence terminal potential difference of a battery decreases when current drawn from it is increased.

27. A voltmeter cannot read the exact EMF of the cell. Why? **(2 times)**

Ans: When a voltmeter is connected across a cell, it will draw some current from the cell and a small potential droptakes place due to the current flowing through the internal resistance of the cell. As a result, the actual emf of the cell decreases and the voltmeter cannot read exact value.

It can be measured accurately by a potentiometer.

28. What is short circuit and open circuit mean to you? **(3 times)**

Ans: when switch is closed and current is passing through the circuit. It is called closed circuit and in this situation resistance is zero whereas the circuit is said to be open if it had infinite resistance and no current is passing through it.

29. Distinguish between electromotive force and terminal potential difference. **(2 times)**

OR What is the difference between electromotive force and terminal potential difference? **(2 times)**

Ans: <u>**Electromotive force:**</u>The energy supplied to a unit charge in moving it from negative to positive electrode inside the source is called electro motive force.

The emf is always present even when no current is drawn through the cell.

<u>**Terminal potential difference**</u>The potential difference across the terminals of a cell or battery when current is being drawn from it is called terminal potential difference.

The potential difference across the conductor is zero when no current flows through it.

30. A potential difference is applied across the ends of a copper wire. What is the effect on the drift velocity of free electrons by decreasing the length and temperature of the wire? **(4 Times)**

Ans: By decreasing the length and temperature of wire, the value of resistance in the wire also decreases which causes an increase in the value of current. Hence, the drift velocity of free electrons also increases.

31. Briefly describe the current through a metallic conductor and drift velocity.

Ans: In a metallic conductor, free electrons are in random motion with the speed of several hundred km/s at the room temperature.

If the ends of wire are connected to a battery, the free electrons experience a force and directed to move in the $-\vec{E}$ direction. The accelerating electrons keep on colliding with atoms of the conductor and transfer their energy to the lattice with the result that the electrons acquire an average velocity, called **drift velocity**.

The drift velocity is of the order of 10^{-3}m/s. A steady current is established in the wire.

32. Under what conditions emf of cell and terminal potential difference become equal.

Ans: When the switch is open, no current passes through the cell. In this case, the voltmeter reads the emf "E" as terminal potential difference "V_t".

$$E = V_t + Ir$$

Topic VIII: Kirchhoff's Rules:

33. Give statements of Kirchhoff 1st rule and 2nd rule. **(5 times)**

Ans: <u>**Kirchhoff's 1st Rule**</u>

The sum of all currents meeting at a point in the circuit is zero.

$$\sum I = 0$$

<u>**Kirchhoff's 2nd Rule**</u>

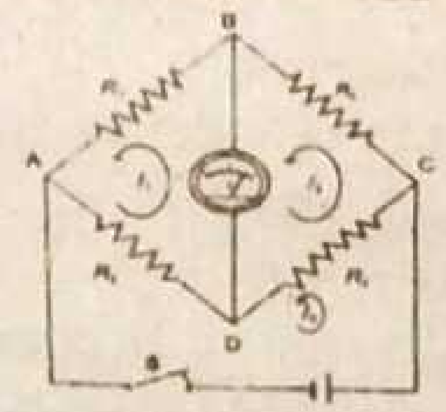
The algebraic sum of all potential changes in a closed circuit is zero.

$$\sum V = 0$$

Topic IX: Wheatstone Bridge:

34. What is wheat stone bridge? Write down its relation for finding unknown resistance? **(3 times) (C.W)**

Ans: It is an electrical circuit which can be used to find the unknown resistance of a wire.



It consists of four resistances connected in the form of a mesh ,galvanometer, battery and a switch. And unknown resistance can be found as

$$\frac{R_1}{R_2} = \frac{R_3}{R_4}$$

35. Why does no current pass through galvanometer in a balanced wheat stone bridge although the two keys in the circuit are closed?

Ans: No current pass through the galvanometer when wheat stone bridge is balanced. Because at this stage, both the terminals of the galvanometer are at the same potential. Hence no current will flow through it.

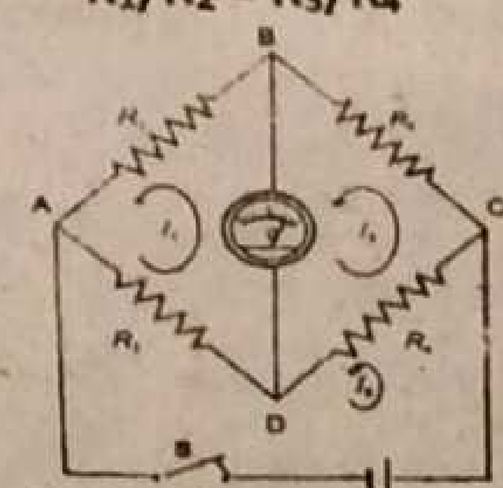
36. How a Wheatstone bridge is used to determine an unknown resistance? (4 times)

OR What is wheatstone bridge?

Ans: Wheatstone bridge is an especially designed electrical circuit used to calculate the accurate value of any unknown resistance. It consists of four resistances, a galvanometer, a battery and a switch connected in as shown in fig.

When the switch is closed current passes through galvanometer and then the three known resistances R_1, R_2 and R_3 are adjusted in such a way that galvanometer shows no deflection. In this balanced condition the fourth unknown resistance R_4 can be calculated by using this relation.

$$R_1/R_2 = R_3/R_4$$



Topic X: Potentiometer:

37. Why potentiometer is accurate measuring meter?

Ans: The voltage measured using potentiometer is the voltage across the terminals of the cell when current is not flowing through it. This voltage is exactly the emf of the cell.

Further, the accuracy of a potentiometer can be increased to a great extent by increasing the length of the "potentiometer wire."

LONG QUESTION'S OF CHAPTER-13
ACCORDING TO ALP SMART SYLLABUS-2020

Topic III: Resistivity and its dependence upon temperature:

1. Define resistivity and explain its dependence upon temperature. Also derive a relation for temperature co-efficient in terms of resistivity. **(2 times)**

Topic VI: Electric Power and Power dissipation in Resistor:

2. Determine the electric power dissipated in a resistor carrying current.
3. Define Electric power. Also explain how power is dissipated in resistors?

Topic VIII: Kirchhoof's Rules:

4. State Kirchhoff rules and explain the voltage rule.
5. Define Kirchhoff 2nd rule, by applying this rule derive an expression for unknown, resistance by wheat stone bridge.

Topic IX: Wheatstone Bridge:

6. What is wheat stone bridge? Describe its construction and working. How can it be used to find the unknown resistance of a wire? **(4 times)**
7. What is Wheatstone bridge? Explain and prove the principle of Wheatstone bridge.

Topic X: Potentiometer:

8. What is potentiometer? Give its construction and how can it be used to find unknown emf. **(2 times)**
9. Describe construction and working of a potentiometer.
10. What is Potentiometer? How it can be used as: **(2 times)**
    (i) Potential Divider (ii) Measuring of emf of a cell

Numerical Problems OF CHAPTER-13
ACCORDING TO ALP SMART SYLLABUS-2020

Topic II: Ohm's Law:

1. The potential difference between the terminals of a battery in open circuit is $2.2\ volts$. When it is connected across a resistance of $5\ \Omega$. The potential falls to $1.8\ volt$. Calculate the current and the internal resistance of battery. **(2 times)** **(Example 13.4)**

Ans: Given that $E = 2.2\ V$

$$R = 5\ \Omega$$
$$V = 1.8\ V$$
$$I = ?$$
$$r = ?$$

Since $V = IR$

$$I = \frac{V}{R}$$
$$I = \frac{1.8}{5}$$
$$\boxed{I = 0.36\ A}$$

And $E = V + Ir$

$$r = \frac{E - V}{I}$$
$$r = \frac{2.2 - 1.8}{0.36}$$
$$r = \frac{0.4}{0.36}\ \boxed{= 1.11\ \Omega}$$

Topic III: Resistivity and its dependence upon temperature:

2. A rectangular bar of iron is $2\ cm$ by $2\ cm$ in cross section and $40\ cm$ long. Calculate its resistance if the resistivity of iron is $11 \times 10^{-8}\ \Omega m$. **(7 times)** **(H.W)**

Ans: Given that $area\ of\ bar = A = 2\ cm \times 2\ cm = 4\ cm^2$

$$A = 4 \times 10^{-4} m^2$$
$$length\ of\ bar = L = 40\ cm = 0.4\ m$$
$$resisitivity\ of\ bar = \rho = 11 \times 10^{-8}\ \Omega m$$
$$resistance = R = ?$$

Since $R = \frac{\rho L}{A}$

$$R = \frac{11 \times 10^{-8} \times 0.4}{4 \times 10^{-4}}\ \boxed{= 1.1 \times 10^{-4}\ \Omega}$$

3. A platinum wire has resistance of $10\ \Omega$ at 0^oC and $20\ \Omega$ at 273^oC. Find the value of temperature coefficient of resistance of platinum. (4 times) **(Example No. 13.3)**

Ans: Given that $R_o = 10\ \Omega$

$$R_t = 20\ \Omega$$
$$t_o = 0^oC = 0 + 273 = 273\ K$$
$$t_t = 273^oC = 273 + 273 = 546\ K$$
$$t = t_t - t_o = 546 - 273$$
$$t = 273\ K$$

Since $\alpha = \frac{R_t - R_o}{R_o t}$

$$\alpha = \frac{20 - 10}{10 \times 273}$$
$$\alpha = \frac{10}{10 \times 273}$$
$$\alpha = \frac{1}{273\ K}\ \boxed{= 3.66 \times 10^{-3} K^{-1}}$$

4. The resistance of an iron core at 0^oC is $1 \times 10^4\Omega$. What is the resistance at 500^oC if the temperature coefficient of resistance of iron is $5.2 \times 10^{-3} K^{-1}$. **(6 times)** **(H.W)**

Ans: Given that $resistance\ at\ 0^oC = R_o = 1 \times 10^4 \Omega$

$$resistance\ at\ 500^oC = R_t = ?$$
$$\alpha = 5.2 \times 10^{-3} K^{-1}$$
$$t_o = 0^oC = 0 + 273 = 273\ K$$
$$t_t = 500^oC = 500 + 273 = 773\ K$$
$$t = t_t - t_o = 773 - 273 = 500\ K$$

Since $\alpha = \frac{R_t - R_o}{R_o t}$

$$\alpha R_o t = R_t - R_o$$
$$R_t = \alpha R_o t + R_o$$
$$R_t = (\alpha t + 1) R_o$$

$$R_t = (5.2\times10^{-3}\times500+1)1\times10^4 \boxed{=3.6\times10^4\Omega}$$

5. **0.75 A current flows through an iron wire when a battery of 1.5 $volt$ is connected across its ends. The length of the wire is 5.0 m and its cross-sectional area is $2.5\times10^{-7}m^2$. Compute the resistivity of iron.** (Example No 13.2)

Ans: Given that $V = 1.5\,V$

$$I = 0.75\,A$$
$$A = 2.5\times10^{-7}m^2$$
$$L = 5\,m$$
$$\rho = ?$$

Since $V = IR$

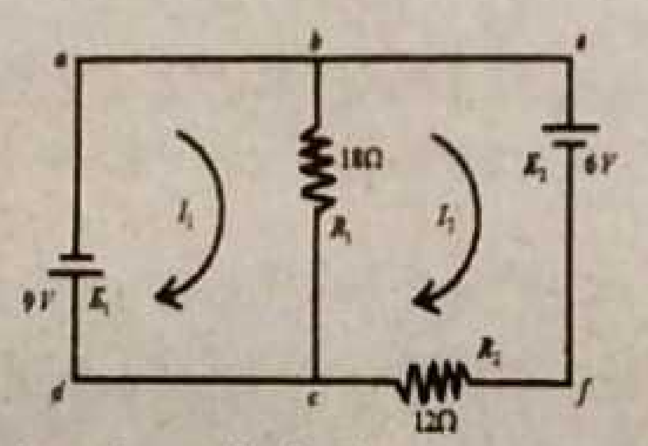
$$R = \frac{V}{I}$$
$$R = \frac{1.5}{0.75}$$
$$R = 2\,\Omega$$

Now $\rho = \frac{RA}{L}$

$$\rho = \frac{2\times2.5\times10^{-7}}{5} \boxed{=1\times10^{-7}\,\Omega m}$$

Topic VIII: Kirchoof's Rules:

6. **Find the current which flows in all the resistance of the circuit of figure given below:** **(2 times)** (C.W)



Ans: Let I_1 & I_2 are the currents flowing through the loops in clockwise direction.
Applying kirchhoff's 2nd rule to loop abcda,

$$-E_1 + (I_1 - I_2)R_1 = 0$$
$$-9 + (I_1 - I_2)18 = 0$$
$$-9 + 18I_1 - 18I_2 = 0$$
$$-1 + 2I_1 - 2I_2 = 0$$
$$2I_1 - 2I_2 = 1 \quad \text{--------(i)}$$

Applying kircchoff's 2nd rule to loop befcb

$$-E_2 + I_2R_2 + (I_2 - I_1)R_1 = 0$$
$$-E_2 + I_2R_2 + I_2R_1 - I_1R_1 = 0$$
$$-6 + 12I_2 + 18\,I_2 - 18I_1 = 0$$
$$-6 + 30I_2 - 18I_1 = 0$$
$$-18\,I_1 + 30\,I_2 = 6$$
$$-3I_1 + 5I_2 = 1 \quad \text{--------(ii)}$$

Multiplying equation (i) by 3 and equation (ii) by 2 and then adding

$$6I_1 - 6I_2 = 3$$
$$-6I_1 + 10I_2 = 2$$

$$4\,I_2 = 5$$
$$I_2 = \frac{5}{4}$$
$$I_2 = 1.25\,A$$

Putting this value in equation (i) $2I_1 - 2(1.25) = 1$

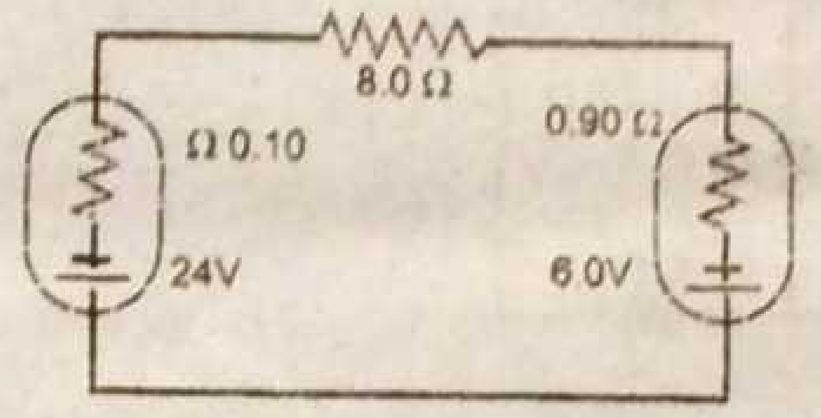
$$2I_1 - 2.5 = 1$$
$$2I_1 = 1.2.5$$
$$2I_1 = 3.5$$
$$I_1 = \frac{3.5}{2} = 1.75\,A$$

Current through the resistor R_1 is $= I_1 - I_2 = 1.75 - 1.25 = 0.5\,A$

Current through the resistor R_2 is $I_2 = 1.25\,A$

ALP SMART SYLLABUS 2020

1. Calcuate terminal potential difference of each of cells in circuit of Figure. (C.W)



Sol:

Potential of cell $E_1 = 24V$

Resistance of cell $E_1 = r_1 = 0.10\Omega$

Potential of cell $E_2 = 6.0V$

Resistance of cell $E_2 = r_2 = 0.9\Omega$

Resistance in circuit = R= 8

Terminal potential difference of $E_1 = V_{t1} = ?$

Terminal potential difference of $E_2 = V_{t2} = ?$

As r_1, r_2 and R are in series, so their equivalent resistance 'Re' is

$$R_e = r_1 + r_2 + R$$
$$R_e = 0.10 + 0.90 + 8$$
$$R_e = 9.0\,\Omega$$

As two batteries are opposite to each other , so effective emf (i.e net voltage) in the circuit is

$$E = E_1 - E_2$$
$$E = 24 - 6 = 18V$$

Thus current 'I' in the circuit is

$$I = \frac{E}{R_e} = \frac{18}{9} = 2A$$

Terminal potential difference of cell E_1 is V_{t1} and is given as

$V_{t1} = E_1 - Ir$

$V_{t1} = 24 - 2\times0.10 = 24 - 0.20$

$V_{t1} = 23.8V$

The current in battery E_2 flows in reverse direction to its conventional current, so it is taken as -ve . This terminal potential difference of cell E_2 is

$V_{t2} = E_2 - (-I)r_2$

$V_{t2} = E_2 + Ir_2$

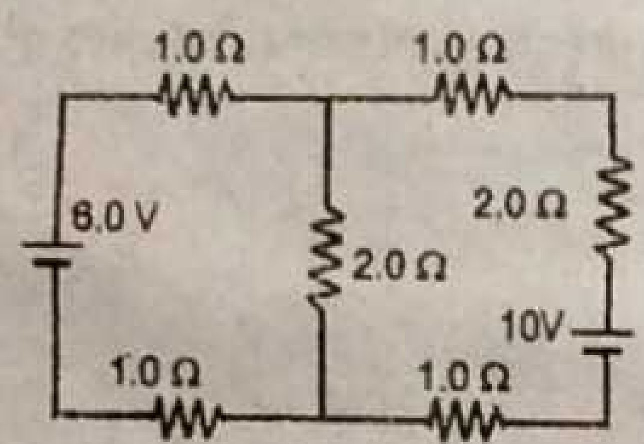
Putting the values, we get

$V_{t2} = 6.0 + 2.0\times0.9$

$V_{t2} = 6.0 + 1.8$

$V_{t2} = 7.8V$

2. Find the current and power dissipated in each resistance of the circuit, shown in Figure. (C.W)



Sol:

EMF of first cell = $E_1 = 6V$

EMF of 2nd cell = $E_2 = 10V$

$R_1 = 1.0\Omega$, $R_2 = 2.0\Omega$

$R_3 = 1.0\Omega$, $R_4 = 1.0\Omega$

$R_5 = 2.0\Omega$, $R_6 = 2.0\Omega$

(i) Current through each resistance:

$I_1 = ?\ ,\ I_2 = ?, I_3 = ?$

$I_4 = ?,\ I_5 = ?,\ I_6 = ?$

(ii) Power dissipated in $R_1, R_2, R_3, R_4, R_5, R_6$

Suppose I_1 and I_2 are the current flowing thorugh loop 'abcda' and 'befcb' respectively in the clock direction as shown in figure.

Now applying Kirchoff's 2nd rule on loop 'abcda'

$E_1 - IR_1 - (I_1 - I_2)R_2 - I_1R_3 = 0$

Putting values, we get

$6 - I_1(1.0) - (I_1 - I_2)(2) - I_1(1.0) = 0$

$6 - I_1 - 2I_1 + 2I_2 - I_1 = 0$

$6 - 4I_1 + 2I_2 = 0 \Rightarrow 3 - 2I_1 + I_2 = 0$

$-2I_1 + I_2 = -3$ ....(1)

Using Kichhoff's 2nd rule for the loop 'befcb' we get

$-E_2 - I_2R_6 - (I_2 - I_1)R_2 - I_2R_4 - I_2R_5 = 0$

$-10 - I_2(1.0) - (I_2 - I_1)(2.0) - I_2(1.0) - I_2(2.0) = 0$

$-10 - I_2 - 2I_2 + 2I_1 - I_2 - 2I_2 = 0$

$-10 - 6I_2 + 2I_2 = 0$

$2I_1 - 6I_2 = 10$ 2

Adding eq. (1) and (2), we get

$-2I_1 + I_2 = -3$

$+2I_1 - 6I_2 = +10$

$-5I_2 = 7$

$I_2 = -\frac{7}{5}$

$I_2 = -1.4A$

Putting I_2 in eq. (1), we get

$-2I_2 - 1.4 = -3$ or $-2I_1 = -1.6$

$I_1 = 0.8A$

Negative sign with I_2 whows that current in loop 'befcb' is in anti-clock direction.

(i) Current through each resistance

Current through $R_1 = 0.8A$

Current through $R_2 = I_1 - I_2 = 0.8 - (-1.4) = 0.8 + 1.4 = 2.2A$

Current through $R_3 = 0.8A$

Current through $R_4 = 1.4A$

Current through $R_5 = 1.4A$

Current through $R_6 = 1.4A$

(ii) Power dissipated in each resistance

As formula for power dissipation is $P = I^2R$, thus

Power dissipated in $R_1 = P_1 = I_1^2R_1 = (0.8)^2\times(1.0) = 0.64W$

Power dissipated in $R_2 = P_2 = (I_1 + I_2)^2R_2 = (0.8 + 1.4)^2\times2 = 9.68W$

Power dissipated in $R_3 = P_3 = I_1^2R_3 = (0.8)^2\times(1.0) = 0.64W$

Power dissipated in $R_4 = P_4 = I_2^2R_4 = (1.4)^2\times(1.0) = 1.96W$

Power dissipated in $R_5 = P_5 = I_2^2R_5 = (1.4)^2\times(2.0) = 3.92W$

Power dissipated in $R_6 = P_6 = I_2^2R_6 = (1.4)^2\times(1.0) = 1.96W$

OBJECTIVES (MCQ'S) OF CHAPTER-14 ACCORDING TO ALP SMART SYLLABUS-2020

Topic II: Force on a current carrying conductor in a uniform magnetic field

1. The magnetic force is simply a: **(4 Times)**
(A) Reflecting force (B) Deflecting force (C) Restoring force (D) Gravitational force

2. If the number of turns become double but length remain same, then magnetic field in the solenoid become.
(A) Zero (B) remain same (C) half (D) double

3. A current carrying conductor experiences maximum magnetic force in a uniform magnetic field when it is placed.
(A) Perpendicular to field (B) Parallel to field
(C) At an angle of 60° to the field (D) At an angle of 180° to the field

Topic III: Magnetic Flux and Flux Density:

4. Tesla can be written as: **(3 times)**
(A) NAm^{-1} (B) $NA^{-1}m^{-1}$ (C) $N^{-1}Am^{-1}$ (D) $NA^{-1}m$

5. A metal rod of length 1m is moving at a speed of $1ms^{-1}$ in a direction making an angle of $30°$ with 0.5T magnetic field. The emf produce is:
(A) 0.25N (B) 0.25V (C) 2.5V (D) 2.5N

6. Magnetic density at a point due to the current carrying conductor be determined by: **(2 times)**
(A) Ampere's law (B) Faraday's law (C) Newton's law (D) Lenz's law

7. SI unit of magnetic flux is:
(A) Wb (B) Wbm^{-2} (C) Wbm^{-1} (D) T

8. Magnitude of the motional emf induced in a conducting bar of length L moving through a magnetic field B with velocity V is:
(A) $\varepsilon = BvL$ (B) $\varepsilon = BvL\cos\theta$ (C) $\varepsilon = BvL\sin\theta$ (D) $\varepsilon = Bv/L$

9. Magnetic flux density is measured in: **(2 times)**
(A) Weber (B) Weber/m^2 (C) Tesla – m (D) Gauss

10. The magnetic flux $\emptyset_B$ is equal to:
(A) $\vec{B}.\vec{A}$ (B) $\vec{B} \times \vec{A}$ (C) $\frac{B}{A}$ (D) BA Sinθ

11. The SI unit of magnetic induction is: **(3 times)**
(A) Weber (B) Tesla (C) Newton (D) Weber per meter

12. The unit of magnetic flux:
(a) $N.mA^{-1}$ (b) $Nm^{-1}A$ (c) $Nm^{-1}A^{-1}$ (d) NmA

13. 1 tesla is equal to:
(a) 1 NmA^{-1} (b) 1 $Nm^{-1}A^{-1}$ (c) 1 Nm^{-1} (d) 1 $Nm^{-2}A^{-1}$

14. S.I. Unit of E is NC^{-1} and that of B is $NA^{-1}m^{-1}$, then the unit of $\frac{E}{B}$ is:
(A) $m^{-1}s^{-1}$ (B) ms^{-1} (C) ms^{-2} (D) ms

15. If the coil is wound on an iron core, the magnetic flux through it will:
(A) Zero (B) Increases (C) Decreases (D) Ramain constant

16. Energy stored per unit volume in magnetic field is called:
(A) Electric flux (B) Energy density (C) Work (D) Power

Topic IV: Ampere's Law:

17. $\sum_{r=1}^{N}(B.\Delta L)_r = \mu_o I$ is the relation for:
(A) Millikan's law (B) Gauss's law (C) Ampere's law (D) Lenz's law

18. The field inside a solenoid is given by:
(A) $\mu_o nI$ (B) $\mu_o n^2 I$ (C) $\mu_o nI^2$ (D) $\mu_o NI$

19. In current carrying long solenoid the magnetic field produced does not depend upon.
(A) The radius of solenoid (B) Number of turns per unit length
(C) Current flowing through solenoid (D) All of above

20. The magnetic inside a current carrying long solenoid is:
(A) Non-uniform (B) Weak (C) Uniform and strong (D) Zero

Topic V: Force on a moving charge in a uniform magnetic field:

21. Direction of the vector $\vec{L} \times \vec{B}$ is same as:
(A) Force (B) Magnetic field (C) Electric field (D) Length of conductor

22. Magnetic force on a moving charged particle is perpendicular to the ______:
(A) Magnetic field (B) Electric field (C) Velocity of the particle (D) A and C both

23. In equation $\varepsilon = -VBL\sin\theta$, θ is angle between:
(A) I and B (B) V and B (C) V and L (D) L and B

24. If a charge is free to move in an electric field, then acceleration will be:
(A) $\frac{qE}{m}$ (B) qEm (C) $\frac{q}{Em}$ (D) $\frac{m}{qE}$

25. Force on a moving charge in a uniform magnetic field will be maximum, when the angle between V and B is:
(A) $0°$ (B) $30°$ (C) $60°$ (D) $90°$

26. An electron of mass 'm' and charge 'e' is moving in a circle of radius 'r' with speed 'v' in a uniform magnetic field of strength B, then:
(A) $r \propto m$ (B) $r \propto B$ (C) $r \propto \frac{1}{v}$ (D) $r \propto \frac{1}{m}$

27. A positively charged particle of certain mass may be held suspended (at rest) in electrical field of suitable strength if the field is directed:
(A) Outward (B) Inward (C) Upward (D) Downward

28. The unit of permeability (μ_o) of free space is:
(A) Wbm^{-2} (B) $WbmA^{-1}$ (C) $WbA^{-1}m^{-1}$ (D) $WbAm^{-1}$

29. Work done on charged particle moving in uniform magnetic field is: **(2 times)**
(A) Maximum (B) Zero (C) Minimum (D) Negative

30. The value of permeability of free space in SI unit is: **(3 Times)**
(A) $4\pi \times 10^{-9} WbA^{-1}m^{-1}$ (B) $4\pi \times 10^{-7} WbA^{-1}m^{-1}$
(C) $4\pi \times 10^{-10} WbA^{-1}m^{-1}$ (D) $4\pi \times 10^{7} WbA^{-1}m^{-1}$

31. Millikan and flecher could determine the charge on oil droplets in:
(A) Thermal equilibrium (B) Electrical equilibrium
(C) Mechanical equilibrium (D) Unstable equilibrium

32. If a charge is at rest in a magnetic field then force on charge is: **(3 times)**
(A) Zero (B) q $(\vec{V} \times \vec{B})$ (C) q VB sinθ (D) q VB cosθ

33. If F_1 and F_2 are forces acting on α-Particle and electron respectively, when moving perpendicular to the magnetic field then: **(2 times)**
(A) $F_1 = F_2$ (B) $F_1 > F_2$ (C) $F_1 < F_2$ (D) $F_1 = 4F_2$

34. An electron enters the magnetic field at right angle from left, *B* is into paper. The electron will be deflected:-
(a) Upward (b) Towards right (c) Downward (d) Towards left

35. When a charge is projected perpendicular to a uniform magnetic field, its path:
(a) Spiral (b) helix (c) ellips (d) circular

36. The charges moving perpendicular to magnetic field experience force:
(a) Maximum (b) minimum (c) zero (d) infinite

37. Force on moving charge in a magnetic field is given by:
(A) $F = q(\vec{B} \times \vec{V})$ (B) $\vec{F} = q(\vec{V} \times \vec{B})$ (C) $F = q(\vec{B} + \vec{V})$ (D) $F = q(\vec{B} - \vec{V})$

38. Which one of the following particles moving in the magnetic field cannot be deflected:
(A) α - particle (B) β - Particle (C) Electron (D) Neutron

39. A 5m wire carrying a current of 2A is at right angle to the uniform magnetic field of 0.5 weber/m². The force on the wire is:
(A) 2N (B) 4N (C) 5 N (D) 1.5 N

Topic VI: Motion of charge particle in electric and magnetic field:

40. The Lorentz force on a charged particle moving in electric field E and magnetic field B is given by: **(2 times)**
(A) $F = F_E + F_B$ (B) $F = F_E - F_B$ (C) $F = \frac{F_B}{F_E}$ (D) $F = F_B F_E$

41. The sum of electric and magnetic force is called:
(A) Maxwell force (B) Lorentz force (C) Newton's Force (D) Centripetal force

Topic VII: Determination of e/m value of an electron:

42. Charge to mass ratio of Neutron is: **(2 Times)**
(A) 1.758×10^{-11}C/kg (B) 9.58×10^{7}C/kg
(C) 1.758×10^{11}C/kg (D) Zero

43. $\frac{e}{m}$ of an electron is:
(A) $\frac{B^2r^2}{2V}$ (B) $\frac{Br^2}{2V}$ (C) $\frac{2V}{B^2r^2}$ (D) $\frac{2V^2}{B^2r^2}$

44. The value of $^e/_m$ is smallest for: **(3 times)**
(a) Proton (b) Electron (c) β-particle (d) Positron

45. $\frac{e}{m}$ of an electron is given by:
(A) $9.11 \times 10^{-31} \frac{C}{kg}$ (B) $1.61 \times 10^{-19} \frac{C}{kg}$ (C) $1.71 \times 10^{11} \frac{C}{kg}$ (D) $1.7 \times 10^{-11} \frac{C}{kg}$

Topic VIII: Cathode Ray Osciloscope:

46. The brightness of the input on CRO screen is controlled by: **(7 Times)**
(A) Cathode (B) Anode (C) Grid (D) Plato

47. In CRO, the output wave form of time base generator is: **(2 times)**
(A) Circular (B) Square (C) Sinusoidal (D) Saw-tooth

48. The CRO is used for:
(A) Displaying wave form of frequency (B) Displaying wave form of given vibration
(C) Converting A.C into D.C (D) Displaying wave form of given voltage

49. The velocity of an oscillating charge as it moves to and fro along the wire is:
(a) Changing (b) Constant (c) Infinite (d) Zero

50. Cathode Ray Oscilloscope works by deflecting beam of: **(4 times)**
(A) Neutrons (B) electrons (C) Protons (D) Positrons

51. Filament in C.R.O:
(A) Conductors (B) Insulators (C) Perfect conductors (D) Perfect insulators

52. If an electron of charge 'e' is accelerated through a potential difference v, it will acquire energy:
(A) Ve (B) V/2 (C) E/V (D) Ve²

53. The function of three anodes in a C.R.O is.
(A) To accelerate electrons only (B) To focus the electrons only
(C) To control the brightness of spot on screen (D) To accelerate and focus the electrons

Topic IX: Torque on a current carrying coil:

54. The relation for maximum value of deflecting couple is given by:
(A) $\tau = B/NIA$ (B) $\tau = BINA$ (C) $\tau = BNA$ (D) $\tau = BNA\sin\theta$

55. The grid in the cathode ray oscilloscope:
(A) Controls number of waves (B) Controls the brightness of spot formed
(C) Has positive potential with respect to cathode (D) Accelerates electrons

56. Beam of electrons are also called:
(A) Positive rays (B) X-rays (C) Cathode rays (D) Cosmic rays

57. Direction of torque on a current carrying coil is:
(A) Clock wise (B) Anti clock wise
(C) Regular reversal of clock and anti-clock wise (D) No direction

58. The couple C for the unit twist of the suspension wire can be decreased by:
(A) Increasing its length (B) Decreasing its length
(C) Increasing its diameter (D) It cannot be decreased

59. Torque on a current carrying coil has the equation:
(A) $\tau = q(V \times B)$ (B) $\tau = BILq$ (C) $\tau = BINA\cos\alpha$ (D) $\tau = NLAB\cos\alpha$

60. Torque is produced in a current carrying coil when it is placed in a:
(A) Magnetic field (B) Electric field (C) Gravitational field (D) Nuclear field

61. Torque on a current carrying coil is given by:
(a) ILB cos α (b) ILB cos sin α (c) IBA cos α (d) IBA sin α

Topic XI: Avometer - Multimeter:

62. In AVO meter the current is measure when number of low resistances are connected with galvanometer in:
(A) Series (B) Parallel (C) Series and parallel (D) Perpendicular

63. Useful device to measure resistance current and voltage is an electronic instrument called:
(A) Voltmeter (B) Ammeter (C) Ohmmeter (D) Digital Multimeter

64. An AVOmeter can also be called as:
(A) Digital multimeter (B) Digital voltmeter (C) Digital ammeter (D) Digital ohm-meter

2018

65. For a current carrying solenoid the term "n" has units as:
(a) No unit (b) m^{-1} (c) m^{-2} (d) m^{-3}

66. The magnetic force on an electron, travelling at 10^6 m/s parallel to the field of strength 1 Weber /m² is: **(3 times)**
(a) 10^{-12} N (b) Zero (c) 10^3N (d) 16×10^{-12}N

67. A charged particle having charge q is moving at right angle to magnetic field. The quantity which varies is:
(A) speed (B) kinetic energy (C) path of motion (D) Angular velocity

68. The force on current carrying conductor placed in magnetic field is expressed by:
(A) $\vec{F} = I\vec{L}.\vec{B}$ (B) $\vec{F} = I\vec{L} \times \vec{B}$ (C) $\vec{F} = I^2\vec{L} \times \vec{B}$ (D) $\vec{F} = I\vec{B} \times \vec{L}$

69. Two parallel wires carrying currents in opposite direction: **(2 times)**
(A) Repel each other (B) Attract each other
(C) Neither attract nor repel each other (D) Stick to each other

70. A current carrying conductor is placed in uniform magnetic field parallel to it. The magnetic force experienced by the conductor is:
(A) F = ILB (B) F = ILB sinθ (C) F = ILB cosθ (D) F is zero

71. If length of Solenoid is doubted but N same, $\vec{B}$ inside the Solenoid becomes:
(A) Half (B) Double (C) One Fourth (D) Four Times

72. A 50 mH coil carries a current of 2 Amp. The energy stored in its magnetic field is:
(A) 0.05 J (B) 0.1 J (C) 10 J (D) 50 J

73. The current flowing towards the reader can be represented by a symbol:
(A) Dot (B) Dash (C) Cross (D) Line

74. If current flowing through a solenoid becomes four times, then magnetic field inside it becomes:
(A) two times (B) three times (C) four times (D) half

75. The SI unit of flux density is: **(2 times)**
(A) $Nm^{-1}A^{-2}$ (B) $NA^{-1}m^{-1}$ (C) NAm^{-1} (D) $NA^{-1}m$

76. Two parallel wires carrying current in the opposite directions:
(A) may repel or attract each other (B) attract each other

(C) have no effect on each other (D) repel each other

2019

77. Magnetic field of 0.5 T is parallel to vector area of $1m^2$ of a coil, flux through the coil is:
(A) Zero (B) 5 web (C) 0.2 web (D) 0.5 web

78. The brightness of spot in CRO is controlled by:
(A) Cathode (B) Anode (C) Grid (D) Deflecting plates

79. The brightness of spot on CRO screen is controlled by:
(A) Anode (B) Cathode (C) Grid (D) Plates

80. S.I unit of magnetic permeability is:
(A) Wb A^{-1} m^{-1} (B) Wb m^2 (C) Wb mA^{-1} (D) Wb Am^{-1}

81. Formula for magnetic field due to solenoid is given by:
(A) $\mu_o I$ (B) $\mu_o nI$ (C) $\mu_o SI$ (D) $\mu_o nI$

82. The relation $B=\frac{\mu_o I}{2\pi r}$ is called:
(A) Ampere's law (B) Faraday's law (C) Lenz's law (D)Gauss's law

83. A 5m wire carrying current 2 A at right angle to uniform magnetic field of 0.5 T. The force on the wire is:
(A) 1.5 N (B) 5 N (C) 2.5 N (D) 4 N

84. When a charged particle is projected opposite to the direction of magnetic field, it experiences a force equl to:
(A) quB cosθ (B) quB sin90° (C) quB (D) zero

85. The Force acting in a particle moving under the influence of both Electric and Magnetic Field is equal to:
(A) $F = F_e - Fm$ (B) $F = F_e + Fm$ (C) $F = F_e \times Fm$ (D) $F = F_e / Fm$

86. The magnetic induction has the same unit as of:
(A) Flux (B) Flux density (C) Electric intensity (D) Magnetization

ANSWERS OF THE MULTIPLE CHOICE QUESTIONS

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
B	D	A	B	B	A	B	C	B	A	B	A	B	B	B
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
B	C	A	A	C	B	D	B	A	D	A	C	C	B	B
31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
B	A	B	A	D	A	B	D	C	A	B	D	C	A	C
46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
C	D	D	A	B	A	A	D	B	B	C	A	A	C	A
61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
C	B	D	A	B	B	C	B	A	D	A	B	A	C	B
76	77	78	79	80	81	82	83	84	85	86				
D	D	C	C	A	B	A	A	D	B	B				

SHORT QUESTIONS OF CHAPTER-14 ACCORDING TO ALP SMART SYLLABUS-2020

Topic I: Magnetic Field due to current in a straight long wire:

1. Can a charge at rest be set into motion by bringing a magnet close to it?

Ans: No a charge at rest cannot be set into motion by bringing a magnet close to it. Because $\vec{F} = q(\vec{v} \times \vec{B})$ only acts on moving charges.

2. On what factors the induced currents due to motional emf depend?

Ans: The current can be increased by the following factors:

i. Using a stronger magnetic field ii. Moving The loop faster
iii. Replacing the loop with a coil of many turns.

3. State the right hand palm rule.

Ans: If the middle finger of the right hand points in the direction of the magnetic field, the thumb in direction of current, the force on the conductor will be normal to the palm towards the reader.

4. Define electromagnetism and give the name of one device in which electromagnetism is used.

Ans: The branch of physics which deals with electricity and magnetism and the interaction between them is known as electromagnetism.

Electromagnetism is used in door bells, electric motors such as electric fan etc.

5. How might a loop of wire carrying a current be used as compass? How could such a compass distinguish between north and south pole?

Ans: A current carrying loop of wire generates a magnetic field which acts like the magnetic field of a small magnet. North and south poles of this magnet are found by right hand rule.
The magnetic compass shows the magnetic north and south poles which is aligned according to the earth's magnetic field.

Topic II: Force on a current carrying conductor in a uniform magnetic field:

6. Define Tesla and write its formula. **(2 times)**

Ans: If a magnetic field exerts a force of 1N on 1m length of the conductor placed at right angles to the magnetic field carrying a current of 1A then the strength of magnetic field is said to be one tesla.

$$1 \text{ T} = 1 \text{ NA}^{-1}\text{m}^{-1}$$

Topic III: Magnetic Flux and Flux Density:

7. Describe the change in magnetic field inside a solenoid carrying a steady current I, if the length of the solenoid is double but the number of turns remains the same. E **(7 Time)**

Ans: The magnetic field strength inside a current carrying solenoid is

$$B = \mu_0 nI$$

$$B = \frac{\mu_0 NI}{L}$$

By applying given conditions $B' = \frac{\mu_0 NI}{2L}$

$$B' = \frac{B}{2}$$

Thus on doubling the length of solenoid by keeping the turns constant, the magnetic field strength becomes one half of its original value.

8. A plane conducting loop is located in a uniform magnetic field that directed along the x-axis. For what orientation of the loop is the flux maximum? For what orientation is the flux minimum? E **(3 times) (C.W)**

Ans: Magnetic Flux is given as $\Phi_B = \vec{B}.\vec{A} = BA\cos\theta$

i. When vector area of the conducting loop is in the direction of magnetic field strength then flux will be maximum.

$$\Phi_B = BA\cos 0^o$$

$$\Phi_B = BA$$

i. When vector area of the conducting loop is perpendicular to magnetic field strength then flux will be minimum.

$$\Phi_B = BA\cos 90^o$$

$$\Phi_B = 0$$

9. Define magnetic flux give its unit. **(2 times)**

Ans: The number of magnetic lines of force passing through certain area element is called magnetic flux. Mathematically,

$$\Phi_B = \vec{B}.\vec{A}$$

$$\Phi_B = BA\cos\theta$$

Magnetic flux is a scalar quantity and its SI unit is NmA^{-1} which also called $weber\ (Wb)$.

10. Distinguish between magnetic flux and magnetic flux density. Write their SI units. **(5 times)**

OR Define magnetic flux and magnetic flux density. **(4 times)**

Ans: **Magnetic flux**: The number of magnetic lines of force passing through certain element of area is called magnetic flux. Magnetic flux is a scalar quantity and its SI unit is NmA^{-1} which is also called $weber\ (Wb)$.

Magnetic flux density: The magnetic flux per unit area of a surface perpendicular to magnetic field is called magnetic flux density. Its SI unit is $Nm^{-1}A^{-1}$ which is also called $tesla\ (T)$.

11. Define Energy density and give its equation.

Ans: The magnetic energy stored in the inductor per unit volume is referred as energy density. Mathematically, $U = \frac{1}{2}\frac{B^2}{\mu_o}$

12. Define magnetic flux and solenoid.

Ans: The number of magnetic field lines passing through a certain element of area is known as **magnetic flux** through that surface.

A **solenoid** is a long, tightly wound, cylindrical coil of wire. When current passes through such a coil, it behaves like a bar magnet.

13. Define magnetic flux and mention the factors upon which it depends.

Ans: The number of magnetic lines of force passing through certain element of area is called its magnetic flux.

$$\phi_B = \vec{B} \cdot \vec{A} = BA\cos\theta$$

It depends upon magnetic field intensity B, flat surface area A and an angle θ between the normal to the surface and a magnetic field.

14 Define magnetic flux and one tesla.

Ans: The number of magnetic field lines passing through a certain element of area is known as **magnetic flux** through that area.

A magnetic field is said to have a strength of **one tesla** if it exerts a force of one newton on one meter length of the conductor placed at right angles to the field when a current of one ampere passes through the conductor.

15 Define magnetic induction and tesla.

Ans: When a conductor is moved through a magnetic field, the electric current flow through the circuit. The emf produced in the conductor is called induced emf, and the current generated is called induced current. This phenomenon is called **electromagnetic induction.**

A magnetic field is said to have a strength of **one tesla** if it exerts a force of one newton on one meter length of the conductor placed at right angle to the field when a current of one ampere passes through the conductor.

Topic IV: Ampere's Law:

16. Describe change in magnetic field inside a solenoid carrying steady current I if the number of turns is double but the length remain same. **(3 Times)** **C.W**

Ans: The magnetic field strength inside a current carrying conductor is

$$B = \mu_0 nI$$

$$B = \frac{\mu_0 NI}{L}$$

By applying given conditions $B' = \frac{\mu_0(2N)I}{L}$

$$B' = 2B$$

Thus on doubling the number of turns of solenoid by keeping its length constant, the magnetic field strength becomes doubled of its original value.

17. What is Lorentz force? Give the role of electric and magnetic force in this regard. **(2 times)**

Ans: The vector sum of electric force and magnetic force is called Lorentz force.

$$\vec{F} = \vec{F_e} + \vec{F_b}$$

$$\vec{F} = q\vec{E} + q(\vec{v} \times \vec{B})$$

Only the electric force does work, while no work is done by the magnetic force which is simply a deflecting force.

18. A current in a conductor produces a magnetic field, which can be calculated by using Ampere's law. Since current is defined as the rate of flow of charge, what can you conclude about the magnetic field due to stationary charges? What about moving charges? **C.W**

Ans: In case of stationary charges, the rate of flow of charges is zero. $I = 0$

So there will be no magnetic field.

But, The moving charges produce current, so the magnetic field produced around the path of its motion similar to the magnetic field produced around a current carrying conductor.

19. Why is B non-zero outside a solenoid?

Ans: The magnetic field outside a solenoid is not zero. This is only true for an infinitely (thus unreal) long solenoid.

Infinitely long solenoids cannot be found in nature. The magnetic field outside a real solenoid is less dense than inside the solenoid and often one is only concerned with the field inside, which is approximately constant.

20. State ampere's law. Write down its formula. **(3 times)**

Ans: Ampere's law states that the sum of the quantities $\vec{B}.\overrightarrow{\Delta L}$ for all path elements into which the complete loop has been divided equals μ_o times the total current enclosed by the loop.

According to Ampere's law, $\sum_{r=1}^{N} \vec{B}.\overrightarrow{\Delta L} = \mu_o I$

21. Why does the picture on a TV screen become distorted when a magnet is brought near the screen? **(22 Times)**

Ans: As we know that when charges are moving in a certain region, a magnetic field is existed around the charges due to the flow of current.

The electrons emitted from electron gun produce their own magnetic field when they are moving towards the screen of the television. When a magnet is brought near the screen, the electrons emitting from the electron gun experience an external magnetic force $\vec{F} = q\ (\vec{v} \times \vec{B})$ and hence are deflected. Due to their change of path by outer magnet the picture will be distorted.

22. At a given instant, a proton moves in positive x direction in a region where there is a magnetic field in the negative z direction. What is direction of magnetic force? **C.W**

Ans: As we know that the magnitude of magnetic force $\vec{F}$ acting on a charge moving with velocity $\vec{v}$ inside a magnetic field $\vec{B}$ is given by,

$$\vec{F} = q\,(\vec{v} \times \vec{B})$$

According to Right Hand Rule, the direction of force $\vec{F}$ is perpendicular to the plane containing $\vec{v}$ and $\vec{B}$. As proton is moving along x-axis, magnetic field is directed along z-axis, therefore, the magnetic force will be directed along y-axis.

23. Give dimensions of permeability of free space μ_o.

Ans: From Ampere's law, for a solenoid

$$B = \mu_o\, n\, I$$

$$\frac{F}{IL} = \mu_o \frac{N}{L} I$$

$$\mu_o = \frac{F}{NI^2}$$

$$[\mu_o] = \frac{[F]}{[N][I]^2}$$

number of turns "N" being a constant is dimensionless, so

$$[\mu_o] = \frac{[MLT^{-2}]}{[I]^2}$$

$$[\mu_o] = [MLT^{-2}][I^{-1}]^2$$

$$[\mu_o] = [MLT^{-2}I^{-2}]$$

24. Is it possible to obtain an isolated north pole? Give reason.

Or Why is it impossible to have an isolated north or south pole of magnet? Explain.

Ans: No.

The source of magnetism of an atom is the electrons. Accepting this view of magnetism it is concluded that it is impossible to obtain an isolated north pole. The north pole is merely one side of a current loop. The other side will always be present as a south pole and these cannot be separated. This is an experimental reality

Saw-tooth voltage increases linearly with time for a period T and then drops to zero as shown in figure above.

Topic V: Force on a moving change in a uniform magnetic field:

25. If a charge particle moves in a straight line through some region of space, can you say that magnetic field in the region is zero? (8 Times) (C.W)

Ans: The magnitude of magnetic force on a charge particle is

$$F = qvB\sin\theta$$

Magnetic force will be zero due to the following reasons

i. Magnetic field strength B in the region is zero.

ii. Magnetic field is parallel or anti-parallel to the direction of motion.

26. Two charged particle are projected into a region where there is a magnetic field perpendicular to their velocities. If the charge is deflected in opposite directions, what you can say about them? (4 Times) (C.W)

Ans: When a charged particle is projected in a magnetic field, it will experience the magnetic force i.e. $\vec{F_b} = q(\vec{v} \times \vec{B})$

The magnetic force is a deflecting force. Thus if the charged particles are deflected in opposite direction, then particles are oppositely charged. i.e., one particle is positively charged and the other is negatively charged.

27. How can you use a magnetic field to separate isotopes of chemical element? (19 Times) (C.W)

Ans: Since isotopes of an element have same charge number but different mass number.

As we know that the radius of a charged particle inside a magnetic field is given as, $r = \frac{mv}{qB}$ or $r \propto m$

It shows that the isotopes projected from the same point at right angle to the magnetic field **B** will follow circular path of different radii due to their different masses. So, they can be distinguished easily.

28. Can a charged particle move through a magnetic field without experiencing any magnetic force? If so then how?

Ans: Yes, if a charged particle is moving parallel to magnetic field then magnetic force on it will be zero.

As $\vec{F} = q(\vec{v} \times \vec{B})$

$\Rightarrow F = qvB\sin 0^0 = qvB(0) = 0$

Topic VI: Motion of charge particle in electric and magnetic field:

29. Suppose that a charge 'q' is moving in a uniform magnetic field with a velocity V. Why is there no work done by the magnetic force that acts on the charge 'q'. (6 Times)

Ans: Work done is given as $W = \vec{F}.\vec{d} = Fd\cos\theta$

The magnetic force on a charged particle will act normal to the direction of motion of the particle i.e. $\vec{F} = q(\vec{v} \times \vec{B})$

$F = qvB$

So $\theta = 90^o$

and $W = Fd\cos 90^o$

$W = 0$

Thus we can say that magnetic force is a deflecting force and it cannot do any work.

30. Define Lorentz Force. Write its formula. (12 Times)

OR What is Lorentz Force?

Ans: The combined effect of electric force and magnetic force exerted on charged particle is called Lorentz force. Mathematically,

$$\vec{F} = \vec{F_e} + \vec{F_b}$$

$$\vec{F} = q\vec{E} + q(\vec{v} \times \vec{B})$$

Only the electric force does work, while no work is done by the magnetic force which is simply a deflecting force.

Topic VIII: Cathode Ray Osciloscope:

31. Briefly give the function of Filament, Cathode, Gird and plates in C.R.O.

Ans: **Filament:** It heats the cathode.

Cathode: It emits electrons.

Grid: It controls the number of electrons (brightness).

Plates: The two sets of plates are used to deflect the beam of electrons along x-axis and y-axis.

32. Write any two uses of CRO. (12 Times)

Ans: i. The CRO is used for displaying the waveform of a given voltage.

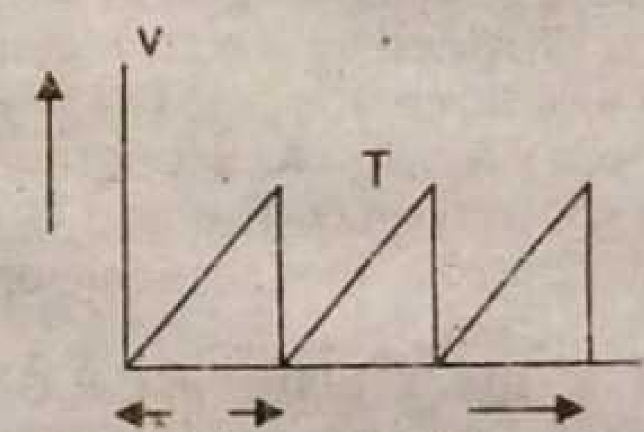
ii. Once the waveform is displayed, we can measure the voltage, its frequency and phase.

33. What is the function of grid in cathode ray oscilloscope? (7 Times)

Ans: Grid is at negative potential relative to cathode. It controls the number of electrons reaching the screen and thus controls the brightness of spot on the screen.

34. Draw Saw tooth voltage wave form and describe it.

Ans: A voltage that is applied across x plates is usually provided by a circuit that is built-in CRO and is called sweep or time base generator. Its output waveform is a saw tooth voltage of period T.



35. Define galvanometer and cathode ray oscilloscope. (2 Times)

Ans: Galvanometer: Galvanometer is a device used to detect the passage of current.

Cathode ray oscilloscope: Cathode ray oscilloscope (CRO) is a high speed graph plotting device.

36. Name the main parts of C.R.O. (3 Times)

OR Give name of compeoents of CRO.

Ans: A filament, cathode, grid (together they form election gun), anodes, horizontal deflection plates, vertical deflection plates and a florescent screen.

37. What is Time Base Generator? (3 Times)

OR Define sweep voltage.

Ans: Time Base Generator: A voltage that is applied across x plates is usually provided by a circuit that is built-in CRO and is called sweep or time base generator. Its output waveform is a saw tooth voltage of period T.

38. What is cathode ray oscilloscope? **(3 times)**

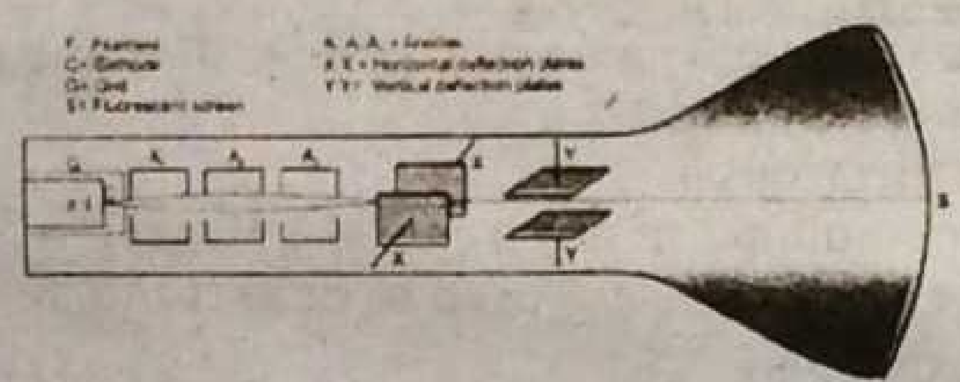
Ans: Cathode ray oscilloscope is a high speed graph plotting device. It is called cathode ray oscilloscope because it traces the desired waveform with a beam of electrons which are also called cathode rays.
It is mainly consists of
i. Electron gun
ii. Vertical Deflection plates
iii. Horizontal Deflection plates
iv. Fluorescent Screen

39. How can you explain the waveform of various voltages formed in CRO?

Ans: We can easily find the instantaneous value and peak value of the voltage with the help of calibration of y-axis in volts.
The time period can also be determined by using the time calibration of x-axis.
Information about the phase difference between two voltages can be obtained by simultaneously displaying their waveforms.

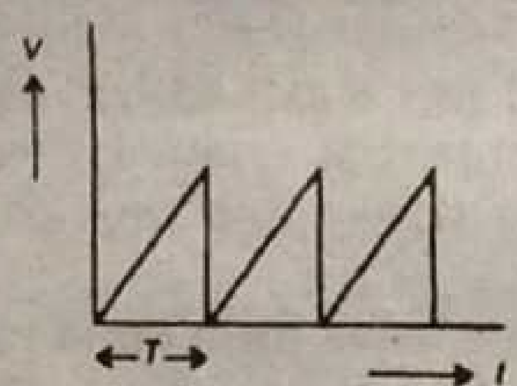
40. How the beam of electron is focused on the screen of CRO? Show it with diagram.

Ans: CRO works by deflecting beam of electrons as they pass through uniform electric field between the two sets of parallel plates as shown in figure below.
The deflecting beam then falls on a fluorescent screen where it makes a visible spot.



41. Draw saw-tooth voltage wave form and explain it.

Ans:



Saw tooth voltage waveform

42. Explain briefly the working of electron gun in CRO.

Ans: The beam of electrons is provided by electron gun which consists of an indirectly heated cathode, a grid and three anodes. The filament F heats cathode C which emits electrons. The anodes A_1, A_2, A_3 accelerate as well as focus the electronic beam to fixed spot on the screen S. The grid G is at a negative potential with respect to cathode. It controls the number of electrons and thus controls brightness of spot on the screen.

43 What is the function of 'X' and 'Y' plates in C.R.O?

Ans: A voltage applied between the x plates deflects the beam of electron horizontally on the screen i.e. Parallel to x – axis.
A voltage applied between the y – plates deflects the beam vertically on the screen i.e along y – axis.

44 What is CRO? What is the function of Grid in CRO?

Ans: **CRO** stands for cathode ray oscilloscope. It is a high speed graph plotting device. It traces the desired waveform by deflecting beam of electrons as they pass through uniform electric field between the two sets of parallel plates.
Grid controls the number of electrons reaching the screen and thus controls the brightness of spot on the screen.

Topic IX: Torque on a current carrying coil:

45. Is the possible to orient a current loop in a uniform magnetic field such that the loop will not tend to rotate? Explain. **(8 Times) (C.W)**

Ans: The torque experienced by a current carrying loop when placed in magnetic field is $\tau = NIBA\cos\alpha$
Clearly when plane of the coil makes and angle of 90^o with magnetic field, thetorque on the coil will be zero. In this condition,the coil will not tend to rotate.

46. What should be the orientation of a current carrying coil in magnetic field so that the torque acting upon the coil is: (a) maximum (b) minimum **(2 Times)**

Ans: The torque experienced by a current carrying loop when placed in magnetic field is
$$\tau = NIBA\cos\alpha$$
i. When plane of the coil makes and angle of 0^o with magnetic field, the torque on the coil will be maximum.
$$\tau = NIBA\cos 0^o$$
$$\tau = NIBA$$
ii. When plane of the coil makes and angle of 90^o with magnetic field, the torque on the coil will be zero or minimum.
$$\tau = NIBA\cos 90^o$$
$$\tau = 0$$

47. How can a current loop be used to determine the pressure of a magnetic field in a given region of space? **(12 Times)**

Ans: The torque experienced by a current carrying loop when placed in magnetic field is$\tau = NIBA\cos\alpha$
If the loop is deflected in a given region, then it confirms the presence of magnetic field, otherwise not.

48. What should be the orientation of a current carrying coil in a magnetic field so that torque acting upon the coil is maximum? **(2 times)**

Ans: The torque experienced by a current carrying loop when placed in magnetic field is
$$\tau = NIBA\cos\alpha$$
When plane of the coil makes an angle of 0^o with magnetic field, the torque on the coil will be maximum.
$$\tau_o = NIBA\cos 0^o$$
$$\tau_o = NIBA$$

49. A loop of wire is suspended between poles of a magnet with its plane parallel to the pole faces. What happens if a direct current is put through the coil? What happens if an alternating current is used instead?

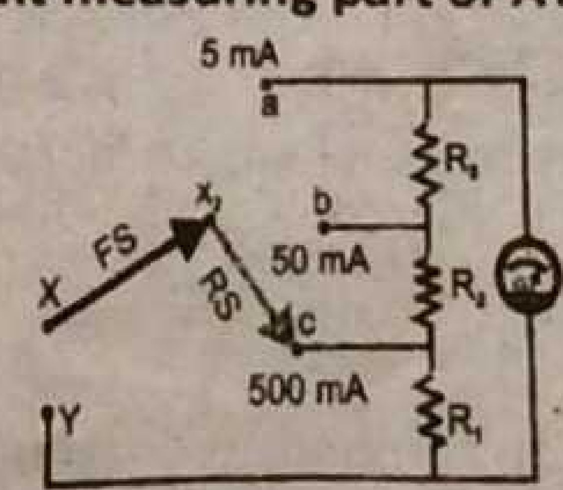
Ans: As the loop of wire is suspended between the poles of a magnet with its plane parallel to the pole faces, so, there will be no effect on the motion of the coil in both cases because the magnetic field becomes perpendicular to the plane of loop.
i.e $\alpha = 90°$
and $\tau = IBA\cos 90° = IBA \times 0 = 0$ $(\because \cos 90° = 0)$

Topic XI: Avometer-Multimeter:

50. Discuss briefly digital multi meter. (DMM) **(4 times)**

Ans: It is a digital version of an AVO meter. It is used to measure resistance, voltage and current. It has become very popular testing device because the digital values are displayed automatically with decimal point, polarity and the unit for voltage, current and resistance.
These meters are generally easier to use because they eliminate the human error that often occur in reading the dial of an ordinary AVO meter.

51. Draw a diagram of current measuring part of AVO meter.



52. Write the formula used to convert a galvanometer into a voltmeter. Why the resistance of voltmeter should be high?

Ans: Galvanometer can be converted into ammeter using the relation

$$R_h = \frac{V}{I_g} - R_g$$

A voltmeter is connected in parallel to the resistor to measure potential difference across it. It should have very high resistance so that practically, a very little current should pass through it and the current of the circuit should almost remain constant, so that it might measure the potential difference across a resistor accurately.

53. What is digital multimeter? Give its two advantages over AVO meter. (3 times)

Ans: It is a digital version of an AVO meter. It is used to measure resistance, voltage and current.

Advantages:

(i) The digital values are displayed automatically with decimal point, polarity and the unit for voltage, current and resistance.

(ii) These meters are generally easier to use because they eliminate the human error that often occur in reading the dial of an ordinary AVO meter.

54. What is AVO-meter? Explain.

Ans: It is an instrument which can measure current in amperes, potential difference in volts and resistance in ohms. It basically consists of a sensitive moving coil galvanometer which is converted into multirange ammeter, voltmeter or ohmmeter accordingly as a circuit.

LONG QUESTIONS OF CHAPTER-14 ACCORDING TO ALP SMART SYLLABUS-2020

Topic II: Force on a current carrying conductor in a uniform magnetic field:

1. Derive an expression for force acting on a current carrying conductor of length L placed in a uniform magnetic filed of strength B.

Topic IV: Ampere's Law:

2. Define Ampere's law. Calculate the magnetic field due to current flowing through a solenoid. **(3 times)**
3. State Amphere's law and apply it to find the felid due to a current carrying solenoid. **(9 Times)**

Topic V: Force on a moving change in a uniform magnetic field:

4. Find the force on moving charge in magnetic field.
5. A moving charge enters a uniform magnetic field. Derive a relation for magnetic force on that charge.
6. Derive expression for force on a moving charge in magnetic field? **(3 Times)**
7. Define magnetic field. Find the value of force on a moving positive charge in a magnetic field.

Topic VII: Determination of e/m value of an electron:

8. Define Lorentz force. Determine the e/m of an electron.
9. Explain how e/m (charge to mass ratio) for an electron is determined? **(4 Times)**
10. How can you find the relation of e/m of an electron?

Topic VIII: Cathode Ray Osciloscope:

11. What is cathode ray oscilloscope? Explain the functions of:
(i) Cathode (ii) Grid (iii) Anodes (iv) Deflecting plates (v)Sweep generator

Topic IX: Torque on a current carrying coil:

12. Establish a relation for the torque experienced by a current carrying rectangular coil in a uniform magnetic field.
13. Derive the expression for torque on current carrying coil in uniform magnetic field. **(3 Times)**

Numerical Problems OF CHAPTER-14 ACCORDING TO ALP SMART SYLLABUS-2020

Topic I: Magnetic Field due to current in a straight long wire:

1. A power line 10 m high carries a current 200 A. Find the magnetic field of the wire at the ground? (14 Times) (C.W)

Ans: Given that height of power line = h= $r = 10\ m$

$$I = 200\ A$$
$$B = ?$$

Using Ampere's law $B(2\pi r) = \mu_0 I$

$$B = \frac{\mu_0 I}{2\pi r}$$
$$B = \frac{4\pi \times 10^{-7} \times 200}{2\pi \times 10}$$
$$B = 40\times 10^{-7}\ T$$
$$B = 4 \times 10^{-6}\ T$$
$$\boxed{B = 4\ \mu T}$$

Topic IV: Ampere's Law:

2. What current should pass through a solenoid that is 50 cm long with 10000turns of copper wire so that it will have a magnetic field of 0.4 T? (7 Times) (H.W)

Ans: Given that $L = 50\ cm = 0.5\ m$

$$N = 10000$$
$$B = 0.4\ T$$
$$\mu_o = 4\pi \times 10^{-7}\ Wb/Am$$
$$I = ?$$

Since $B = \mu_0 n I$

$$I = \frac{B}{\mu_0 n}$$

Here, $n = \frac{N}{L} = \frac{10000}{0.5} = 20000\ turns/m$

Putting the values, we get

$$I = \frac{0.4}{4\pi \times 10^{-7} \times 20000}$$
$$I = 15.92\ A$$
$$\boxed{I \cong 16\ A}$$

3. A solenoid 15 cm long has 300 $turns$ of wire. A current of 5 $ampere$ flows through it. What is the magnitude of magnetic field inside the solenoid? (2 times) (Example No. 14.3)

Ans: Given that $length\ of\ the\ solenoid = l = 15\ cm = 0.15\ m$

$$number\ of\ turns = N = 300\ turns$$
$$current = I = 5\ A$$
$$number\ of\ turns\ per\ unit\ length = n = \frac{N}{l} = \frac{300}{0.15}$$
$$n = 2000\ turns/m$$
$$magnetic\ field = B = ?$$

Since

$$B = \mu_0 nI$$
$$B = 4\pi \times 10^{-7} \times 2000 \times 5$$
$$\boxed{B = 1.3 \times 10^{-2}\ Wbm^{-2}}$$

Topic VI: Motion of charge particle in electric and magnetic field:

4. How fast must a proton move in magnetic field of $2.50 \times 10^{-3}\ T$ such that the magnetic force is equal to its weight? **(6 Times)** **(H.W)**

Ans: Given that $mass\ of\ proton = m_P = 1.67 \times 10^{-27}\ kg$
$$charge\ on\ proton = q = 1.6 \times 10^{-19}\ C$$
$$magnetic\ field = B = 2.50 \times 10^{-3}\ T$$
$$velocity\ of\ proton = v = ?$$

According to given condition

Magnetic force = weight
$$F_B = W$$
$$qvB = mg$$
$$v = \frac{mg}{qB}$$
$$v = \frac{1.67 \times 10^{-27} \times 9.8}{1.6 \times 10^{-19} \times 2.50 \times 10^{-3}}$$
$$\boxed{v = 4.09 \times 10^{-5}\ ms^{-1}}$$

5. Find the radius of an orbit of an electron moving at a rate of $2.0 \times 10^{7}\ ms^{-1}$ in a uniform magnetic field of $1.2 \times 10^{-3}\ T$. (2 times) **(Example No. 14.4)**

Ans: Given that $v = 2.0 \times 10^{7}\ ms^{-1}$
$$B = 1.2 \times 10^{-3}\ T$$
$$m = 9.1 \times 10^{-31}\ kg$$
$$e = 1.6 \times 10^{-19}\ C$$
$$r = ?$$

Since $r = \frac{mv}{eB}$
$$r = \frac{9.1 \times 10^{-31} \times 2.0 \times 10^{7}}{1.6 \times 10^{-19} \times 1.2 \times 10^{-3}}$$
$$\boxed{r = 9.43 \times 10^{-2}\ m}$$

6. Alpha particles ranging in speed from $1000\ ms^{-1}$ to $2000\ ms^{-1}$ enter a velocity select where electric intensity is $300\ Vm^{-1}$ and the magnetic induction is $0.20\ T$. Which particle will move undeviated through the field? (3 Times) **(Eample No. 14.5)**

Ans: Given that $E = 300\ Vm^{-1} = 300\ NC^{-1}$
$$B = 0.20\ T$$

Here only those particles will move undeviated through the field for which
$$F_e = F_B$$
$$qE = qvB$$
$$E = vB$$
$$v = \frac{E}{B}$$
$$v = \frac{300}{0.20}$$
$$\boxed{v = 1500\ ms^{-1}}$$

The alpha particles having a speed of $1500\ ms^{-1}$ will move undeviated through the field.

Topic IX: Torque on a current carrying coil:

7. A coil of $0.1\ m \times 0.1\ m$ and of $200\ turns$ carrying a current of $1\ mA$ is placed in a uniform magnetic field of $0.1\ T$. Calculate the maximum torque

that acts on the oil. **(2 times)** **(C.W)**

Ans: Given that $area\ of\ coil = A = 0.1\ m \times 0.1\ m = 0.01\ m^2$
$$number\ of\ turns = N = 200$$
$$current = I = 1\ mA = 1 \times 10^{-3}\ A$$
$$magnetic\ field = B = 0.1\ T$$
$$maximum\ torque = \tau_{max} = ?$$

Since $\tau = NIAB\cos\alpha$

For maximum torque $\alpha = 0^o$

So $\tau_{max} = NIAB\cos 0^o$
$$\tau_{max} = NIAB$$
$$\tau_{max} = 200 \times 1 \times 10^{-3} \times 0.01 \times 0.1$$
$$\boxed{\tau_{max} = 2 \times 10^{-4}\ Nm}$$

Topic X: Galvanometer:

8. The resistance of galvanometer is 50 Ohm and reads full deflection with a current of 2.0 mA. Show by diagram how to convert this galvanometer into voltmeter reading 200 volt full scale.

Ans: Given that
$$R_g = 50.0\ \Omega$$
$$I_g = 2.0\ mA = 2 \times 10^{-3}\ A$$
$$V = 200\ V$$
$$R_h = ?$$

Since for converting galvanometer into voltmeter expression is,
$$R_h = \frac{V}{I_g} - R_g$$

Putting the values we get,
$$R_h = \frac{200}{2 \times 10^{-3}} - 50$$
$$R_h = 100 \times 10^{3} - 50$$
$$\boxed{= 99950\ \Omega}$$

ALP SMART SYLLABUS 2020

1. A 20.0 cm wire carrying a current of 10.0 A is placed in a uniform magnetic field of 0.30 T. If the wire makes an angle of 40° with the direction of magnetic field, find the magnitude of the force acting on the wire. **Example 14.1**

Sol:

Length of the wire = L = 20.0 cm $= \frac{20}{100}\ m$

=0.20 m

Current in the wire = I = 10.0 A

Strength of magnetic field = B = 0.30 T

Angle between $\vec{L}$ and $\vec{B}$ = α = 40°

Magnitude of the force = F = ?

Using the formula

F = ILBSin α

Putting the values, we get

F = 10 × 0.20 × 0.30 × sin 40°

F = 0.60 × 0.642

F = 0.39 N

2. The magnetic field in a certaing region is given by $\vec{B} = (40\hat{\imath} - 18\hat{k})Wb\,m^{-2}$. How much flux passes through a 5.0 cm^2 area loop in this region if the loop lies flat in the xy-plane?

Example 14.2

Sol:

Magnetic induction = $\vec{B} = (40\hat{\imath} - 18\hat{k})Wb\,m^{-2}$

Area of the loop = $\Delta\vec{A} = 5.0\,cm^2\hat{k} = 5.0 \times 10^{-4}m^2\hat{k}$

Magnetic flux = $\phi_B = ?$

As we know that

$$\phi_B = \vec{B}.\Delta\vec{A}$$

Putting the values, we get

$$\phi_B = (40\hat{\imath} - 18\hat{k}).(5 \times 10^{-4}\hat{k})$$
$$\phi_B = (40)(0) - (18 \times 5 \times 10^{-4})$$
$$\phi_B = 0 - 90 \times 10^{-4}Wb$$
$$\phi_B = -90 \times 10^{-4}\,Wb$$

3. Find the value of the magnetic field that will cause a maximum force of 7.0 × 10^{-3} N on a 20.0 cm straight wire carrying current of 10.0 A. **(C.W)**

Sol:

Maximum force = $F_{max} = 7.0 \times 10^{-3}N$

Length of wire = $L = 20.0\,cm = 20 \times 10^{-2}m$

Current = I = 10A

Magnetic field = B = ?

As $\vec{F} = I\vec{L} \times \vec{B}$

F = ILB sin θ

For maximum force 0 = 90^o

$$F_{max} = ILB \sin 90^o$$
$$F_{max} = ILB$$

or $B = \frac{F_{max}}{IL}$

Puitting the values, we get

$$B = \frac{7.0 \times 10^{-3}}{10 \times 20 \times 10^{2}} = \frac{7 \times 10^{-3}}{2 \times 10^{2} \times 10^{-2}}$$
$$B = 3.5 \times 10^{-3}T$$

4. A velocity selector has a magnetic field of 0.30 T. If a perpendicular electric field of 10,000 Vm^{-1} is applied, what will be the speed of the particle that will pas through the selector?

Sol: **(C.W)**

Magnetic field = B = 0.30 T

Electric field = E = 10,000 v/m

Speed of particle = v = ?

The particle will pass through the selector if

Magnetic force = Electric force

$$qvB = qE$$
$$vB = E$$
$$v = \frac{E}{B}$$

Putting the values, we get

$$v = \frac{10,000}{0.30}$$
$$v = 3.3 \times 10^4\ m/sec$$

5. You are asked to design a solenoid that will give a magnetic field of 0.10 T, yet the current must not exceed 10.0 A. Find the number of turns per unit length that the solenoid should have. **(C.W)**

Sol:

Magnetic field = B = 0.10 T

Maximum current = I = 10.0 A

Number of turns per unit length = n = ?

$$B = \mu_o nI$$

or $n = \frac{B}{\mu_o I}$

Where $\mu_o = 4\pi \times 10^{-7}\,wbA^{-1}\,m^{-1}$

Putting the values, we get

$$n = \frac{0.1}{4\pi \times 10^{-7} \times 10}$$
$$n = \frac{0.1}{4 \times 3.14 \times 10^{-7} \times 10}$$
$$n = \frac{10^5}{4 \times 3.14}$$
$$n = 0.796 \times 10^5$$
$$n = \frac{0.1 \times 10^7}{125.6}$$
$$n = 0.000796 \times 10^7$$
$$n = 7.96 \times 10^3\ turn/length$$

OBJECTIVES (MCQ'S) OF CHAPTER-15 ACCORDING TO ALP SMART SYLLABUS-2020

Topic I: Induce emf and Induce current:

1. When a conductor moves across a magnetic field, an emf is set up, this emf is called:

(A) Length of conductor (B) Speed of conductor

(C) Strength of magnet (D) All of these

2. A metal rod of 1 m is moving at a speed of 1ms^{-1} in a direction making an angle 30° with 0.5 T magnetic feild. The emf produced is:

(A) 0.25 N (B) 2.5 N (C) 0.25 V (D) 2.5 V

Topic II: Motional emf:

3. The motional emf is given by:

(A) qvB (B) IBL (C) eBL (D) vBL

4. The rod of unit length is moving at 30° through a magnetic field of 1 T. If velocity of rod is 1 m/s , then induced emf in the rod will be given by:

(A) 1 V (B) 0.2 V (C) 0.5 V (D) 0.6 V

5. $\frac{B^2}{2\mu_o}$ is the expression of:

(a) Lenz's law (b) magnetic energy (c) Magnetic energy density (d) back emf

6. The motional emf depends upon the:

(A) Variable emf (B) Constant emf (C) Induced emf (D) Back emf

Topic III: Farad Law:

7. The maximum value of emf induced in armature of N turns and area A rotating in magnetic field B with frequency "f" is given by:

(A) $2\pi fN AB$ (B) $2\pi fN^2 AB$ (C) NfAB (D) $4\pi f^2N AB$

8. Energy stored per unit volume inside a solenoid is called:
(A) Electric flux (B) Energy density (C) Work (D) Volume charge density

9. The 'emf' always ____ even when no current is drawn through the battery of cell
(A) Zero (B) Present (C) Absent (D) Maximum

10. The SI unit if induced emf is:
(A) Ohm (B) Tesla (C) Henry (D) Volt

11. A rod of length 20 m is moving with 20 m/s in a direction perpendicular to magnetic field of 20 T what is the value of emf:
(A) 2000V (B) 4000V (C) 6000V (D) 8000V

12. The ratio of average induced emf to the rate of change of current in the coil is called:
(A) Self-inductance (B) Mutual inductance (C) Self-induction (D) Mutual induction

13. The relation $\varepsilon = -N\frac{\Delta\phi}{\Delta t}$ is known as:
(A) Ampere's law (B) Faraday's law (C) Lenz's law (D) Kickoff's law

14. The negative sign with induced emf in Faraday's law is in accordance with:
(A) Lenz's law (B) Ampere's law (C) Gauss's law (D) Boyle's law

15. The product of induced current and resistance of the wire through which the current is passing is called:
(A) Mutual induction (B) Self-induction (C) Induced current (D) Induced emf

16. If we make magnetic field stronger the value of induced current: (2 times)
(A) Decrease (B) Increase (C) Vanishes (D) Remains constant

17. Emf is induced due to change in: (2 times)
(A) Charge (B) Current (C) Magnetic flux (D) Electric field

18. A changing electric flux creates:
(A) Electric field (B) gravitational field (C) Magnetic field (D) electric charge

19. Electromagnetic Induction obeys Law of Conservation of:
(A) Charge (B) Energy (C) Momentum (D) Mass

Topic IV: Lenz's Law:

20. Lenz's law is a consequence of the law of conversation of: (4 Times)
(A) Charge (B) Current (C) Energy (D) Momentum

21. Lenz's law deals with: (5 times)
(a) Magnitude of emf (b) direction of emf
(c) Direction of induced current (d) resistance

22. Lenz's law is in accordance with the law of conservation of: (3 times)
(A) Momentum (B) Angular momentum (C) Charge (D) Energy

Topic V: Mutual Induction:

23. The magnetic force acting on a unit +ve charge moving at right angle to the magnetic field with unit velocity is called:
(A) Magnetic flux (B) Induced emf (C) Motional emf (D) Magnetic induction

24. The notation for Henry is: (8 Times)
(A) $VS^{-1}A$ (B) $N.m.A^{-1}$ (C) $V^{-1}.S.A$ (D) $V.S.A^{-1}$

25. One of the practical applications of mutual inductance is: (5 times)
(A) Step-down transformer (B) Operational amplifier
(C) Rectifier (D) Choke

26. Henry is SI unit of: (4 Times)
(A) Current (B) Resistance (C) Flux (D) Self induction

27. Mutual induction between two coils depends upon their:
(A) Size (B) Shape
(C) Separation (D) Size, shape, separation and orientation

28. The mutual induction between two coils depends upon:
(A) Area of coils (B) Number of turns of the coils
(C) Distance between the coils (D) All of these

29. Inductance of the coil can be increased by using:
(A) Paramagnetic core (B) Diamagnetic core
(C) Ferromagnetic core (D) Antiferromagnetic core

30. Mutual Induction has a practical role in the performance of the:
(A) Radio Choke (B) Transformer (C) A.C Generator (D) D.C Generator

31. The mutual Inductance between two coils depends upon their:
(A) Size (B) Core material
(C) Separation (D) Size, Core material and Separation

Topic VI: Self-Induction:

32. Self inductance does not depend upon:
(A) Number of turns of the coil (B) Area of cross-section of the core
(C) Nature of material of the core (D) Current through inductor

33. Self-induced emf is sometimes called as: (2 times)
(A) Motional emf (B) Constant emf (C) Back emf (D) Variable emf

34. The self-inductance of solenoid is:-
(a) $L=\mu_0 nAl$ (b) $L=\mu_0 N^2Al$ (c) $L=\mu_0 n^2Al$ (d) $L=\mu_0 NAl$

35. The S.I unit of self-inductance or mutual inductance is:
(A) Maxwell (B) Weber (C) Henry (D) Tesla

Topic VII: Energy Stored in an Inductor:

36. Energy stored in the indicator is: (6 Times)
(A) $\frac{1}{2}L^2I$ (B) $\frac{1}{2}LI$ (C) $\frac{1}{2}LI^2$ (D) $\frac{1}{2}L^2I^2$

37. Formula for energy density for an inductor is:
(A) $\frac{B^2}{2\mu_0}$ (B) $\frac{1}{2}\varepsilon_0 E^2$ (C) $\frac{1}{2}CV^2$ (D) $\frac{1}{2}LI^2$

38. If an inductor has N turns of a coil and ϕ is magnetic flux through its each turn when current I is following, then its self-inductance is given by L: (2 Times)
(A) $\frac{I}{N\phi}$ (B) $\frac{N\phi}{I}$ (C) $\frac{NI}{\phi}$ (D) $\frac{\phi}{NI}$

39. An inductor may store energy in: (3 Times)
(A) Its magnetic field (B) Its electric field (C) Its coil (D) A neighboring circuit

40. Energy density is an inductor is:
(A) Directly proportional to magnetic field
(B) Directly proportional to square of magnetic field
(C) Inversely proportional to magnetic field
(D) Inversely proportional to square of magnetic field

Topic VIII: Alternating Current Generator:

41. The devices in the circuit that consume electrical energy are known as:
(a) Dissipaters (b) generators (c) load (d) motors

42. Which one is not present in A.C generator? (2 times)
(a) Armature (b) Magnet (c) Slip rings (d) Commutator

43. The emf produced by an alternating current generator is:
(A) NwAB sin θ (B) NwAB cos θ (C) NwAB sin2 θ (D) NwAB cos2 θ

44. Induced emf in A.C. generator can be increased by
(A) Decreasing area of coil (B) Decreasing magnetic field
(C) Increasing area of coil (D) Slowing down speed of coil

2018

45. The mutual inductance of the coils depends upon:
(a) density of coil (b) material of coil (c) geometry of coil (d) stiffness of coil

46. A 50 mH coil carries a current of 2.0 A. then energy stored in its magnetic field is:
(a) 0.1 J (b) 10 J (c) 100 J (d) 1000 J

47. The expression for energy density of solenoid is given as:
(A) $\frac{B^2}{\mu_0}$ (B) $2\frac{B^2}{\mu_0}$ (C) $\frac{1}{2}\frac{B^2}{\mu_0}$ (D) $B^2\mu_0$

48. In A.C inductor behaves as:
(A) Capacitor (B) Resistor (C) Cummulators (D) Transistor

49. In A.C generator when plane of coil is perpendicular to the magnetic field, then output of generator is:
(A) NWAB (B) $2\pi f$ (C) maximum (D) zero

2019

50. Energy stored in the inductor is in the form of:
(A) electrical energy (B) Magnetic energy (C) Kinetic energy (D) Chemical energy

51. When current flowing through an inductor is doubled, then energy stored in it becomes:
(A) half (B) four times (C) one fourth (D) doubled

52. If a conductor of length 1m is moved with Velocity V across a magnetic field B at an angle 30° with B, then the Motional emf will be:
(A) vBL (B) $\frac{1}{2}$vBL (C) $\frac{1}{2}$vB (D) 0.866 vB

53. If the Angular Frequency of A.C. Generator increased to double, the time period would become:
(A) Double (B) 4 Times (C) $\frac{1}{4}$ Times (D) Half

54. During each cycle of A.C. Voltage reaches a peak value:
(A) Once (B) Twice (C) Thrice (D) Four Times

55. The Lenz's Law is also a statement of:
(A) Law of Conservation of Momentum (B) Law of Conservation of Charge
(C) Law of Conservation of Energy (D) Faraday Law of Electromagnetic Induction

56. Electric current produces magnetic field was discovered by:
(A) Faraday (B) Maxwell (C) Oersted (D) Lenz

57. Maximum emf generated in a generator is:
(A) $\varepsilon_o = \varepsilon \sin\theta$ (B) $\varepsilon = \varepsilon_o \sin\theta$ (C) $\varepsilon_o = N\omega AB \sin\theta$ (D) $\varepsilon_o = N\omega AB$

ANSWERS OF THE MULTIPLE CHOICE QUESTIONS

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
D	C	D	C	C	C	A	B	B	D	D	A	B	A	D
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
B	C	C	B	C	C	D	D	D	A	D	D	D	C	B
31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
D	D	C	C	C	C	A	B	A	B	C	D	A	C	C
46	47	48	49	50	51	52	53	54	55	56	57			
A	C	B	D	B	B	C	D	B	C	C	D			

SHORT QUESTIONS OF CHAPTER-15 ACCORDING TO ALP SMART SYLLABUS-2020

Topic I: Induce emf and Induce current:

1. Does the induced emf always act to decrease the magnetic flux through a circuit? **(20 Time) (H.W)**

Ans: No, the induced emf always opposes the cause that produces it.
If the magnetic flux through the circuit is increasing, then induced emf acts to decrease the magnetic flux.
If the magnetic flux through the circuit is decreasing, then induced emf acts to increase the magnetic flux.

2. Show that ε and $\frac{\Delta\varphi}{\Delta t}$ have the same units. **(24 Time) (H.W)**
OR Show that induced emf and rate of change of flux has the same units.

Ans: Since

$$\varepsilon = \frac{W}{q}$$
$$\varepsilon = \frac{joule}{coulomb}$$
$$\varepsilon = volt$$

and
$$\frac{\Delta\varphi}{\Delta t} = \frac{B\Delta A}{\Delta t}$$
$$\frac{\Delta\varphi}{\Delta t} = \frac{(NA^{-1}m^{-1})(m^2)}{s}$$
$$\frac{\Delta\varphi}{\Delta t} = \frac{Nm}{As}$$
$$\frac{\Delta\varphi}{\Delta t} = \frac{joule}{coulomb}$$
$$\frac{\Delta\varphi}{\Delta t} = volt$$

Thus ε and $\frac{\Delta\varphi}{\Delta t}$ have the same units.

3. Does the induced emf in a circuit depend upon the resistance of the circuit? Does the induced current depend on the resistance of the circuit? (10 Time) (C.W)

Ans: Since $\varepsilon = -N\frac{\Delta\varphi}{\Delta t}$
Thus the induced emf in a circuit does not depend upon the resistance of the circuit. It depends upon the rate of change of magnetic flux.
And $I = \frac{\varepsilon}{R}$
Thus the induced current depends on the resistance of the circuit.

4. What is electromagnet? Mention two practical examples of electromagnet.

Ans: When a specimen of iron is placed inside a current carrying solenoid, it becomes an electromagnet.
Examples are
i. Transformers ii. Motors

5. Define electromagnetic induction.

Ans: When a conductor is moved through a magnetic field, the electric current flow through the circuit. The emf produced in the conductor is called induced emf, and the current generated is called induced current. This phenomenon is known as electromagnetic induction.

6. A square loop of wire is moving through a uniform magnetic field. The normal to the loop is oriented parallel to the magnetic field. Is emf induced in the loop? Give a reason for your answer. **(2 times) (C.W)**

Ans: No, The induced emf in the wire is $\varepsilon = vBL\sin\theta$
In the present case $\theta = 0^o$, so $\varepsilon = vBL\sin 0^o$
$$\varepsilon = vBL(0)$$
$$\varepsilon = 0$$
Thus, emf induced in the loop is zero.

7. Write down any one method used for the production of induced emf.

Ans: Induced emf can be induced by electromagnetic induction.
When a conductor is moved through a magnetic field, the electric current flow through the circuit. The emf produced in the conductor is called induced emf, and the current generated is called induced current.

8. IS it possible to change both the area of the loop and magnetic field passing through the loop and still have no induced emf in the loop? Explain briefly. **(6 times) (C.W)**

Ans: Yes, if the plane of the loop is kept parallel to the direction of the magnetic field, magnetic flux through the coil will be zero, no emf will be induced in the loop either by changing its area or by changing the magnetic field.

9. If area of the loop and magnetic field both are changing and still have no induced emf. Explain why?

Ans: If the plane of the loop is kept parallel to the direction of the magnetic field, magnetic flux through the coil will be zero, no emf will be induced in the loop either by changing its area or by changing the magnetic field.

10. Define induced emf and induced current. **(4 Times)**

Ans: If a conductor moves through a magnetic field then due to change in magnetic flux, an emf is induced across the ends of the conductor which is known as back emf. If the circuit is closed, it will cause an electric current which is called as induced current.

11. Name four methods to produce induce emf.

Ans: An induced emf is produced in the loop if the magnetic flux through it changes. The methods to produce induced emf are:

(i) A bar magnet is moved towards the coil.
(ii) By changing the area of the coil in a constant magnetic field.
(iii) A coil of constant area is rotated in a constant magnetic field.
(iv) The coil is placed in the magnetic field of an electromagnet.

12. Considering induced emf produced by A.C. generator of loop resistance R, correlate the instantaneous emf and maximum emf. Also instantaneous current and maximum current.

Ans: The instantaneous emf "ε" and maximum emf "ε_o" are correlated by

$$\varepsilon = \varepsilon_o \sin\theta$$

If R is the resistance of loop, then by Ohm's law instantaneous current "I" and maximum current "I_o" are correlated as

$$I = \frac{\varepsilon}{R} = \frac{\varepsilon_o \sin\theta}{R} = I_o \sin\theta$$

These relations show that both the ε & I varies sinusoidally with time.

13. A glass rod of length "L" is moving perpendicular to the applied magnetic field P with velocity v. Explain briefly about the induced emf in it.

Ans: Induced emf is zero.
As glass rod is insulator and there are no free electrons to be shifted from one extreme to the other. Therefore, there will be no effect of perpendicular magnetic field. The induced emf is only produced by moving a conductor across the magnetic field.

14. How the induced current can be increased?

Ans: The induced current can be increased by

(i) using a stronger magnetic field. (ii) moving the loop faster.
(i) replacing the loop by a coil of many turns.

15. Define electromagnetic induction and induced emf.

Ans: When a conductor is moved through a magnetic field, the electric current flow through the circuit. The emf produced in the conductor is called **induced emf**, and the current generated is called induced current. This phenomenon is called **electromagnetic induction**.

Topic II: Motional emf:

16. How should you position a flat loop of wire in a changing magnetic field so that there is no emf induced in the loop? **(10 Time) (C.W)**

Ans: Since
$$\varepsilon = N\omega AB\sin\theta$$
If the plane of loop of wire is placed perpendicular to changing magnetic field i.e. $\theta = 0^o$ then
$$\varepsilon = N\omega AB\sin 0^o$$
$$\varepsilon = N\omega AB(0)$$
$$\varepsilon = 0$$
Hence no emf will be induced through the loop.

17. Define motional emf and write its formula. **(2 times)**

Ans: If a conductor moves through a magnetic field then due to change in magnetic flux, an emf is induced across the ends of the conductor which is known as motional emf.

$$\varepsilon = vBL\sin\theta$$

Topic III: Farad Law:

18. State Faraday's law of electromagnetic induction. **(9 Time)**

OR State Faraday's law of electromagnetic induction. Write its mathematical form.

Ans: Its states that

"The average emf induced in a conducting coil of N loops is equal to the negative of the rate at which the magnetic flux through the coil is changing with time.

$$\text{"}\varepsilon = -N\frac{\Delta\phi}{\Delta t}$$

19. State the Lenz's law and define Henry.

Ans: <u>**Lenz's law:**</u>
It states that the direction of the induced current is always so as to oppose the change which causes the current.

<u>**Henry:**</u>
If current in the primary is changing at the rate of one ampere per second and the emf induced across the ends of the secondary coil is one volt then the mutual inductance is called one Henry.

20. Define mutual inductance of the coils and also define its unit henry.

Ans: The ratio of average emf induced in the secondary to the time rate of change of current in the primary is called **mutual inductance.**
If current in the primary is changing at the rate of one ampere per second and the emf induced across the ends of the secondary coil is one volt then the mutual inductance is called **one henry.**

Topic IV: Lenz's Law:

21. How does Lenz's law explain law of conversation of energy phenomenon of electromagnetic induction?

Ans: When a rod is moving in a magnetic field towards right, an induced current flows through the loop in anti-clock wise direction. Since current carrying rod experiences a magnetic force opposite to that of velocity. An external force equal in magnitude and opposite in direction must be applied to keep the rod moving with constant velocity. This dragging force provides the energy for the induced current to flow. This energy is the source of induced current. Thus electromagnetic induction is exactly according to law of conservation of energy.

22. A suspended magnet is oscillating freely in the horizontal plane. The oscillations are strongly damped when a metal plate is placed under the magnet. Explain why this occurs? **(3 Times)**

Ans: The oscillating magnet produces change of magnetic flux close to it. The metal plate placed below it experiences the change of magnetic flux. As the result, eddy currents are produced inside metal. According to Lenz's law, these eddy currents oppose the cause which produced it. So, the oscillations of magnet are strongly damped.

23. State the Lenz's Law. **(3 times)**

Ans: It states that the direction of the induced current is always so as to oppose the change which causes the current.

24. A light metallic ring is released from above into a vertical bar magnet with South Pole to the upside. Does the current flow clockwise or anticlockwise in the ring? **(C.W)**

Ans: When the metallic ring is released from above into a bar magnet, the magnetic flux is changed in the ring and an induced emf is produced in it. According to Lenz's law, the direction of produced current is opposite to the cause which produced it. So, the side of ring facing magnet must be South Pole of the induced magnetic field. When that metallic ring viewed from above, then the current in the ring will be anticlockwise.

25. State Lenz's law and Faraday's law of electromagnetic induction.

Ans: <u>**Lenz's law:**</u>
It states that the direction of the induced current is always so as to oppose the change which causes the current.

<u>**Faraday's law:**</u>
Its states that, "The average emf induced in a conducting coil of N loops is equal to the negative of the rate at which the magnetic flux through the coil is changing with time. "

$$\varepsilon = -N\frac{\Delta\phi}{\Delta t}$$

26. What is the unit of magnetic induction "B"? Define it.

Ans: The unit of magnetic induction is tesla.
Magnetic induction is one tesla if magnetic field exerts a force of one newton on one meter length of the conductor placed at right angle to the field when a current of one ampere passes through the conductor.

$$1T = \frac{1N}{1A.1m}$$

Topic V: Mutual Induction:

27. On what factors, the mutual inductance of two coils depends? (4 times)

Ans: Mutual inductance is given as $M = -\frac{\varepsilon_S}{\Delta I_P/\Delta t}$

So it depends upon induced emf of the secondary coil ε_S and the time rate of change in primary coil $\Delta I_P/\Delta t$.
It also depends upon number of turns of the coil, area of cross-section of the coil, closeness of coils and nature of the core materials.

28. Define mutual induction. Write its SI unit. (3 times)

Ans: The phenomenon in which the changing current in one coil induces an emf in another coil is called the mutual induction.

$$M = -\frac{\varepsilon_S}{\Delta I_P/\Delta t}$$

29. In a certain region the earth's magnetic field points vertically down. When a plane flies due north, which wing tip is positively charged? (5 Times) (C.W)

Ans: The magnetic force on electron is $\vec{F_B} = -e(\vec{v} \times \vec{B})$
When the plane flies due north in the earth's magnetic field directed vertically downward, then electrons will experience force in east direction. Thus west wingtip of the plane is positively charged.

30. Define Henry. OR Define the SI Unit of mutual inductance. (7 times)

Ans: If current is changing at the rate of one ampere per second and the emf induced across the ends of the coil is one volt then the inductance is called one Henry.
Its S.I units are VsA^{-1}

31. What are the dimensions of mutual inductance? (3 times)

Ans: Mutual inductance is given by

$$M = N\phi/I$$

$$[M] = \frac{[N][\varphi]}{[I]}$$

number of turns "N" being a constant is dimensionless, so

$$[M] = \frac{[\phi]}{[I]}$$

$$[M] = \frac{[ML^2T^{-2}I^{-1}]}{[I]}$$

$$[M] = [ML^2T^{-2}I^{-2}]$$

32. Define mutual inductance and write at least two factors at which it depends. (3 times)

Ans: The ratio of average emf induced in the secondary to the time rate of change of current in the primary is called mutual inductance.
Mathematically,

$$M = \frac{\varepsilon_S}{\Delta I_P/\Delta t}$$

It depends upon number of turns of the coil, area of cross-section of the coil, closeness of coils and nature of the core materials.

33. Define mutual induction and Henry. (2 times)

Ans: The phenomenon in which a changing current in one coil induces an emf in another coil is called the **mutual induction**.
One henry is the mutual inductance of the pair of coils in which the rate of change of current of one ampere per second in the primary causes an induced emf of one volt in the secondary.

Topic VI: Self-Induction:

34. Define self-induction. Write its SI unit. (2 times)
OR Define self-inductance and its unit.

Ans: The phenomenon in which the changing current in a coil induces an emf in itself is called the self-induction.

$$L = -\frac{\varepsilon_L}{\Delta I/\Delta t}$$

Its SI unit is VsA^{-1}. It is also called as $henry\ (H)$.

35. Name the factors upon which the self-inductance depends. (4 Time)

Ans: Since $L = -\frac{\varepsilon_L}{\Delta I/\Delta t}$
It depends upon induced emf and time rate of change of current in the coil. It also depends upon the number of turns of the coil, its area of cross-section and the core material.

36. Define self-induction and mutual induction.

Ans: The phenomenon in which a changing current in a coil induces an emf in itself is called **self-induction**.
The phenomenon in which a changing current in one coil induces an emf in another coil is called **mutual induction**.

37. Define self induction and self inductance.

Ans: The phenomenon in which a changing current in a coil induces an emf in itself is called **self induction**.
Self inductance is defined as "the ratio of the emf to the rate of change of current in the coil".

$$L = \frac{\varepsilon_L}{\Delta I/\Delta t}$$

Topic VIII: Alternating Current Generator:

38. What are the factors on which maximum value ε_o of emf induced across terminals of armature of an A.C generator depend?

Ans: Since $\varepsilon_0 = N\omega AB$
This shows that maximum value of induced emf depend upon
i. Number of turns ii. Angular frequency iii. Area of the loop
iv. Magnetic field v. Angle between area of the loop A and magnetic field B.

39. What happen to the current of a circuit if a load resistance of the circuit is much less than the power transferred?

Ans: The greater the load the larger the current is supplied by the generator. When the load resistance of the circuit is much less, small current is supplied by the generator.

LONG QUESTIONS OF CHAPTER-15
ACCORDING TO ALP SMART SYLLABUS-2020

Topic II: Motional emf:
1. Define motional emf and derive a relation for it. **(4 Times)**

Topic III: Faraday's Law:
2. State and prove the Faraday's law of electromagnetic induction. **(4 Times)**

Topic IV: Lenz's Law:
3. State Lenz's law. Explain how this law explains conservation of energy during electromagnetic induction.

Topic V: Mutual Induction:
4. Define and explain mutual induction. Also derive relation for mutual inductance.
5. Define and explain the phenomena of mutual induction. Also give S.I unit. **(4 Times)**

Topic VI: Self-Induction:
6. Define self-induction. Explain how energy is stored in magnetic field. Also find energy density.

Topic VII: Energy Stored in an Inductor:

7. What is an inductor? Derive the relation for energy stored in an inductor.(2 Times)
8. Define energy density. Prove that energy density is directly proportional to the square of magnetic field.
9. Why is energy stored in an inductor when a current flows in it? Derive relation for energy density of magnetic field.

NUMERICAL PROBLEMS OF CHAPTER-15 ACCORDING TO ALP SMART SYLLABUS-2020

Topic I: Induce emf and Induce current:

1. A metal rod of length 25 cm is moving at a speed of 0.5 ms^{-1} in direction perpendicular to a 0.25 T magnetic field. Find emf produced along the rod. (3 times)

(Example No. 15.1)

Ans: Given that

$$v = 0.5\ ms^{-1}$$
$$L = 25\ cm = 0.25\ m$$
$$B = 0.25\ T$$
$$\theta = 90^\circ$$
$$\varepsilon = ?$$

So

$$\varepsilon = vBL\sin\theta$$
$$\varepsilon = (0.5)(0.25)(0.25)\sin 90^\circ$$
$$\varepsilon = 0.03125$$
$$\varepsilon = 3.125 \times 10^{-2}\ V = 3.13 \times 10^{-2}\ V$$

2. A solenoid has 250 turns and its self inductance is 2.4 mH. What is the flux through each turn when the current is 2A? What is the induced emf when the current changes at the rate of 20As^{-1}? (C.W)

Ans: Given that

$$\text{number of turns} = N = 250\ \text{turns}$$
$$\text{self induction} = L = 2.4\ mH = 2.4 \times 10^{-3} H$$
$$\text{current} = I = 2\ A$$
$$\text{rate of change of current} = \frac{\Delta I}{\Delta t} = 20\ As^{-1}$$
$$\text{emf} = \varepsilon = ?$$
$$\text{flux through each turn} = \phi = ?$$

We know

$$L = \frac{N\phi}{I}$$
$$\phi = \frac{LI}{N}$$

Putting the values,

$$\phi = \frac{2.4 \times 10^{-3} \times 2}{250} \boxed{= 1.92 \times 10^{-5}\ Wb}$$

Now,

$$\varepsilon = L\frac{\Delta I}{\Delta t}$$

Putting the values,

$$\varepsilon = 2.4 \times 10^{-3} \times 20 = 0.048\ V$$
$$\varepsilon = 48 \times 10^{-3}\ V \boxed{= 48 \times 10^{-3}\ mV}$$

3. A loop of a wire is placed in a uniform magnetic filed that is perpendicular to plane of a loop. The strength of magnetic field is 0.6T. The area of loop beging to shrink at a constant rate of $\Delta A / \Delta t = 0.8 m^2 s^{-1}$. What is the magnitude of emf induce in the loop while it is shrinking. (Example No. 15.2)

Sol:

$$\frac{\Delta A}{\Delta t} = 0.8 m^2 S^{-1}$$
$$B = 0.6T$$
$$\varepsilon = ?$$

Rate of change of flux

$$\frac{\Delta\phi}{\Delta t} = \frac{B\Delta A}{\Delta t} Cos0^0$$
$$\frac{\Delta\phi}{\Delta t} = \frac{B\Delta A}{\Delta t}(1) = B\frac{\Delta A}{\Delta t}$$

Applying Faraday's law

$$\varepsilon = N\frac{\Delta\phi}{\Delta t}$$
$$= N \times \frac{B\Delta A}{\Delta t}$$

Putting values, we get

$$\varepsilon = 1 \times 0.6 \times 0.8 = 0.48V$$

4. A coil of 10 turns and 35cm^2area is in a perpendicular magnetic field of 0.5T. The coil is pulled out of the field in 1.0s. Find the induced emf in the coil as it is pulled out of the field. (4 times) (C.W)

Sol:

$r = 4.0cm = 4 \times 10^{-2} m$, $R = 1.0m\Omega$, $R = 1.0 \times 10^{-3}\Omega$

$B_1 = 0.2T$, $B_2 = 0.4T$, $\Delta t = 5 \times 10^{-3} S$

$N = 1$, $I = ?$

$\Delta B = B_2 - B_1$

$\Delta B = 0.4 - 0.2 = 0.2T$

By definition

$\phi_B = \vec{B}.\vec{A}$

$$\phi_B = BA\cos 0$$
$$(Cos0^0 = 1)$$
$$\phi_B = BA(1) \quad \because (A = \pi r^2)$$
$$\Delta\phi_B = \Delta(B\pi r^2)$$
$$\Delta\phi_B = \Delta B \pi r^2$$

As

$$\varepsilon = N\frac{\Delta\phi}{\Delta t}$$
$$\varepsilon = N\frac{\Delta B \times \pi r^2}{\Delta t}$$
$$\varepsilon = (1) \times \frac{0.20 \times 3.14 \times (4 \times 10^{-2})^2}{5 \times 10^{-3}}$$
$$\varepsilon = \frac{10.048}{5} \times 10^{-1}$$
$$\varepsilon = 0.201V$$

From ohm's law

$$I = \frac{\epsilon}{R}$$

$$I = \frac{0.201}{1\times10^{-3}} = 201\,A$$

Topic II: Motional emf:

5. **An emf of $0.45\,V$ is induced between the ends of a metal bar moving through a magnetic field of $0.22\,T$. What field strength would be needed to produce an emf of $1.5\,V$ between the ends of the bar, assuming that all the other factors remain the same.** (C.W)

Ans:

Given that

$$\varepsilon_1 = 0.45\,V$$
$$B_1 = 0.22\,T$$
$$\varepsilon_2 = 1.5\,V$$
$$B_2 = ?$$

Since

$$\varepsilon_1 = B_1 vL\sin\theta$$
$$\frac{\varepsilon_1}{B_1} = vL\sin\theta$$

And

$$\varepsilon_2 = B_2 vL\sin\theta$$
$$\frac{\varepsilon_2}{B_2} = vL\sin\theta$$

On comparison, we get

$$\frac{\varepsilon_1}{B_1} = \frac{\varepsilon_2}{B_2}$$
$$B_2 = \frac{\varepsilon_2 B_1}{\varepsilon_1}$$
$$B_2 = \frac{(1.5)(0.22)}{0.45} \boxed{= 0.73\,T}$$

6. **A square coil of side $16\,cm$ has $200\,turns$ and rotates in a uniform magnetic field of $0.05T$. If the peak emf is $12\,V$, what is the angular velocity of the coil?** (5 Time) (H.W)

Ans: Given that

$$\text{Peak } emf = \varepsilon_0 = 12\,V$$
$$number\ of\ turns = N = 200\ turns$$
$$area\ of\ coil = A = 16\,cm \times 16\,cm = 256\,cm^2 = 2.56 \times 10^{-2} m^2$$
$$magnetic\ field = B = 0.05\,T \quad \omega = ?$$

As

$$\varepsilon_0 = B\omega NA$$
$$\omega = \frac{\varepsilon_0}{BNA}$$
$$\omega = \frac{12}{0.05 \times 200 \times 2.56 \times 10^{-2}} \boxed{= 47\,rad\,s^{-1}}$$

Topic V: Mutual Induction:

7. **Two coils are placed side by side. An emf of 0.8V is observed in one coil when the current is changing at the rate of $200As^{-1}$ in the other coil. What is the mutual induction of the coil?** (H.W)

Ans:

$$\text{rate of change of current} = \frac{\Delta I}{\Delta t} = 200\,As^{-1}$$
$$\text{emf in one coil} = \varepsilon = 0.8\,V$$
$$\text{mutual induction} = M = ?$$

We know,

$$\varepsilon = M\frac{\Delta I}{\Delta t}$$
$$M = \frac{\varepsilon}{\left(\frac{\Delta I}{\Delta t}\right)}$$

Putting the values,

$$M = \frac{0.8}{200} = 4 \times 10^{-3}\,H$$
$$\boxed{M = 4\,mH}$$

Topic VI: Self-Induction:

8. **The current in a coil of $1000\,turns$ is changed from $5\,A$ to zero is $0.2\,s$. If an average emf of $50\,V$ is induced during this interval, what is the self-inductance of the coil?** (Example No. 15.4)

Ans: Given that

$$change\ in\ current = \Delta I = 5 - 0 = 5\,A$$
$$time\ interval = \Delta t = 0.2\,s$$
$$emf\ induced = \varepsilon = 50\,V$$
$$self\ induction = L = ?$$
$$number\ of\ turns = N = 1000$$

Since

$$L = \frac{\varepsilon}{\Delta I/\Delta t}$$
$$L = \frac{50}{5/0.2} = 2\,VsA^{-1} \boxed{= 2\,H}$$

9. **A circular coil has 15 turns of radius = 2cm each. The plane of the coil lies at 40^0 to a uniform magnetic field of 0.2T. If the field is increased by 0.5T in 0.2 s, find the magnitude of induced emf.** (H.W)

$N = 15\ turns$ $\qquad r = 2cm = 0.02m$

Angle between $\vec{B}$ and plane of coil $\theta' = 40^0$

Angle between $\vec{B}$ and vector Area $\vec{A} = \theta = 90^0 = \theta'$

$$\theta = 90^0 - 40^0 = 50^0$$

$B_1 = 0.2T \qquad B_2 = 0.5T$

$$\Delta B = B_2 - B_1 = 0.5 - 0.2 = 0.3T$$

$\Delta t = 0.2S \qquad \varepsilon = ?$

as

$$\varepsilon = -N\frac{\Delta\phi}{\Delta t}$$

or

$$\varepsilon = -N\frac{\Delta BACos\theta}{\Delta t} \qquad (\because \Delta\phi = \Delta\vec{B}.\vec{A} = \Delta BACos\theta)$$

or

$$\varepsilon = -N\frac{\Delta B\pi r^2 Cos\theta}{\Delta t} \quad (\because A = \pi r^2)$$

Putting values, we get

$$\varepsilon = -15\frac{(0.3)(3.14)(0.02)^2\,Cos50^0}{0.2}$$

or $\varepsilon = 1.82\times10^{-2}V$ $\qquad$ or $\qquad \varepsilon = 1.82\times10^{-2}V$

ALP SMART SYLLABUS 2020

1. An emf of 5.6 V is induced in a coil while the current in a nearby coil is decreased from 100 A to 20 A in 0.02 s. What is the mutual inductance of the two coils? If the secondary has 200 truns, find the change in flux during this interval. Example 15.3

Sol: Emf induced in the secondary = $\varepsilon_s = 5.6\,V$

Change in current in primary = $\Delta I_P = 100A - 20A = 80A$

Time interval for the change = $\Delta t = 0.02\,sec$

Number of turns in the secondary = $N_s = 200$

(i) Mutual inductance = M = ?

(ii) Change in flux = $\Delta\emptyset$ =?

(i) As according to the formula of mutual inductance

$$\varepsilon_s = M\,\frac{\Delta I_P}{\Delta t}$$

$$or \qquad M = \varepsilon_s \times \frac{\Delta t}{\Delta I_P}$$

Putting the values , we get

$$M = 5.6 \times \frac{0.02}{80}$$
$$M = 0.0014\,VsA^{-1}$$
$$M = 1.4 \times 10^{-3} VsA^{-1}$$

(ii) According to Faraday's law

$$\varepsilon_s = N_s\,\frac{\Delta\emptyset_s}{\Delta t}$$

$$or \qquad \Delta\emptyset_s = \varepsilon_s \times \frac{\Delta t}{N_s}$$

Putting the values, we get

$$\Delta\emptyset_s = 5.6 \times \frac{0.02}{200}$$
$$\Delta\emptyset_s = 0.00056\,Wb$$
$$or \qquad \Delta\emptyset_s = 5.6 \times 10^{-4}\,Wb$$

2. An alternating current generator operating at 50 Hz has a coil of 200 turns. The coil has an area of 120 cm^2. What should be the magnetic field in which the coil rotates in order to produce an emf of maximum value of 240 volts? Example 15.6

Sol: Frequency of rotation = f = 50 Hz

Number of turns of the coil = N = 200

Area of the coil = A = 120 cm^2 = $1.2 \times 10^{-2}\,m^2$

Maximum value of emf = $\varepsilon_0 = \varepsilon_{max} = 240V$

Magnetic flux density = B = ?

As maximum value of emf is given by the relation

$$\varepsilon_0 = N\omega AB$$

As angular speed ω is

$$\omega = 2\pi f$$

$$Hence \qquad \varepsilon_0 = N\,(2\pi f)AB$$

$$or \qquad B = \frac{\varepsilon_0}{2\pi f\,NA}$$

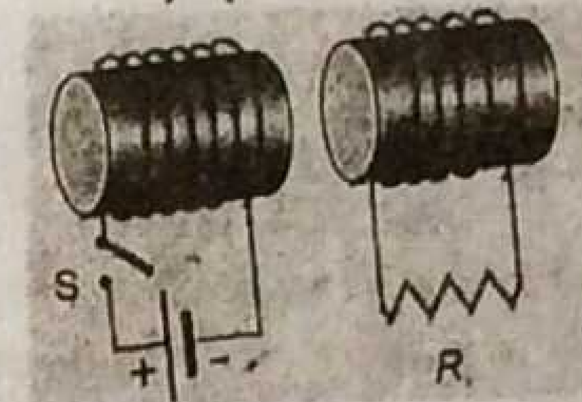
Putting the values, we get

$$B = \frac{240}{2 \times 3.14 \times 50 \times 200 \times 1.2 \times 10^{-2}}$$
$$B = \frac{240}{2 \times 3.14 \times 50 \times 2 \times 1.2}$$
$$B = \frac{240}{753.6}$$
$$B = 0.32\,T$$

3. What is the direction of the current through resistor R is shown Figure? (H.W)

When switch S is

a) closed **b) opened**



Ans. a) The direction of current through resistor R is from left to right.

When switch is closed, the current in the primary coil increases from zero to a maximum steady value, which produces an induced emf in the secondary coil.

According to Lenz's law the direction of current in primary is clockwise, therefore the direction of current in secondary will be anti-clockwise i.e. from left to right through R.

b) In the case, the direction of current through R from right to left.

When switch is opened again the current in primary coil decreases from maximum value to zero, the flux through the direction of induced current is such that is acts to increase the magnetic flux. Hence the direction of induced current is reversed i.e. flows from right to left in clockwise direction.

4: The flux density B in a region between the pole faces of a horse-shoe magnet is 0.5 Wbm^{-2} direction vertically downward. Find the emf induced in a straight wire 5.0 cm long, perpendicular to 8 when is moved in a direction at an angle of 60° with the horizontal with a speed of 100 cms^{-1}. (C.W)

Sol: Flux density = B = 0.5 Wb/m^2 (Vertically downward)

Length of wire = L = 5.0 cm = $5 \times 10^{-2}\,m$

Angle = $\theta_1 = 60^o$ (with horizontal)

Speed of wire = v = 100 cm/sec = 1.0 m/sec

Induced emf = ε = ?

As $\theta_1 = 60^o$ with horizontal, so with the vertical i.e., angle of $\vec{V}$ with $\vec{B}$,

$\theta = 90^o - 60^o = 30^o$

$$As \quad \varepsilon = v\,Bl\,sin\theta$$

Putting the values, we get

$$\varepsilon = 0.5 \times 1.0 \times 5 \times 10^{-2} \times \sin 30^o$$
$$= 0.025 \times 0.5 = 0.0125\,V$$
$$\varepsilon = 1.25 \times 10^{-2} V$$

5. A coil of wire has 10 loops. Each loop has an area of $1.5 \times 10^{-3} m^2$. A magnetic field to perpendicular the surface of each loop at all times. If the magnetic field is changed from 0.05 T to 0.06 T in find the average emf induced in 0.15. The coil during this time. (C.W)

Sol: Number of loops of coil = N = 10

Area of each loop = A = $1.5 \times 10^{-3} m^2$

Initial magnetic field = $B_1 = 0.05\,T$

Final magnetic field = $B_2 = 0.06\,T$

Change in magnetic field = $\Delta B = 0.06 - 0.05 = 0.01\ T$

Time interval = $\Delta t = 0.1$ sec

Emf induced = ε = ?

As $\varepsilon = -N\dfrac{\Delta\phi}{\Delta t}$ ……. (1)

Where $\Delta\phi = \Delta BA\cos\theta$ (where θ is the angle between magnetic field and vector area)

$$\Delta\phi = 0.01 \times 1.5 \times 10^{-3}$$
$$= 0.015 \times 10^{-3}\ Wb$$

Putting the values in eq. (1) we get

$$\varepsilon = \frac{-10 \times 0.015 \times 10^{-3}}{0.1}$$
$$\varepsilon = -1.5 \times 10^{-3} V$$
$$\varepsilon = 1.5 \times 10^{-3}\ V$$

6. A solenoid of length 8.0 cm and cross sectional area 0.5 cm^2 has 520 turns. Find the self inductance of the solenoid when the core is air. If the current in the solenoid increases through 1.5 A in 0.2 s, find the magnitude of induced emf in it. (C.W)

Sol:

Length of solenoid = l = 8.0 cm = 8.0×10^{-2} m

Cross – sectional area of solenoid = A = 0.5 cm^2 = $0.5 \times 10^{-4}\ m^2$

Number of turns = N = 520

Increase in current = ΔI = 1.5 A

Time interval = Δt = 0.2 sec

Permeability for air = $\mu_o = 4\pi \times 10^{-7}\ wbA^{-1}m^{-1}$

Self-induction of solenoid (of air cored) = L = ?

As self-inductance of solenoid with air core is given by

$$L = \mu_o n^2 lA \qquad But\ n = \frac{N}{l}$$

$$So \quad L = \mu_o \times \frac{N^2}{l^2} \times l \times A$$

$$L = \mu_o \times \frac{N^2}{l} \times A$$

Putting the values , we get

$$L = \frac{4\pi \times 10^{-7} \times (520)^2 \times 0.5 \times 10^{-4}}{8.0 \times 10^{-2}}$$
$$= \frac{4 \times 3.14 \times 10^{-7} \times 270400 \times 0.5 \times 10^{-4}}{8.0 \times 10^{-2}}$$
$$L = 2.12 \times 10^{-4}\ H$$

$$and \quad \varepsilon = L\frac{\Delta I}{\Delta t}$$

Putting the values, we get

$$\varepsilon = 2.12 \times 10^{-4} \times \frac{1.5}{0.2}$$
$$\varepsilon = 1.6 \times 10^{-3}\ volts$$

7. Like any field, the earth's magnetic field stores energy. Find the magnetic energy stored in a space where strength of earth's field is 7×10^{-5} T, if the space occupies an area of $10 \times 10^8\ m^2$ and has a height of 750 m. (C.W)

Sol:

Strength of magnetic field = B = $7 \times 10^{-5} T$

Space area = A = $10 \times 10^8\ m^2$

Height of area above earth = h = l = 750 m

Permeability of free space $\mu_o = 4\pi \times 10^{-7}\ WbA^{-1}m^{-1}$

Magnetic energy stored in space = U_m = ?

$$As \quad U_m = \frac{1}{2}\frac{B^2}{\mu_o} \times (Al)$$

Putting the values, we get

$$U_m = \frac{1}{2} \times \frac{(7 \times 10^{-5})^2}{4\pi \times 10^{-7}} \times 10 \times 10^8 \times 750$$
$$= \frac{1}{2} \times \frac{49 \times 10^{-10} \times 10 \times 10^8 \times 750}{4 \times 3.14 \times 10^{-7}}$$
$$= \frac{367500 \times 10^2}{25.12 \times 10^{-7}}$$
$$U_m = 1.462 \times 10^9\ J$$
$$U_m = 1.5 \times 10^9\ J$$

8. A copper ring has a radius of 4.0 cm and resistance of 1.0 mΩ. A magnetic field is applied over the ring, perpendicular to its plane. If the magnetic field increases from 0.2 T to 0.4 T in a time interval of $5 \times 10^{-3} s$, what is the current in the ring during this interval? (C.W)

Sol:

Radius of copper ring = r = 4 cm = $4 \times 10^{-2} m$

Resistance of copper ring = R = 1mΩ = $1 \times 10^{-3}\Omega$

Initial magnetic field = $B_1 = 0.2\ T$

Final magnetic field = $B_2 = 0.4\ T$

Time interval = $\Delta t = 5 \times 10^{-3}$ sec

Number of turn = N = 1

Current in the ring = I = ?

Increase in magnetic field = $\Delta B = B_2 - B_1 = 0.4 - 0.2 = 0.2\ T$

$\Delta\phi = (\Delta B)A\cos\theta$ (where θ is angle between magnetic field and vector area)

Putting the values, we get

$$\Delta\phi = (\Delta B)\pi r^2 cos\theta$$
$$\Delta\phi = 0.2 \times 3.14 \times (4 \times 10^{-2})^2$$
$$\Delta\phi = 0.2 \times 3.14 \times 16 \times 10^{-4}$$
$$\Delta\phi = 10.048 \times 10^{-4}\ Wb$$
$$\varepsilon = N\frac{\Delta\phi}{\Delta t}$$

Putting the values, we get

$$\varepsilon = \frac{1 \times 10.048 \times 10^{-4}}{5 \times 10^{-3}}$$
$$\varepsilon = \frac{10.048}{5} \times 10^{-1}$$
$$\varepsilon = 2.01 \times 10^{-1}\ volts$$

New current through ring is

$$I = \frac{\varepsilon}{R}$$

Putting the values, we get

$$I = \frac{2.01 \times 10^{-1}}{1 \times 10^{-3}}$$
$$I = 2.01 \times 10^2$$
$$or \quad I = 201\ A$$

OBJECTIVES (MCQ'S) OF CHAPTER-16 ACCORDING TO ALP SMART SYLLABUS-2020

Topic I: Alternating Current:

1. The instantaneous value of current is:
(A) $I_o\sin(2\pi f)$ (B) $I_o\sin(2\pi)$ (C) $I_o\sin(2\pi fL)$ (D) $I_o\sin(2\pi ft)$

2. The most common source of alternating voltage is: **(2 Times)**
(A) Motor (B) Transformer (C) AC generator (D) All of these

3. If $I_{rms}=10A$ then I will be equal to:
(A) 14.2A (B) 1.42A (C) 142A (D) 0.142A

4. For an open circuit, the current flowing through circuit will be:
(A) Infinite (B) Finite (C) Maximum (D) Zero

5. If I_o is the peak value of AC supply, then its rms value is given as I_{rms} = ____: **(2 times)**
(A) $\frac{I_o}{\sqrt{2}}$ (B) $\frac{I_o}{0.707}$ (C) $I_o\sqrt{2}$ (D) $\frac{7N}{8}$

6. The phase at negative peak will be:
(A) $\frac{\pi}{2}$ (B) $\frac{\pi}{3}$ (C) $\frac{3\pi}{2}$ (D) π

7. If V_{rms} are the root mean square value of voltage then peak value of voltage is:
(A) $\sqrt{2}V_{rms}$ (B) $2V_{rms}$ (C) $\frac{V_{rms}}{\sqrt{2}}$ (D) $\frac{\sqrt{2}}{V_{rms}}$

8. If $V_{rms}=10\sqrt{2}$ volts, then peak voltage V_o will be:
(A) 10 volts (B) 20 volts (C) 30 volts (D) $10/\sqrt{2}$ volts

9. In AC wave form, negative peak is obtained at the phase angle of:
(A) 90° (B) 120° (C) 270° (D) 360°

10. Main reason for the world wide use of AC is that it can be transmitted to:
(A) Short distance at very low cost (B) Long distance at very high cost
(C) Short distance at very high cost (D) Long distance at very low cost

11. The highest value reached by the voltage or current in one cycle is called:
(A) Peak to peak value (B) Peak value
(C) Instantaneous value (D) Root mean square value

12. The peak value of alternating current is I_o. Its mean square value is:
(A) O (B) $2I_o$ (C) $I_o^2/2$ (D) I_o^2

13. The sum of positive and negative peak values is called: **(2 times)**
(A) Average value (B) r m s value (C) peak value (D) P- P value

14. The phase angle at +ve positive peak is: **(3 times)**
(A) $\frac{\pi}{2}$ (B) π (C) $\frac{3\pi}{2}$ (D) 2π

15. During each cycle AC voltage reaches a peak value: **(2 Times)**
(A) Once (B) Twice (C) Thrice (D) Four times

16. The waveform of alternating voltage is a:
(a) Contangent curve (b) cosine curve (c) Tangent curve (d) sine curve

17. The peak value of A.C source is 20 A, and then its rms value will be:
(a) 14.1 A (b) 10 A (c) 20 A (d) 28.2 A

18. An A.C. Voltmeter reads 220 V, its peak value will be: **(2 Times)**
(A) 255 V (B) 340 V (C) 311.12V (D) 300 V

19. One of the source of an A.C voltage is:

(A) A.C generator (B) Battery (C) UPS (D) Solar cell

20. The sum of positive and negative peak values are usually written as:
(A) P-P value (B) rms values (C) cycle values (D) p-n values

Topic III: A.C through Resistor:

21. The basic circuit element in a D.C circuit is: **(2 Times)**
(A) Resistor (B) Inductor (C) Capacitor (D) Transistor

22. In an AC circuit with resistor only the current and voltage have a phase of angle of:
(A) 180° (B) 90° (C) 0° (D) 60°

23. In pure resistive AC circuit the instantaneous values of current and voltage are:
(A) In phase (B) Perpendicular to each other
(C) Out of phase (D) May or may not be in phase

24. The phase difference between the voltage and current through resistor is: **(2 times)**
(A) 0° (B) 45° (C) 180° (D) 270°

25. Direct current cannot flow through:
(a) Inductor (b) Resistor (c) transistor (d) capacitor

Topic IV: A.C through Capacitor:

26. The phase difference between each pair of coils of a three phase AC generator is:
(A) 0° (B) 90° (C) 120° (D) 180°

27. The reactance Xc of a capacitor C when connected across an AC source of frequency 'f' is given by:
(A) $2\pi fC$ (B) $\frac{1}{2\pi fC}$ (C) $\frac{2\pi f}{C}$ (D) $\frac{C}{2\pi f}$

28. In the capacitive circuit of AC quantity when q = 0 the slope of q-t curve is: **(2 times)**
(A) Maximum (B) Minimum (C) Zero (D) Negative

29. Capacitor will have a large reactance at:
(A) Low frequency (B) High frequency (C) Zero frequency (D) Negative frequency

30. In capacitor:
(A) Current leads voltage by $\frac{\pi}{2}$ (B) Current lags voltage by $\frac{\pi}{2}$
(C) Current leads the voltage by π (D) Both are in phase

31. The slope of q-t curve at any instant of time gives:
(A) Current (B) Voltage (C) Charge (D) Both A and B

32. The opposition offered by a capacitor to the flow of an A.C is called:
(A) Capacitance (B) Resistance (C) Reactance (D) Inductance

33. At high frequency the value of reactance of capacitor will be: **(6 times)**
(A) Small (B) zero (C) large (D) infinite

34. In case of capacitor, the unit of reactance is:
(A) Ohm (B) Mho (C) Farad (D) Henry

35. The reactance of capacitor is equal to:
(A) ωc (B) ω/c (C) c/ω (D) $\frac{1}{\omega c}$

36. 100 μF capacitor is connected to an AC voltage of 24 V and frequency 50 Hz. The reactance of the capacitor is:
(A) 30.8 Ω (B) 31.8 Ω (C) 34.8 Ω (D) 40 Ω

37. In pure capacitor AC circuit, the current I and charge q are:
(A) In phase (B) Out of phase (C) Parallel to each other (D) None of above

Topic V: A.C through Inductor:

38. A device that allows only the flow of DC through a circuit is: **(3 Times)**
(A) Inductor (B) Capacitor (C) AC generator (D) Transformer

39. Inductive reactance of an inductor is:
(A) $X_L=\pi fL$ (B) $X_L=4\pi fL$ (C) $X_L=2\pi fL$ (D) $X_L=2\pi L$

40. Reactance of inductor is very high when there is:
(A) High frequency current (B) Low frequency current

(C) High frequency inductor (D) Low frequency inductor

41. A.C through inductor, the applied voltage:

(A) Leads the current by $\frac{\pi}{2}$ (B) lags the current by $\frac{\pi}{2}$

(C) And Current are in Phase (D) And Current is out of phase 180°

42. The reactance of an inductor is:

(A) ωL (B) $\frac{1}{\omega L}$ (C) $\frac{\omega}{L}$ (D) $\frac{L}{\omega}$

43. The phase difference between current and voltage in an Inductive circuit is:

(A) Zero (B) 90° (C) 180° (D) 45°

44. An inductor of 1 Henry inductance has a reactance 500 Ohms, then the frequency required is approximately: **(2 times)**

(A) 50Hz (B) 100Hz (C) 80Hz (D) 120Hz

45. When an inductor comes close to a metallic object, its inductance is:

(A) Decreased (B) Increased (C) Becomes half (D) Becomes 4 itmes

46. Which consumes small power?

(A) Inductor (B) Resistor (C) Motor (D) All of them

47. The inductiance of a coil can be increased by using.

(A) Air as core metrial (B) Iron as core material

(C) Copper as core material (D) Bismith as core material

48. A device which opposes the flow of A.C. is

(A) resistor (B) capacitor (C) inductor (D) None

Topic VI: Impedance:

49. The impedance Z can be expressed by: **(3 Times)**

(A) $Z = \frac{Vrms}{Irms}$ (B) $Z = \frac{Irms}{Vrms}$ (C) Z = I + V (D) Z = I − V

50. SI unit of impedance is: **(2 Times)**

(A) Henry (B) Hertz (C) Ampere (D) Ohm

51. At resonance frequency the impedance of RLC series circuit is: **(2 Times)**

(A) Zero (B) Minimum (C) Maximum (D) Moderate

52. When 10V are applied to an A.C circuit, the current flowing in it is 100mA. Its impedance is:

(A) 100 Ω (B) 10 Ω (C) 1000 Ω (D) 1 Ω

Topic VII: R.C and R.L Series Circuit:

53. When an RC circuit is connected across a battery amount of charge deposited on plates is ____ times the equilibrium charge after one time constant:

(A) 0.63 (B) 0.67 (C) 0.75 (D) 0.86

54. In LC series circuit the phase angle between X_L and X_C is:

(A) $\tan^{-1}\frac{\omega L}{R}$ (B) $\tan^{-1}\frac{\omega}{RL}$ (C) $\tan^{-1}\frac{\omega C}{R}$ (D) π rad

Topic VIII: Power in A.C Circuits:

55. The power factor of an AC series circuit is:

(A) Always greater than one (B) Always less than one

(C) Always equal to one (D) Zero

56. Power dissipation is zero in a circuit of:

(A) Inductor (B) Capacitor (C) Resistor (D) Inductor and capacitor

57. The power dissipated in AC circuit is given by $P = I_{rms}V_{rms}\cos\theta$ in this relation $\cos\theta$ is called: **(2 Times)**

(A) Phase factor (B) Gain factor (C) Loss factor (D) Power factor

58. Power dissipation in a pure inductive or in a pure capacitance circuit is: **(2 times)**

(A) Infinite (B) Zero (C) Minimum (D) Maximum

59. The power dissipation in AC circuit is expressed as:

(A) $P = I_{rms} \times V_{rms}\cos\theta$ (B) $P = I \times V\cos 2\theta$

(C) $P = I_{rms} \times V_{rms}\sin\theta$ (D) $P = I \times V\sin 2\theta$

60. Power dissipated in pure conductor is:

a) Large (b) small (c) infinite (d) zero

Topic IX: Series Resonance Circuit:

61. In RLC series resonance circuit, at resonance frequency, impedance 'Z' is: (2 times)

(A) $\sqrt{R^2 + X_L^2}$ (B) R (C) $\sqrt{R^2 + X_C^2}$ (D) X_L

62. At higher frequencies, which of the following plays a dominant role in RLC series circuit:

(A) Resistor (B) Inductor (C) Capacitor (D) Transistor

63. The condition of resonance in R-L-C series circuit is:

(A) $X_L = X_C$ (B) $X_L > X_C$ (C) $X_L < X_C$ (D) All of these

64. In R-C-L series circuit, the current at resonance frequency is: **(2 times)**

(A) Minimum (B) Zero (C) Maximum (D) Infinite

65. Resonating frequency of RLC series circuit of $f_r =$ _____:

(A) $\frac{2\pi}{\sqrt{LC}}$ (B) $\frac{1}{2\pi}\sqrt{LC}$ (C) $\frac{1}{2\pi\sqrt{LC}}$ (D) $2\pi\sqrt{LC}$

66. At resonance the value of current in RLC series circuit is equal to:

(A) $\frac{V_o}{R}$ (B) V_oR (C) $\frac{1}{2}$ (D) Zero

67. During frequency modulation when amplitude of signal is zero, the frequency of carrier wave is:

(A) Zero (B) Maximum (C) Minimum (D) Normal

68. In RLC series circuit at resonance the phase difference between capacitor and inductor reactances is:

(A) 90° (B) 270° (C) 0° (D) 180°

69. At resonance frequency the impedance of RLC series circuit is:

(A) Zero (B) Minimum (C) Maximum (D) Moderate

70. In RLC – series circuit, at resonance frequency X_C and X_L are:

(A) In phase (B) Opposite in phase (C) Differ by a phase $\frac{\pi}{2}$ (D) At angle of 120°

71. If the frequency of AC supplied is doubled then the capacitive reactance becomes:

(A) Half (B) Two times (C) Four Times (D) One Fourth

Topic X: Parallel Resonance Circuit:

72. At resonance frequency, the impedance of RLC — Parallel Circuit is:-

(a) Zero (b) Infinite (c) Minimum (d) Maximum

73. In R-L-C circuit, the energy is dissipated in:-

(a) R only (b) R and L (c) R and C (d) R, L and C

Topic XI: Three Phase A.C Supply:

74. Three phae AC supply machine has:

(A) No terminal (B) 2 terminal (C) 4 terminal (D) 6 terminal

75. In three phase voltage across any two lines is about: **(2 times)**

(a) 220 V (b) 230 V (c) 400 V (d) 430 V

76. In a three phase AC generator the phase difference between each pair of coil is: **(3 Times)**

(a) 45° (b) 60° (c) 90° (d) 120°

Topic XII: Principle of Metal Detector:

77. Metal detector work with the help of:

(A) RC circuit (B) RL circuit (C) LC circuit (D) RLC series circuit

Topic XIII: Choke:

78. Resistance of choke is: **(2 times)**

(A) Zero (B) Very small (C) Large (D) Infinite

79. In choke of inductance L and resistance R:

(A) L is large and R is small (B) L is small R is large
(C) Both L and R are large (D) Both L and R are small

80. Choke consumes extremely small: **(3 Times)**
(a) Current (b) Charge (c) Power (d) Potential

Topic XIV: Electromagnetic Waves:

81. X-Rays have wavelength of the order of:
(A) 10^{-4}m (B) 10^{-5}m (C) 10^{-10}m (D) 10^{-2}m

82. High frequency radio wave is called: **(3 Times)**
(A) Fluctuated wave (B) Carrier wave (C) Matter wave (D) Energy wave

83. The amplitude modulated transmission waves have frequencies range:
(A) 540 Hz to 1600 Hz (B) 540 kHz to 1600 kHz
(C) 540 Hz to 1600 MHz (D) 88 MHz to 108 MHz

84.Electrons vibration 94,000 times each second will produce radio waves of frequency.
(A) 94Hz (B) 940Hz (C) 940 KHz (D) 94 KHz

85. The frequency range for F.M is given by: **(3 times)**
(A) 88 MHz – 108 MHz (B) 88 KHz – 108 KHz
(C) 540 MHz – 1600 MHz (D) 540 KHz – 1600 KHz

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86. If the frequency of A.C. Supply is doubled then the reactance of the capacitor is:
(a) Half (b) Two times (c) four times (d) one fourth

87. In three phase A.C. supply, if first coil has phase 0^0, then the other two coils will have phases: **(2 times)**
(a) 0^0 to 120^0 (b) 120^0 and 240^0 (c) 240^0 and 360^0 (d) 0^0 and 360^0

88. The unit of $\sqrt{LC}$ is:
(a) second (b) Ampere (c) Hertz (d) Farad

89. At what frequency, 1 H inductance offers same impedance as 1μF capacitor:
(a) 50Hz (b) 159 Hz (c) 512 Hz (d) 1590 Hz

90. Metal detector consists of:
(A) L C circuit (B) R L circuit (C) R C circuit (D) R L C series circuit

91. S.I unit of reactance is: **(2 times)**
(A) Farad (B) Volt (C) Ampere (D) Ohm

92. The device which allows only the continuous flow of AC through it is:
(A) Capacitor (B) Inductor (C) Battery (D) Thermistor

93. The inductive reactance of a coil is directly proportional to:
(A) Inductance (B) Resistance
(C) Frequency of A.C (D) Both Frequency of A.C and Inductance

94. At resonance, the behaviour of R – L – C series circuit is:
(A) Resistive (B) Capacitive (C) Inductive (D) Modulative

95. In metal detectors, we use:
(A) RL circuit (B) RC circuit (C) LC circuit (D) any of these

96. In frequency modulation, which factor is changed:
(A) Amplitude of carrier waves (B) Frequency of carrier wave
(C) Amplitude of signal (D) Frequency of signal

97. If V_0 is the peak value of A.C. voltage, its rms value is:
(A) $V_{rms} = \sqrt{2}V_0$ (B) $V_{rms} = \frac{V_0}{2}$ (C) $V_{rms} = \frac{\sqrt{2}}{V_0}$ (D) $V_{rms} = \frac{V_0}{\sqrt{2}}$

98. The inductive reactance X_L of coil of inductance 'L' across an A.C. source is given by:
(A) $X_L = \frac{1}{2\pi f L}$ (B) $X_L = \frac{2\pi f}{L}$ (C) $X_L = \frac{1}{\pi f L}$ (D) $X_L = 2\pi f L$

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99. When a metal detector comes close to a metal then its frequecy:

(A) becomes double (B) Remains same (C) Becomes half (D) Increases

100. In RLC series circuit, at higher frequencies:
(A) $X_L = X_C$ (B) $X_L > X_C$ (C) $X_L < X_C$ (D) $X_L = 0$

101. Which device permits the flow of D.C?
(A) Capacitor (B) Photocell (C) Inductor (D) Transformer

102. Which of the following waves do not travel at the speed of light:
(A) Radio waves (B)X-rays (C) Sound waves (D) Heat waves

103. When A.C passes through an inductor, voltage leads the current by an angle:
(A) 0° (B) 45° (C) 90° (D) 180°

104. If we connect an ordinary D.C. Ammeter to measure alternating current, it would measure its value as:
(A) Instantaneous Value over a cycle (B) Peak to peak value
(C) Averaged over a cycle (D) r.m.s. value

105. The impedance of R-L series circuit is:
(A) $Z=\sqrt{R^2+X_L^2}$ (B) $Z=\sqrt{R^2+X_C^2}$ (C) $Z=\sqrt{R+X_L}$ (D) Z=R

106. The capacitance required to construct a resonance circuit of frequency 1000 kHz with an inductor of 5mH is:
(A) 5.09 pF (B) 5.09 μF (C) 5.09mF (D) 50.9 pF

107. The peak to peak value is:
(A) V_0 (B) - V_0 (C) $\sqrt{2}V_0$ (D) 2 V_0

ANSWERS OF THE MULTIPLE CHOICE QUESTIONS

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
D	C	A	D	A	C	A	B	C	D	B	C	D	A	B	D
17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
A	C	A	A	A	C	A	A	D	C	B	A	A	A	A	C
33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
A	A	D	B	B	A	C	A	A	A	B	C	A	A	B	C
49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64
A	D	B	A	A	D	C	D	D	B	A	D	B	B	A	C
65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
C	A	D	D	B	B	A	D	A	C	C	D	C	B	A	C
81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96
C	B	B	D	A	A	B	A	B	A	D	A	D	A	C	B
97	98	99	100	101	102	103	104	105	106	107					
D	D	D	B	C	C	C	C	A	A	D					

SHORT QUESTIONS OF CHAPTER-16
ACCORDING TO ALP SMART SYLLABUS-2020

Topic I: Alternating Current:

1. A sinusoidal current has rms value of 10A. What is the maximum or peak value? **(16 Times) (H.W)**

Ans: It is given that
$$I_{rms} = 10\ A$$
$$I_0 = ?$$
Since
$$I_{rms} = \frac{I_0}{\sqrt{2}}$$
$$I_0 = \sqrt{2}I_{rms}$$
$$I_0 = 1.414 \times 10$$
$$I_0 = 14.14\ A$$

2. Differentiate between peak value and peak to peak value. **(4 Times)**

Ans: **Peak value:** It is the highest value reached by the voltage or current in one cycle. It is denoted by the V_0.

Peak to peak value: It is the sum of the positive and negative peak values usually written as p-p value.

3. In relation $V = V_0 \sin\theta$. What angle θ shows?

Ans: In $V = V_0 \sin\theta$

Here $\theta = \omega t$

It specifies the instantaneous value of the alternating voltage or current known as its phase.

4. Find the peak value of the voltage V_o of an AC supply for which root mean square voltage is 0.7 V.

Ans: Given that

$$V_{rms} = 0.7\,V$$
$$V_o = ?$$

Since

$$V_{rms} = \frac{V_o}{\sqrt{2}}$$
$$V_o = \sqrt{2}V_{rms}$$
$$V_o = \sqrt{2}(0.7)$$
$$V_o = 0.989\,V \approx 1\,V$$

5. What is the root mean square value of current? Explain. **(2 times)**

Ans: The square root of mean square values of current is called root mean square (rms) value of current.

$$I_{rms} = \frac{I_0}{\sqrt{2}}$$

The average value of current over a cycle is zero but the power delivered during a cycle is not zero because power is I^2R and the values of I^2 are positive even for negative values of I.

6. Define Instantaneous Value and Peak Value of Current. **(2 times)**

Ans: The value of current or voltage at any instant is called instantaneous value and the maximum value of current or voltage is called peak value.

7. Define peak to peak value of A.C. voltage.

Ans: It is the sum of the positive and negative peak values. If V_o is the peak value of the voltage waveform then p-p value is $2V_o$.

8. Define phase of alternating voltage. **(2 times)**

Ans: The angle $\theta = \omega t$ which specifies the instantaneous value of the alternating voltage or current is known as its phase.

9. How many times per second will an incandescent lamp reach maximum brilliance when connected to a 50 Hz source? Explain. **(10 Times) (C.W)**

Ans: An incandescent lamp will reach maximum brilliance two times in a cycle. One time for positive half cycle and one for negative half cycle.

So, the maximum brilliance per second will be

$$2f = 2 \times 50 = 100 \text{ times}$$

10. What is the difference between A.C circuit and D.C circuit?

Ans: In A.C circuit, in addition to resistor R, inductor and capacitor are used to control the current and voltage.

In D.C circuit, resistor R is used to control the current and voltage.

11. What is the main reason for the world-wide use of A.C.?

Ans: Because it can be transmitted to long distances easily and at a very low cost. Its power losses are very small and it may step up or step down by means of a transformer.

12. An AC voltmeter reads 250V. What is its peak value? **(2 Time)**

Ans: Given that $V_{rms} = 250V$, $V_0 = ?$

We know that

$$V_{rms} = \frac{V_0}{\sqrt{2}}$$

$$V_0 = V_{rms}\sqrt{2} = \sqrt{2} \times 250V = 353.5V$$

13. An alternating current is represented by equation I = 20 Sin100πt. Compute its frequency and rms value of current.

Ans: I = 20 Sin100πt ________ (i)

f = ?

I_{rms} = ?

An alternating current is given by

$I = I_0$ Sin2πft ________ (ii)

Comparing equation (i) and (ii)

I_0 = 20A

& 2πft = 100πt

⇨ 2f = 100

⇨ f = 50Hz

We know that

$$I_{rms} = \frac{I_0}{\sqrt{2}} = \frac{20}{\sqrt{2}} = 14A$$

14. What do you mean by phase lag and phase lead? **(2 Time)**

Ans: The angle θ which specifies the instantaneous value of the alternative voltage or current, gives the phase lag or phase lead of one quantity over the other. The phase difference between two alternative quantities is observed at different points. The quantity which has greater phase at all points is said to be leading and the other is said to be lagging behind.

15. Define A.C current. Make its waveform.

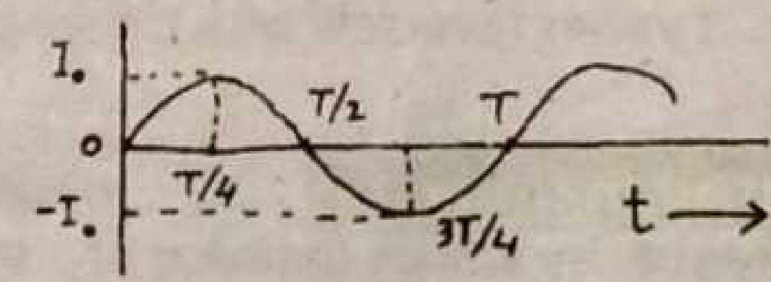
Ans: A.C is that which is produced by a voltage source whose polarity keeps on reversing with time.

16. A sinusoidal current has rms value of 15A. What is the maximum value?

Ans: As $I_{rms} = \frac{I_0}{\sqrt{2}}$

Or $I_0 = \sqrt{2}I_{rms}$

$I_0 = \sqrt{2} \times 15 = 21.21A$



17. Define peak value and peak to peak value of voltage or current.

Ans: **Peak value** is the highest value reached by the voltage or current in one cycle. **Peak to peak value** is the sum of the positive and negative peak values.

Topic III: A.C through Resistor:

18. Define reactance. Describe the condition which will make the reactance small.

Ans: The opposition offered by capacitor or inductor to the flow of alternating current is called reactance.

For a capacitor reactance will be small when frequency is large and for an inductor reactance will be small when frequency is small.

Topic IV: A.C through Capacitor:

19. How does doubling the frequency affect the reactance of an inductor and a capacitor? **(23 Time) (H.W)**

Ans: For inductor $X_L = \omega L = 2\pi f L$

By doubling the frequency

$$X_L' = 2\pi(2f)L = 2(2\pi f L)$$
$$X_L' = 2X_L$$

That is, inductive Reactance will be doubled.

and for capacitor $X_C = \frac{1}{\omega C} = \frac{1}{2\pi f C}$

By doubling the frequency

$$X_C' = \frac{1}{2\pi(2f)C} = \frac{1}{2(2\pi f C)}$$
$$X_C' = \frac{1}{2}X_C$$

That is, capacitive Reactance will be halved.

20. Name the device that will: **(9 times) C.W**

a) Permit flow of direct current but oppose the flow of alternating current.

b) Permit flow of alternating current but not the direct current.

a) **Ans:** An inductor is a device which permits flow of direct current but opposes the flow of alternating current.

b) A capacitor is a device which permits flow of alternating current but not the direct current.

21. What is meant by inductive and capacitive reactance? **(2 Times)**

Ans: The measure of opposition offered by the inductor to the flow of alternating current is called inductive reactance. $X_L = \omega L$

And

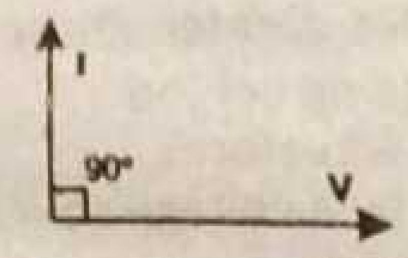
The measure of opposition offered by the capacitor to the flow of alternating current is called capacitive reactance.

$$X_C = \frac{1}{\omega C}$$

22. Which quantity, voltage or current leads in a capacitor and by how much angle?

Ans: Current leads the voltage in a capacitor by 90^o or $\frac{\pi}{2}$.

Vectorially



23. Define reactance of a Capacitor. Also write down its formula.

Ans: The opposition offered by a capacitor in the flow of A.C is called capacitive reactance. It varies inversely with the frequency of A.C. i.e.

$$X_C = \frac{1}{2\pi fC}$$

Topic V: A.C through Inductor:

24. At what frequency will an inductor of 1.0H have a reactance of 500Ω?(3 Times)

Ans: Given that

$$L = 1\,H$$
$$X_L = 500\,\Omega$$
$$f = ?$$

Since

$$X_L = \omega L$$
$$X_L = 2\pi f L$$
$$f = \frac{X_L}{2\pi L}$$
$$f = \frac{(500)}{2(3.14)(1)}$$
$$f = 80\,Hz$$

25. Define reactance of an inductor and write its formula.

Ans: The opposition offered by an inductor in the flow of AC is called inductive reactance which varies directly with frequency of AC. i.e. $X_L = 2\pi fL$

26. Why is power dissipated zero in pure inductive and pure capacitive circuit?

Ans: We know that in pure inductive circuit, voltage is leading 90° from current.

In pure capacitive circuit, current is leading by 90° from voltage.

In both the cases, the phase difference between current and voltage is 90°.

Therefore, power dissipated is zero.

As $P = VI\cos\theta$

So, $P = VI\cos 90^o = VI(0) = 0$

27. A circuit contains an iron – cored inductor, a switch and a D.C source arranged in series. The switch is closed and after an interval reopened. Explain why a spark jumps across the switch contacts. **(3 Times) C.W**

Ans: When switch is closed then circuit completes, current increases from zero to I and steady current flows through inductor.

When switch is reopened, the circuit will be open, and current suddenly decreases from I to zero.

According to Lenz's law "the direction of induced current is always so as to oppose the change which produced it". Thus when current decreases, induced current reinforce it and sparks are produced due to large value of current.

Topic VI: Impedance:

28. Define impedance and resonant frequency.

Ans: A measure of the opposition to the flow of charges in an AC circuit is called impedance. It is the combined effect of resistance and inductive and capacitive reactance's.

$$Z = \frac{V_{rms}}{I_{rms}}$$

Its unit is Ohm (Ω).

And

The frequency at which inductive and capacitive reactance become equal is called resonant frequency.

$$f_R = \frac{1}{2\pi\sqrt{LC}}$$

29. Define impedance, also give its units. **(3 times)**

OR Define impedance write down its unit and symbol.

Ans: The combined effect of resistances and reactances in an AC circuit is known as impedance. It is denoted by 'Z' and its SI unit is ohm (Ω).

30. Define impedance and write the impedance expression for R – L series circuits.

Ans: The combined effect of resistance and reactances in an AC circuit is known as impedance and is denoted by Z.

Impedance of R – L series circuit is given by

$$Z = \sqrt{R^2 + (\omega L)^2}$$

31. What is impedance? Write its formula.

Ans: The combined effect of resistances and reactances in an AC circuit is called impedance. It is denoted by "Z".

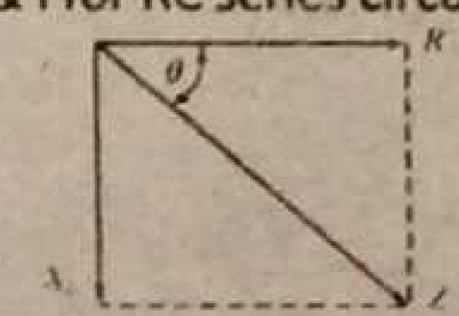
It is measured by the ratio of the rms value of the applied voltage to the rms value of resulting AC.

Thus $Z = \frac{V_{rms}}{I_{rms}}$

Topic VII: R.C and R.L Series Circuit:

32. Show that for RC circuit, the angle between current and voltage is given as $\theta = \tan^{-1}\left(\frac{1}{\omega RC}\right)$

Ans: Vector representation of V & I for RC series circuit is given as



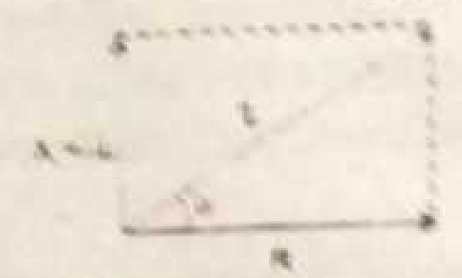
From figure,

$$\tan\theta = \frac{X_C}{R}$$
$$\tan\theta = \frac{\frac{1}{\omega CR}}{}$$
$$\theta = \tan^{-1}\left(\frac{1}{\omega RC}\right)$$

33. In a RL circuit, will the current lag or lead the voltage? Illustrate your answer by vector diagram. **(6 Times) C.W**

Ans: In an RL circuit, current lags the voltage by an angle

$$\theta = \tan^{-1}\left(\frac{\omega L}{R}\right)$$



Topic VIII: Power in A.C Circuits:

34. How power is calculated in an A.C circuit? Write its formula.

Ans: The power dissipated in A.C circuits is calculated by using the formula

$$P = I_{rms} V_{rms} \cos\theta$$

Where θ is the phase difference between I_{rms} & V_{rms} and cosθ is the power factor.

35. How can you establish the formula for power in A.C circuits? Explain the role of power factor in it.

Ans: When V and I are in phase, the expression for power is

$$P = V_{rms} I_{rms}$$

In A.C circuits the phase difference between applied voltage V and current I_{rms} is θ. The component of V along current I_{rms} is V_{rms} cosθ. So the power dissipated in A.C circuit is

$$P = I_{rms} V_{rms} \cos\theta$$

The factor cosθ is known as power factor. For resistive circuits power factor is one.

Topic IX: Series Resonance Circuit:

36. Write three characteristics of series resonance circuit.

Ans: The resonance frequency is given

$$f_r = \frac{1}{2\pi\sqrt{LC}}$$

The impedance of the circuit is minimum at resonance frequency and the current is maximum.

The impedance of the circuit at resonance is resistive so the current and the voltage are in phase and power factor is 1.

37. At resonance frequency the impedance of RLC series circuit is only resistive. Why?

Ans: At resonance frequency, the inductive reactance becomes equal and opposite to capacitive reactance and cancels each other. So the impedance of RLC circuit is only resistive.

38. Prove that $f_r = \frac{1}{2\pi\sqrt{LC}}$.

Ans: As at resonance condition $X_L = X_C$

$$\omega_r L = \frac{1}{\omega_r C}$$

$$\omega_r^2 = \frac{1}{LC}$$

$$\omega_r = \frac{1}{\sqrt{LC}}$$

$$2\pi f_r = \frac{1}{\sqrt{LC}}$$

$$f_r = \frac{1}{2\pi\sqrt{LC}}$$

Hence proved.

39. Write two properties of RLC series circuit.

OR Write two properties of series resonance circuit. **(2 times)**

Ans: 1. The impedance of the circuit at resonance is minimum and equal to R.

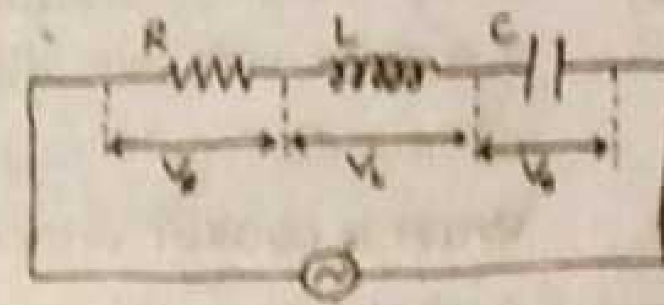
2. The power factor of RLC series circuit is 1.

3. The resonance frequency is given

$$f_r = \frac{1}{2\pi\sqrt{LC}}$$

40. Show that potential difference across LC is zero at resonating frequency in series LRC series circuit.

Ans: At resonance frequency



$$X_L = X_C$$

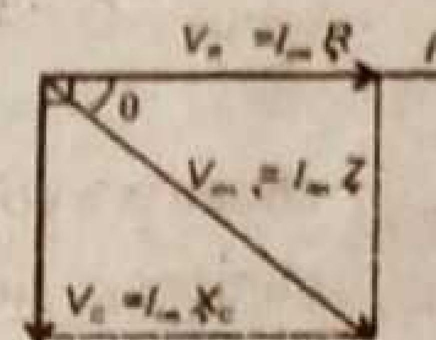
Or $IX_L = IX_C$

Or $V_L = V_C$

In inductor voltage V_L leads the current and in capacitor voltage V_C lags behind the current. Phase difference between V_L and V_C is 180°. Therefore, V_L and V_C being equal in magnitude cancels each other.

41. In R-C series circuit, will the current lag or lead the voltage. Illustrate your answer by a vector diagram.

Ans: In R-C series circuit current leads the voltage by an angle "θ" as shown in figure below.



The phase difference "θ" is given as

$$\theta = \tan^{-1}\left(\frac{V_c}{V_r}\right) = \tan^{-1}\left(\frac{1}{\omega CR}\right)$$

Topic X: Parallel Resonance Circuit:

42. Give any two properties of parallel resonant circuit. **(2 Times)**

Ans: At resonance frequency, the circuit impedance is maximum.

At resonance, the circuit current is minimum and is in phase with the applied voltage.

Topic XI: Three Phase A.C Supply:

43. Write down two advantages or uses of three phase AC supply. **(4 Time)**

Ans: I. The main advantage of having a three phase supply is that the total load of the house or a factory is divided in three parts, so that none of the line is overloaded.

i. Three phase supply also provides 400 V which can be used to operate some special appliances which require 400 V for their operation.

Topic XII: Principle of Metal Detector:

44. Explain the principle of metal detector.

Ans: Difference of frequencies of two LC oscillator circuits caused by placing the metallic object near one of them results to produce the beats.

45. What is the principle of metal detector? Write two uses of metal detector.

Ans: In metal detectors, two electric (L – C) oscillators A and B having same resonance frequency are used. When inductor B, called the search coil comes near a metal object, its inductance decreases and corresponding oscillator frequency increases and thus a beat note is heard in the attached speaker.

(i) It is used for various security checks.

(ii) It is used to locate buried metal objects.

Topic XIII: Choke:

46. A choke coil placed in series with an electric lamp in AC circuit, the lamp to become dim, why is it so? **(2 Times)**

Ans: When there is no inductance or capacitance in the circuit then

$$Z = R$$

So $I_1 = \frac{V}{R}$

And when choke coil is in series with an electric lamp then

$$Z = \sqrt{R^2 + X_L^2}$$

So $I_2 = \frac{V}{\sqrt{R^2 + X_L^2}}$

On comparison, it can be seen that $I_2 < I_1$

Thus an electric lamp is dimmed on placing a choke coil in the circuit.

(4 Times)

47. What is choke?

Ans: It is a coil of thick copper wire wound closely over a soft iron laminated cores. It is used in AC circuits to limit current with extremely small wastage of energy as compared to a resistance or a rheostat.

48. What is choke? Why is it used in AC circuit? **(3 Times)**

Ans: A choke is a coil made of thick insulated copper wire wound closely in a large number of turns over a soft iron laminated core. It is used to control alternating current through a circuit without much loss of energy.

49. Define alternating current and choke.

Ans: Alternating current is that which is produced by a voltage source whose polarity keeps on reversing with time.

$$I = I_0 \sin 2\pi ft$$

Choke is a coil which consists of thick copper wire wound closely in a large number of turns over a soft iron laminated core. Its resistance is very small. It consumes extremely small power.

50. Define choke and impedance.

Ans: Choke is a coil which consists of thick copper wire wound closely in a large number of turns over a soft iron laminated cores. It consumes extremely small power.

The combined effect of resistances and reactances in an A.C circuit is called **impedance.**

$$Z = \frac{V_{rms}}{I_{rms}}$$

Topic XIV: Electromagnetic Waves:

51. Write the conditions under which electromagnetic waves are produced from a source? **(8 Times)**

Ans: Electromagnetic waves are produced according to the following

"A changing magnetic flux creates an electric field and a changing electric flux creates magnetic field."

52. Define choke and electromagnetic waves.

Ans: Choke is a coil which consists of thick copper wire wound closely in a large number of turns over a soft iron laminated cores. It consumes extremely small power.

Electromagnetic waves are those which require no medium for transmission and rapidly propagate through vacuum. e.g. visible light, x-rays, gamma rays etc.

Topic XV: Principle of Generation:

53. How the reception of a particular radio station is selected on your radio set? **(8 Time)**

Ans: A particular radio station can be selected on a radio set by tuning it. When the frequency of the LC oscillator in the radio set is equal to the frequency of the radio wave from a particular radio station, a resonance is produced.

$$f_r = \frac{1}{2\pi\sqrt{LC}}$$

The current of this signal becomes maximum and can be detected and amplified.

54. What is the principle of generation of electromagnetic waves.

Ans: According to Maxwell's equations:

"A changing magnetic flux creates an electric field and changing electric flux creates a magnetic field."

Electromagnetic waves are generated when electric or magnetic flux is changing through a certain region of space.

LONG QUESTIONS OF CHAPTER-16 ACCORDING TO ALP SMART SYLLABUS-2020

Topic III: A.C through Resistor:

1. Explain A.C. through resistor in detail.

Topic IV: A.C through Capacitor:

2. Explain phase relationship between voltage and current when an AC source is connected across a capacitor. Also derive the relation for reactance of a capacitor.

Topic V: A.C through Inductor:

3. Discuss the working of an inductor by A.C source. Find its reactance.
4. Explain the behaviour of A.C through an inductor. Also show that the reactance of a coil depends upon the frequency of the A.C. and inductance L. **(2 times)**

Topic VI: Impedance:

5. What is impedance? Describe series resonance circuit and give its two results.
6. Define impedance and derive a relation for impedance and phase angle for RL and RC series circuit.

Topic VII: R.C and R.L Series Circuit:

7. What is RC series circuit? Derive an expression for impedance and phase angle of RC series circuit. **(4 Times)**
8. Describe the behaviour of RC and RL series circuits with an A.C source. Calculate the impedance of both the circuits by drawing their impedance diagram.
9. What is the behavior of A.C. in R-C and R-L series circuit, also find their impedances.

Topic IX: Series Resonance Circuit:

10. Discuss R-L-C series feeding by A.C source. Find out its resonance frequency.
11. Describe RLC Series Circuit and derive the relation for resonance frequency and write down at least two of its properties. **(2 times)**
12. Describe an R-L-C series circuit. Draw its impedance diagram and derive expression for its resonance frequency. Also write down its properties.
13. Describe series resonance circuit. Find formula for resonance frequency and write its properties. **(2 times)**
14. Draw the circuit diagram of (R-L-C) series resonance circuit. Discuss its behavior for A.C and also write down its properties. **(4 Times)**
15. Describe series resonance circuit. Find formula for resonance frequency and write its properties.

Topic XIV: Electromagnetic Waves:

16. What are electromagnetic waves? Discuss principle of generation, transmission and reception of electromagnetic waves. **(5 Times)**

NUMERICAL PROBLEMS OF CHAPTER-16 ACCORDING TO ALP SMART SYLLABUS-2020

Topic IV: A.C through Capacitor:

1. Find the capacitance required to construct a resonance circuit of frequency 1000 kHz with an inductor of 5 mH. **(3 Times)** (Example No. 16.7)

Ans: Given that $resonance\ frequency = f_r = 1000\ kHz = 10^6\ Hz$

$$self\ inductance = L = 5\,mH = 5 \times 10^{-3}\,H$$
$$capacitance = C = ?$$

Since $f_r = \frac{1}{2\pi\sqrt{LC}}$

$$f_r^2 = \frac{1}{4\pi^2 LC}$$
$$C = \frac{1}{4\pi^2 L f_r^2}$$
$$C = \frac{1}{4(3.14)^2(5\times10^{-3})(10^6)^2}$$
$$C = 5.09 \times 10^{-12}\,F \boxed{= 5.09\,pF}$$

2. A 100 μF capacitor is connected to an alternating voltage of $24\,V$ and frequency $50\,Hz$. Calculate (4 Times) (Example No. 16.2)

(a) The reactance of the capacitor

(b) The current in the circuit

Ans: Given that $C = 100\,\mu F = 100 \times 10^{-6}\,F$

$$V = 24\,V$$
$$f = 50\,Hz$$
$$X_C = ?$$
$$I_{rms} = ?$$

(a) The reactance of the capacitor

Since $X_C = \frac{1}{\omega C}$ $\quad X_C = \frac{1}{2\pi f C}$

$$X_C = \frac{1}{2\times3.14\times50\times100\times10^{-6}} \boxed{= 31.8\,\Omega}$$

(b) The current in the circuit

Since $X_C = \frac{V_{rms}}{I_{rms}}$ $\quad I_{rms} = \frac{V_{rms}}{X_C}$

$$I_{rms} = \frac{24}{31.8} \boxed{= 0.75\,A}$$

3. Find the value of current flowing through a capacitance $0.5\,\mu F$ when connected to source of $150\,V$ at $50\,Hz$. (2 times) (H.W)

Ans: Given that $C = 0.5\,\mu F = 0.5 \times 10^{-6}\,F$

$$V = 150\,V$$
$$f = 50\,Hz$$
$$I_{rms} = ?$$

Since $X_C = \frac{1}{\omega C}$ $\quad X_C = \frac{1}{2\pi f C}$

$$X_C = \frac{1}{2\times3.14\times50\times0.5\times10^{-6}}$$
$$X_C = 6369.4\,\Omega$$

Now $X_C = \frac{V_{rms}}{I_{rms}}$ $\quad I_{rms} = \frac{V_{rms}}{X_C}$

$$I_{rms} = \frac{150}{6369.4} \boxed{= 0.024\,A}$$

Topic V: A.C through Inductor:

4. A circuit has an inductance of $1/\pi$ H and resistance of $2000\,\Omega$. A $50\,Hz$ AC is supplied to it. Calculate the reactance and impedance offered by the circuit. (2 times) (H.W)

Ans: Given that $L = \frac{1}{\pi}H$

$$R = 2000\,\Omega$$
$$f = 50\,Hz$$
$$X_L = ?$$
$$Z = ?$$

Since $X_L = \omega L$

$$X_L = 2\pi f L$$
$$X_L = 2\pi \times 50 \times \frac{1}{\pi}$$
$$\boxed{X_L = 100\,\Omega}$$

And $Z = \sqrt{R^2 + X_L^2}$

$$Z = \sqrt{(2000)^2 + (100)^2} \boxed{= 2002.5\,\Omega}$$

5. At what frequency will an inductor of $1.0\,H$ have a reactance of $500\,\Omega$? (3 times) (Example No. 16.4)

Ans: Given that

$$L = 1.0\,H$$
$$X_L = 500\,\Omega$$
$$f = ?$$

Since $X_L = \omega L$

$$X_L = 2\pi f L$$
$$f = \frac{X_L}{2\pi L}$$
$$f = \frac{500}{2\times3.14\times1.0} \boxed{= 80\,Hz}$$

6. Find the value of the current and inductive reactance when AC voltage of $220\,volt$ at $50Hz$ is passed through an inductor of $10H$. (7 Time) (H.W)

Ans: Given that $V = V_{rms} = 220\,V,\ L = 10\,H,\ f = 50\,Hz$

$$I = ?$$
$$X_L = ?$$

Since $X_L = \omega L$

$$X_L = 2\pi f L$$
$$X_L = 2(3.14)(50)(10)$$
$$\boxed{X_L = 3140\,\Omega}$$

And

$$X_L = \frac{V_{rms}}{I_{rms}}$$
$$I_{rms} = \frac{V_{rms}}{X_L}$$
$$I_{rms} = \frac{220}{3140}$$
$$\boxed{I_{rms} = 0.07\,A}$$

Topic VIII: Power in A.C Circuits:

7. A 10 mH, 20 Ω coil is connected across 240 V and $\frac{180}{\pi}$ Hz source. How much power does it dissipate? (7 times) (H.W)

Ans: Given that,

$$L = 10\,mH$$
$$R = 20\,\Omega$$
$$V_{rms} = 240\,V$$
$$f = \frac{180}{\pi}\,Hz$$
$$Power = P = ?$$

We know that,

$$Power = P = V_{rms} \times I_{rms} \cos\theta$$

First we have to calculate I_{rms} and θ, as

$$Z = \sqrt{R^2 + X_L^2}$$

Where, $X_L = 2\pi f L$

$$X_L = 2\pi \times \frac{180}{\pi} \times 10 \times 10^{-3}$$

$$\underline{X_L = 3.6\,\Omega}$$

Now

$$Z = \sqrt{(20)^2 + (3.6)^2}$$

$$Z = \sqrt{400 + 12.96}$$

$$Z = \sqrt{412.96}$$

$$Z = 20.32\,\Omega$$

For calculating I_{rms}

$$Z = \frac{V_{rms}}{I_{rms}}$$

$$I_{rms} = \frac{V_{rms}}{Z}$$

$$I_{rms} = \frac{240}{20.32}$$

$$I_{rms} = 11.81\text{ A}$$

For calculating θ in RL series circuit,

$$\theta = \tan^{-1}\left(\frac{X_L}{R}\right)$$

$$\theta = \tan^{-1}\left(\frac{3.6}{20.3}\right)$$

$$\theta = 10.2^\circ$$

Now power dissipation is,

$$P = V_{rms} \times I_{rms} \cos\theta$$

Putting the values we get,

$$P = 240 \times 11.81 \times \cos 10.2^\circ = 240 \times 11.81 \times 0.98$$

$$\boxed{P = 2778\text{ W}}$$

Topic IX: Series Resonance Circuit:

8. An inductor of inductance 150 μH is connected in parallel with a variable capacitor whose capacitance can be changed from 500 pF to 20 pF. Calculate the maximum frequency and minimum frequency for which the circuit can be tuned. **(C.W)**

Ans: Given that

$$L = 150\,\mu H = 150 \times 10^{-6}\,H$$

$$C_1 = 500\,pF = 500 \times 10^{-12}\,F$$

$$C_2 = 20\,pF = 20 \times 10^{-12}\,F$$

$$maximum\ frequency = f_{max} = ?$$

$$minimum\ frequency = f_{min} = ?$$

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

$$f \propto \frac{1}{\sqrt{C}}$$

So $f_{min} = \frac{1}{2\pi\sqrt{LC_1}}$

$$f_{min} = \frac{1}{2 \times 3.14 \times \sqrt{150 \times 10^{-6} \times 500 \times 10^{-12}}}$$

$$f_{min} = 0.58 \times 10^6\,Hz$$

$$\boxed{f_{min} = 0.58\,MHz}$$

and $f_{max} = \frac{1}{2\pi\sqrt{LC_2}}$

$$f_{max} = \frac{1}{2 \times 3.14 \times \sqrt{150 \times 10^{-6} \times 20 \times 10^{-12}}}$$

$$f_{max} = 2.91 \times 10^6\,Hz \boxed{= 2.91\,MHz}$$

9. What is the resonance frequency of the circuit, which includes a coil of inductance 2.5 H and a capacitance 40 μF? **(6 Times)**

Ans: Given that $L = 2.5\,H$

$$C = 40\,\mu F = 40 \times 10^{-6}\,F$$

$$resonance\ frequency = f_r = ?$$

Since $f_r = \frac{1}{2\pi\sqrt{LC}}$

$$f_r = \frac{1}{2(3.14)\sqrt{2.5 \times 40 \times 10^{-6}}} \boxed{= 15.9\,Hz}$$

Topic XI: Three Phase A.c Supply:

10. An alternating source of emf 12 V and frequency 50 Hz is applied to a capacitor of capacitance 3μF in series with a resistor of resistance 1 $K\Omega$. Calculate the phase angle. **(2 times) (C.W)**

Sol: As $V = 12\,volts$, $f = 50\,Hz$

$$C = 3\mu F = 3 \times 10^{-6}\,F$$

$$R = 1K\Omega = 1000\Omega$$

$$\theta = ?$$

$$X_c = \frac{1}{2\pi fc}$$

$$X_c = \frac{1}{2 \times 3.14 \times 50 \times 3 \times 10^{-6}} = \frac{1}{942} \times 10^6 = 1.061 \times 10^{-3} \times 10^6$$

$$X_c = 1.061 \times 10^3 = 1061\Omega$$

$$\theta = \tan^{-1}\left(\frac{X_c}{R}\right)$$

$$\theta = \tan^{-1}\left(\frac{1061}{1000}\right) = 46.7^\circ$$

ALP SMART SYLLABUS 2020

1. An A.C. voltmeter reads 250 V. What is its peak and instantaneous values if the frequency of alternating voltage is 50 Hz? **Example 16.1**

Sol:

rms value of alternating voltage = $V_{rms} = 250\,V$

Its peak value V_o is given by the relation

$$V_{rms} = \frac{V_o}{\sqrt{2}}$$

$$or \quad V_o = \sqrt{2}\,V_{rms} = \sqrt{2} \times 250\,V = 353.5\,V$$

Angular frequency $\omega = 2\pi f$

$$= 2 \times \pi \times 50Hz = 100\pi\,Hz$$

Therefore, instantaneous value is given by

$$V = V_o \sin \omega t$$

$$= 353.5 \sin(100\,\pi t)V$$

2. When 10 V are applied to an A.C. circuit the current flowing in it is 100 mA. Find its impedance. **Example 16.3**

Sol:

rms value of applied voltage = $V_{rms} = 10\,V$
rms value of current = $I_{rms} = 100\,mA = 100 \times 10^{-3} A$
Impedance Z = $\frac{V_{rms}}{I_{rms}} = \frac{10V}{100 \times 10^{-3}A} = 100\Omega$

3. An iron core coil of 2.0 H and 50 Ω is placed in series with a resistance of 450 Ω. An A.C. supply of 100 V, 50 Hz is connected across the circuit. Find (i) the current flowing in the coil, (ii) phase angle between the current and voltage. Example 16.5

Sol:

Resistance = R = 50 Ω + 450 Ω = 500 Ω
Inductance = L = 2.0 H
Supply voltage = $V_{rms} = 100\,V$
Frequency = f = 50 Hz
The reactance = $X_L = \omega L = 2\pi f L$
$= 2 \times 3.14 \times 50 s^{-1} \times 2.0\,H = 628\,\Omega$
Impedance = Z = $\sqrt{R^2 + (\omega L)^2}$
$= \sqrt{(500\Omega)^2 + (628\Omega)^2} = 803\Omega$
Current $I_{rms} = \frac{V_{rms}}{Z} = \frac{100\,V}{803\,\Omega} = 0.01245\,A = 12.45\,mA$
Phase difference $\theta = tan^{-1}\left(\frac{\omega L}{R}\right) = \tan^{-1}\left(\frac{628}{500}\right) = 51.5^\circ$

4. A circuit consists of a capacitor of $2\mu F$ and a resistance of 1000 Ω connected in series. An alternating voltage of 12 V and frequency 50 Hz is applied. Find (i) the current in the circuit and (ii) the average power supplied. Example 16.6

Sol:

Resistance = R = 1000 Ω
Capacitance = C = $2\mu F = 2 \times 10^{-6}$F
Frequency = f = 50 Hz
Reactance = $X_C = \frac{1}{2\pi f C}$
$= \frac{1}{2 \times 3.14 \times 50 s^{-1} \times 2 \times 10^{-6} F} = 1592\Omega$
Impedance = Z = $\sqrt{R^2 + (X_c)^2}$
$= \sqrt{(1000\Omega)^2 + (1592\Omega)^2} = 1880\Omega$
Current = $I_{rms} = \frac{V_{rms}}{Z} = \frac{12\,V}{1880\,\Omega} = 0.0064\,A = 6.4\,mA$
Phase Difference $\theta = tan^{-1}\frac{X_c}{R} = tan^{-1}\left(\frac{1592\,\Omega}{1000\,\Omega}\right) = 57.87^o$
Average power = $V_{rms} I_{rms} \cos\theta$
$= 12\,V \times 0.0064\,A \times 0.532 = 0.04\,W$

5. An alternating current is represented by the equation I = 20 sin 100 πt. Compute its frequency the maximum and rms values of current. (C.W)

Sol:

Alternating current = I = 20 sin 100 πt

(i) Frequency = f = ?
(ii) Maximum value current = I_o =?
(iii) rms value of current = I_{rms} = ?

As instantaneous value of current is

$I = I_o \sin 2\pi f t$ ....(1)

And given values is

$I = 20 \sin 100\,\pi t$ ......(2)

Comparing eq. (1) and (2), we get

$2\pi f t = 100\pi t$
$2f = 100$
$f = 50\,Hz$

Againg comparing, we get

$I_o = 20\,A$
$I_{rms} = 0.7\,I_o$

Putting the value of I_o, we get

$I_{rms} = 0.7 \times 20$
$I_{rms} = 14A$

6. A sinusoidal A.C. has maximum value of 15A. What are its rms value? If the time is recorded from the instant the current is zero and is becoming positive, what is the instantaneous value of the current after $1/300\,s$, given the frequency is 50 Hz. (C.W)

Sol:

Maximum (peak) value of current = $I_o = 15A$
Time = t = $\frac{1}{300}$ (sec)
Frequency = f = 50 Hz

(i) rms value of current = I_{rms} = ?
(ii) Instantaneous current = I = ?

$I_{rms} = 0.707\,I_o$
Putting the value of I_o, we get
$I_{rms} = 0.707 \times 15$
$I_{rms} = 10.6$ A
Now instantaneous value of current is
I = $I_o \sin 2\pi f t$

Putting the values, we get

$I = 15 \times \sin 2\pi \times 50 \times \frac{1}{300}$
$I = 15 \times \sin\frac{\pi}{3}$
$I = 15 \times \sin 60^o$
$I = 15 \times 0.866$
$I = 12.9\,A$
$1 \approx 13\,A$

7. An inductor of pure inductance $3/\pi$ H is connected in series with a resistance of 40Ω. Find (i) the peak value of the current (ii) the rms value, and (iii) the phase difference between the current and the applied voltage V = 350 sin ($100\pi t$) (C.W)

Sol:

Inductance = L = $\frac{3}{\pi}$ H
Resistance = R = 40 Ω
Voltage = V = 350 sin (100 πt)

(i) Peak value of current = I_o =?

(ii) rms value of current = I_{rms} = ?

(iii) Phase difference = θ = ?

As

$$V = V_o \sin(2\pi f t) \quad ....(1)$$

And given

$$V = 350 \sin(100\pi t) \quad ....(2)$$

Comparing eq. (1) and (2), we get

$$V_o = 350 \text{ volts}$$
$$2f\pi t = 100\pi t$$
$$2f = 100$$
$$f = 50\ Hz$$

Now for impedance

$$Z = \sqrt{(R)^2 + (X_L)^2}$$
$$Z = \sqrt{(R)^2 + (\omega L)^2}$$
$$Z = \sqrt{(R)^2 + (2\pi f L)^2}$$

Putting the values, we get

$$Z = \sqrt{(40)^2 + \left(2\pi \times 50 \times \frac{3}{\pi}\right)^2}$$
$$Z = \sqrt{(40)^2 + (300)^2}$$
$$Z = \sqrt{1600 + 90000}$$
$$Z = 302.65\Omega$$

(i) Peak value of current, $I_o = \frac{V_o}{Z}$

Putting the values, we get

$$I_o = \frac{350}{302.65}$$
$$I_o = 1.16\ A$$

(ii) Now I_{rms} is given by the formula $Irms = 0.7 I_o$

Putting the value of I_o, we get

$$I_{rms} = 0.7 \times 1.16$$
$$I_{rms} = 0.81\ A$$

(iii) Now phase difference is

$$\theta = \tan^{-1}\left(\frac{\omega L}{R}\right)$$
$$\theta = \tan^{-1}\left(\frac{2\pi f L}{R}\right)$$
$$\theta = \tan^{-1}\left(\frac{2\pi \times 50 \times 3/\pi}{40}\right)$$
$$\theta = \tan^{-1}\left(\frac{300}{40}\right)$$
$$\theta = \tan^{-1}(7.5)$$
$$\theta = 82.4°$$

OBJECTIVES (MCQ'S) OF CHAPTER-17 ACCORDING TO ALP SMART SYLLABUS-2020

Topic II: Mechanical Properties of Solids:

1.Reciprocal of bulk modulus is:
(A) Elasticity (B) Young modulus (C) Compressibility (D) Shear modulus

2.Best hard magnetic material is made up of:
(A) AlnicoV (B) Iron (C) Nickel (D) Cobalt

3.The SI unit of strain is:
(A) Nm (B) Nm^{-2} (C) No unit (D) $Kgms^{-2}$

4. Nm^{-2} is also celled:
(A) Telsa (B) Weber (C) Pascal (D) Gauss

5.The metastable state means a time interval of:
(A) 10^{-3} sec (B) 10^{-8} sec (C) 10^{3} sec (D) 10^{8} sec

6.Shear modulus is expressed as:
(A) $G = \frac{\tan\theta}{F/A}$ (B) $G = \frac{\tan\theta}{A}$ (C) $G = \frac{F/A}{\tan\theta}$ (D) $G = \frac{F}{\tan\theta}$

7.Dimensions of strain are:
(A) L^2 (B) L^{-2} (C) $ML^{-1}T^{-2}$ (D) No dimensions

8.Curie temperature for iron is: **(4 Times)**
(A) 0 K (B) 750 k (C) 1023 k (D) 378 k

9.A well-known example of an intrinsic semi-conductor is:
(A) Germanium (B) Phosphorous (C) Aluminum (D) Cobalt

10.How many crystal systems are there on the base of geometric arrangements of the atoms:
(A) 3 (B) 5 (C) 4 (D) 7

11.Holes can exist in:
(A) Super conductors (B) Conductors (C) Semi-conductors (D) Insulators

12.Out of the following which material is brittle: **(2 Times)**
(A) High carbon steel (B) Aluminum (C) Copper (D) Tungsten

13.Strain energy in deformed material is proportional to:
(A) Square of the extension (B) Under root of the extension
(C) Cube root of the extension (D) Extension produced

14.The amount of energy stored in the wire when it is deformed:
(A) $W = \frac{1}{2}F_1 l_1^2$ (B) $W = \frac{1}{2}F_1^2 l_1$ (C) $W = \frac{1}{2}F_1 l_1$ (D) $W = 2F_1 l_1$

15.The stress that produces change in shape in known as:
(A) Tensile stress (B) Shear stress (C) Volume stress (D)Longitudinal stress

16.Chose the correct answer:
(A) An elastic deformation is reversible (B) An elastic deformation is irreversible
(C) A plastic deformation is reversible (D) An elastic deformation is permanent

17.Substances which undergo plastic deformation until they break are known as: **(2 times)**
(A) Brittle Substance (B) Ductile Substance
(C) Non-Magnetic Substance (D) Magnetic Substance

18.Which of the following does not undergo plastic deformation?
(A) Copper (B) Iron (C) Lead (D) Glass

19.Which one of the following is a polymeric solid?
(A) Glass (B) Nylon (C) Copper (D) Zinc

20.To get N — type, the Ge is doped with:-
(a) Aluminum (b) Arsenic (c) Boron (d) Indium

21.Substances which break just after the elastic limit is reached are called as:(3 times)
(a) Ductile Substances (b) Hard Substances (c) Brittle Substances (d) Soft Substances

22.In extrinsic semiconductors doping is of the order of

(A) 1 atom to 10^4 (B) 1 atom to 10^8 (C) 1 atom to 10^3 (D) 1 atom to 10^6

Topic III: Electrical Properties of Solids:

23.Minority carries in P-type substance are:
(A) Protons (B) Neutrons (C) Electrons (D) Positrons

24.Good conductor have conductivities of the order of: **(4 Times)**
(A) $10^{-7}(\Omega m)^{-1}$ (B) $10^{7}(\Omega m)^{-1}$ (C) $10^{2}(\Omega m)^{-1}$ (D) $10^{-2}(\Omega m)^{-1}$

25.To make n-type substance, antimony is mixed with:
(A) Boron (B) Indium (C) Germanium (D) Arsenic

26.Conductivity of metals is of the order of:
(A) $10^{-4}\Omega^{-1}m^{-1}$ (B) $10^{-10}\Omega^{-1}m^{-1}$ (C) $10^{-20}\Omega^{-1}m^{-1}$ (D) $10^{7}\Omega^{-1}m^{-1}$

27.Domains contain atoms:
(A) 10^{3} to 10^{6} (B) 10^{6} to 10^{9} (C) 10^{9} to 10^{12} (D) 10^{12} to 10^{16}

28.At 0°K piece of 'Ge' or 'Si' is a perfect: **(2 times)**
(A) Conductor (B) Insulator (C) Semi-conductor (D)Paramagnetic

29.If the conductivity of the material is high, then it is:
(A) An insulator (B) A semi-conductor (C) A good conductor (D) A super conductor

30. The band in atom containing conductive electrons, according to band theory of solid is:
(A) Conduction band (B) Valance band
(C) Forbidden band (D) First conduction band then forbidden band

31.The substance which have partially filled conduction bands are called:
(A) Insulator (B) Semi-conductor (C) Conductor (D) Super conductor

32.The potential difference across the depletion region of Germanium is:
(A) 0.3 V (B) 0.5 V (C) 0.7 V (D) 0.8 V

33.The potential barrier for silicon is: **(3 Times)**
(A) 0.3 V (B) 0.5 V (C) 0.7 V (D) 0.8 V

34.Semi-conductor resistivity ranges______ $(\Omega m)^{-1}$:
(A) 10^{-6} to 10^{-4} (B) 10^{0} to 10^{4} (C) 10^{-6} to 10^{-8} (D) 10^{-8} to 10^{-16}

35.When a silicon crystal is doped with a pentavalent element, it becomes:
(A) P-type semiconductor (B) n-type semiconductor
(C) Intrinsic semiconductor (D) Extrinsic semiconductor

36. In n-type matrials, the minority carriers are:
(A) Free electrons (B) Holes (C) Protons (D) Mesons

37. In N type material charge carries are:
(A) Free electorns (B) Holes (C) Protons (D) Mesons

Topic IV: Superconductors:

38.The temperature below which resistivity of some materials becomes zero is called
(A) Kelvin temperature (B) Critical temperature
(C) Absolute zero temperature (D) Limiting temperature

39.The critical temperature for mercury is: (2 Times)
(A) 7.2 K (B) 4.2 K (C) 1.18 K (D) 3.7 K

40.The critical temperature (T_c) of lead is:
(A) 7.2 k (B) 3.72 k (C) 125 k (D) 77 k

41.The critical temperature of aluminum is: **(2 times)**
(a) 3.72 K (b) 1.18K (c) 7.2 K (d)8.2 K

Topic V: Magnetic Properties of Solids:

42.The substance in which the atom do not form the magnetic dipoles are called: **(2 times)**
(A) Diamagnetic (B) Paramagnetic (C) Ferromagnetic (D) Crystals

43.Hysteresis loss of the coil can be defined as:
(A) Energy loss (B) Step up process
(C) Step down process (D) Electromagnetic induction

44.The coercive current is:
(A) Magnetizing current (B) Current due to holes (C) Demagnetizing current (D) current due to ions

45.Very weak magnetic field produced by brain can be detected by:
(A) Compass (B) Metallic needle (C) Squids (D) Liquids

46.The substance in which atoms co-operate with each other in such a way so as to exhibit a strong magnetic field is called: **(2 times)**

(A) Ferromagnetic (B) Paramagnetic (C) Diamagnetic (D) Non magnetic

47.Domains are existed in:
(A) Ferromagnetic materials (B) Diamagnetic materials
(C) Paramagnetic materials (D) Semi conductors

48.The most suitable metal for making permanent magnet is: **(3 times)**
(A) Steel (B) Iron (C) Copper (D) Aluminum

2018

49. Very weak magnetic field produced by brain can be detected by:
(a) Compass (b) Metallic needle (c) squids (d) Liquids

50. In ferromagnetic substances, domain contains atoms nearly equal to: (2 times)
(a) 10^8 to 10^{12} (b) 10^{10} to 10^{14} (c) 10^{12} to 10^{16} (d) 10^{14} to 10^{18}

51. Very weak magnetic field produced by brain can be detected by:
(a) Compass (b) Metallic needle (c) Squids (d) Liquids

52. If stress is increased beyond the elastic limit of material, it becomes permanently changed, this behaviour of material is called:
(A) Elasticity (B) Plasticity (C) Yield Strength (D) Ultimate tensile strength

53. A vacant or partially filled band is called: **(2 times)**
(A) Fermi band (B) Valence band (C) Forbidden band (D) Conduction band

54. Glass and High carbon Steel are examples of:
(A) Ductile Substances(B) Brittle Substances (C) Soft Substance (D) Hard Substances

55. A material which is insulator at OK and conduct at room temperature is:
(A) Silver (B) Lead (C) germanium (D) Polythene

56. Curie temperature for iron is:
(A) 780°C (B) 750°C (C) 730°C (D) 710°C

57. Which one pair belongs to acceptor impurity:
(a) Arsenic phosphorous (b) Boron, gallium (c) Antimony, Indium (d) Arsenic, Antimony

2019

58. Which one belongs to trivalent group?
(A) Aluminium (B) Antimoney (C) Phosphorous (D) Arsenic

59. Yttrium barium copper oxide ($YBa_2Cu_3O_7$) is superconductor at temperature:
(A) 163 K (B) 77 K (C) 4.2 K (D) 125 K

60. A device used to detect very weak magnetic field produced by brain is named as?
(A) MRI (B) CAT Scans (C) Squid (D) CRO

61. In extrinsic semi-conductors, doping is of the order of:
(A) 1 atom to 10^4 (B) 1 atom to 10^8 (C) 1 atom to 10^{16} (D) 1 atom to 10^6

62. The source of Magnetism of an atom is the orbital and spin motion of:
(A) Proton (B) Neutron (C) Positron (D) Electron

63. The Young's Modulus of Mercury is:
(A) 70×10^9 Nm^{-2} (B) 15×10^9 Nm^{-2} (C) Zero (D) 91×10^9 Nm^{-2}

64. A single domain in paramagnetic substance contains nearly:
(A) $10^8 - 10^{10}$ atoms (B) $10^{15} - 10^{20}$ atoms (C) $10^{12} - 10^{20}$ atoms (D) $10^{12} - 10^{16}$ atoms

65. SI unit of modulus of elasticity is:
(A) Coulomb (B) Volt (C) Pascal / Nm^{-2} (D) Ampere

66. In p-type substances, the majority charge carriers are:
(A) Electrons (B) Protons (C) Holes (D) Neutrons

ANSWERS OF THE MULTIPLE CHOICE QUESTIONS

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
C	A	C	C	A	C	D	B	A	D	C	A	D	C	B	A
17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
B	D	B	B	C	D	C	B	C	D	D	B	C	A	B	A
33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
C	A	B	B	A	B	B	A	B	A	A	C	C	A	A	A
49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64
C	C	C	B	D	B	C	B	B	A	A	C	D	D	C	D
65	66														
C	C														

SHORT QUESTIONS OF CHAPTER-17 ACCORDING TO ALP SMART SYLLABUS-2020

Topic I: Classification of Solids:

1. Distinguish between crystalline and amorphous or glassy solids. (9 Times)

Ans: **Crystalline:** The solids in which there is a regular and periodic arrangement of the atoms and molecules are called crystalline solids.
For example ionic compound, ceramics etc.
Amorphous: The solids in which there is no regular arrangement of molecules like that in crystalline solids are called amorphous solids.
For example ordinary glass.

2. Define unit cell. **(3 Times)**

Ans: A crystalline solid consists of three dimensional pattern that repeat itself over and over again. This smallest three dimensional basic structure is called unit cell.

3. Define crystal lattice. **(4 Times)**

Ans: The whole structure obtained by the repetition of unit cell is known as crystal lattice.

4. Distinguish between Crystalline, Amorphous and Polymeric Solids. (7 Times)

Ans: **Crystalline:** The solids in which there is a regular and periodic arrangement of the atoms and molecules are called crystalline solids.
For example ionic compounds, ceramics etc.
Amorphous: Any non-crystalline solid in which the atoms and molecules are not organized in a definite lattice pattern. Such solids include glass, plastic, and gel.
Polymers: polymers are solid materials with a structure that is intermediate between order and disorder. They can be classified as partially or poorly crystalline solids. For example plastic, rubber etc.

5. Define polymeric solids and give example. **(2 times)**

Ans: **Polymeric solids:** polymers are solid materials with a structure that is intermediate between order and disorder. They can be classified as partially or poorly crystalline solids. For example plastic, rubber etc.

6. What are glassy solids? Do they possess property of flow?

Ans: Amorphous solids are called as glassy solids. Any non-crystalline solid in which the atoms and molecules are not organized in a definite lattice pattern is called glassy solid. Such solids include glass, plastic, and gel.
No, they do not possess the property of flow.

7. Differentiate between amorphous and polymeric solids.

Ans: **Amorphous** solid, any non-crystalline solid in which the atoms and molecules are not organized in a definite lattice pattern. Such solids include glass, plastic, and gel.
Polymers are said to be more or less solid materials with a structure that is intermediate between order and disorder. They can be classified as partially or poorly crystalline solids.

8. Define polymerization reaction. Write two examples of polymeric solids.

Ans: Polymers are formed by **polymerization** reactions. In these reactions relatively simple molecules are chemically combined into massive long chain molecules, or "three dimensional" structures.
Polythene and nylon are **examples** of polymeric solids.

9. Show that dimensions of Stress and Young's Modulus are the same.

Ans: As stress $\sigma = \frac{F}{A}$

$$\text{Dim. of } \sigma = \frac{\text{Dim. of } F}{\text{Dim. of } A}$$

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

As Young's Modulus $Y = \frac{stress\ \sigma}{strain\ \varepsilon}$

$$\text{Dim. of } Y = \frac{\text{Dim. of } \sigma}{\text{Dim. of } \varepsilon}$$

$$= \frac{[ML^{-1}T^{-2}]}{\text{No Dimensions}} = [ML^{-1}T^{-2}]$$

It is proved that dimension of stress and young's modulus are same.

Topic II: Mechanical Properties of Solids:

10. Distinguish between elasticity and plasticity. **(3 Times)**

Ans: **Elasticity:** In deformed crystalline solid, the atoms return to their equilibrium position after the removal of external force. This ability of the body to return to its original shape is called elasticity.
Plasticity: If the stress is increased beyond elastic limit, the specimen becomes permanently deformed. This is called plasticity.

11. How can the strain energy be determined from the force-extension graph?

Ans: Strain energy can be determined from the force-extension graph according to the following relation: $strain\ energy = \frac{1}{2} l_1 F_1$
where force F_1 is producing extension l_1 in the wire.

12. Define stress and strain. What are their SI units? **(13 Times) (H.W)**

Ans: The force applied on unit area to produce any change in the shape, volume or length of a body is called stress.

$$\sigma = \frac{F}{A}$$

Its SI unit is Nm^{-2}. It is also called $pascal\ (Pa)$.
And, Strain is the measure of deformation of a solid when stress is applied to it.
It has no units.

13. Differentiate between ductile and brittle substances. Give an example for each. **(9 Times) (H.W)**

Ans: **Ductile substances:** Substances that undergo plastic deformation until they break are called ductile substances.
Lead, copper and wrought iron are ductile.
Brittle substances: The substances which break just after the elastic limit is reached, are known as brittle substances.
Glass and high carbon steel are brittle.

14. Define modulus of elasticity. Show that units of modulus of elasticity and stress are same. **(9 times)**

Ans: The ratio of stress to strain is a constant for a given material, provided the external applied force is not too great, called modulus of elasticity.

$$modulus\ of\ elasticity = \frac{stress}{strain}$$

Since strain has no units, so modulus of elasticity will also be measured in Nm^{-2}.
It is also called $pascal\ (Pa)$.
And
Stress is $\sigma = \frac{F}{A}$
Its SI unit is Nm^{-2}. It is also called $pascal\ (Pa)$.
It shows that modulus of elasticity and stress have same units.

15. Differentiate between tensile and shear modes of stress and strain. (2 Times)

Ans: **Tensile stress:** A stress that causes the change in length of an object is called tensile stress.
Shear stress: A stress that causes the change in shape of an object is called shear stress.
Tensile strain: If the strain is due to tensile stress, it is called tensile strain.

$$tensile\ strain = \frac{\Delta l}{l}$$

A strain produced in the object when it is subjected to shear stress is called shear strain.

$$shear\ strain = \frac{\Delta a}{a} = \tan\theta$$

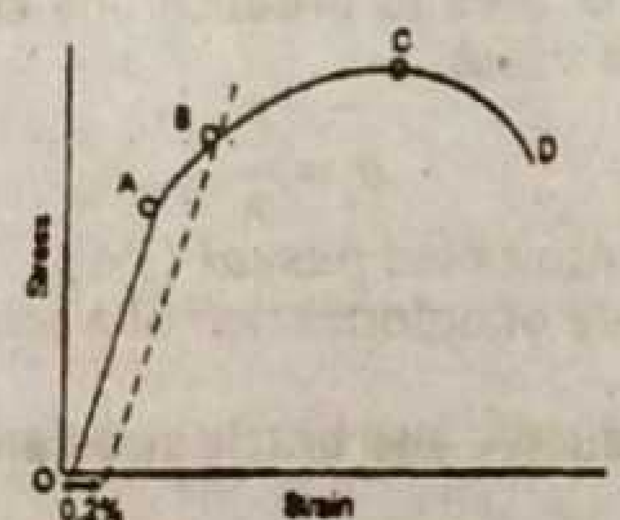
16. A 5m long wire is stretched by 2.5mm when a typical force is applied. Find the value of strain.

Ans:
$$original\ length = l = 5\ m$$
$$change\ in\ length = \Delta l = 2.5\ mm = 0.0025\ m$$

As
$$strain = \frac{\Delta l}{l}$$
$$strain = \frac{0.0025}{5}$$
$$strain = 0.0005$$

17. Define the term Elastic limit and ultimate tensile stress from the graph of stress strain curve for a ductile material. (C.W)

Ans: The greatest stress that a material can endure without any permanent deformation is called elastic limit. This kind of behavior is called elasticity. The region of plasticity is represented by the portion of the curve from B to C.
And
The maximum stress that a material can withstand is called ultimate tensile stress. The point C represents ultimate tensile strength (UTS).



18. Define volumetric strain. (C.W)

Ans: When the applied stress changes the volume, then the change in volume per unit volume is called volumetric strain.

$$volumetric\ strain = \frac{\Delta V}{V}$$

19. What is meant by strain energy? How can it be determined from the force extension graph? **(5 times)**

OR Define strain energy in deformed materials and write formula.

Ans: The amount of P.E stored in a material due to displacement of its molecules from its equilibrium position, under the action of stress, is called strain energy.
Strain energy can be determined from the force-extension graph according to the following relation:

$$strain\ energy = \frac{1}{2} l_1 F_1$$

where force F_1 is producing extension l_1 in the wire.

20. Define (a) Elastic limit (b) Yield point(or strength). **(2 times)**

Ans: **Elastic limit:** The greatest stress that a material can endure without any permanent deformation is called elastic limit. This kind of behavior is called elasticity.
Yield point: The point on the stress-strain curve beyond which if stress is further increased then permanent deformation takes place in the given specimen. This is called yield point.

21. How n-type semi-conductors are formed?

Ans: When a silicon crystal is doped with a pentavalent element, e.g., arsenic,

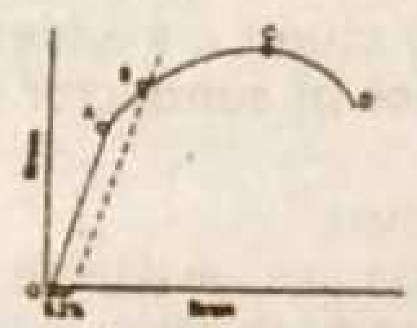
antimony or phosphorous etc., four valence electrons of the impurity atom form covalent bond with the four neighbouring Si atoms, while the fifth valence electron provides a free electron in the crystal. Such a doped semi-conductor is called n-type semi-conductor.

22. Define yield point and ultimate tensile stress. **(2 times)**

Ans: **Yield point:** The point on the stress-strain curve beyond which if stress is further increased then permanent deformation takes place in the given specimen. This is called yield point.
Ultimate tensile stress: The maximum stress that a material can withstand is called ultimate tensile stress.

23. Define UTS of a material.

Ans: The maximum stress that a material can withstand is called ultimate tensile stress. The point C represents ultimate tensile strength (UTS).



24. Define ultimate tensile stress (UTS) and fracture stress.

Or Define ultimate tensile strength and fracture stress.

Ans: **Ultimate tensile strength (UTS):** The maximum stress that a material can withstand is called ultimate tensile strength and can be regarded as the nominal strength of the material.
Fracture stress: Once the limit of ultimate tensile stress (UTS) is crossed, the material breaks and the stress is called fracture stress.
Note: The correct word is Ultimate Tensile Strength. If there is ultimate tensile stress then you will write same answer and change strength to stress.

25. Define Modulus of Elasticity. Write down its three kinds. OR Define Young's modulus and Bulk modulus. **(2 times)**

Ans: **Modulus of Elasticity:** The ratio of stress to strain is a constant for a given material, provided the external applied force is not too great, called modulus of elasticity.

$$\text{modulus of elasticity} = \frac{\text{stress}}{\text{strain}}$$

Three different types are;
(i) The ratio of tensile stress to tensile strain is called Young Modulus(Y).

$$Y = \frac{F/A}{\Delta l/l}$$

(ii) The ratio of volumetric stress to volumetric strain is called Bulk Modulus (K).

$$K = \frac{F/A}{\Delta V/V}$$

(iii) The ratio of shear stress to shear strain is called Shear Modulus(G).

$$G = \frac{F/A}{\tan\theta}$$

26. Define tensile stress and volumetric stress?

Ans: **Tensile Stress:** When stress changes length of a body, it is called tensile stress.
Volumetric Stress: When stress changes volume of a body, it is called volumetric stress.

27. Define plasticity and U.T.S.

Ans: **Plasticity:** If the stress is increased beyond elastic limit, the specimen becomes permanently deformed. This is called plasticity.
Ultimate tensile stress (UTS): The maximum stress that a material can withstand is called ultimate tensile stress.

28. Describe difference between proportional limit and elastic limit.

Ans: **Proportional limit:** The greatest stress that a material can endure without losing

straight line proportionality between stress and strain. Hooke's law is obeyed in this region.
Elastic limit: The greatest stress that a material can endure without any permanent deformation is called elastic limit. This kind of behavior is called elasticity.

$$\sigma = \frac{F}{A}$$

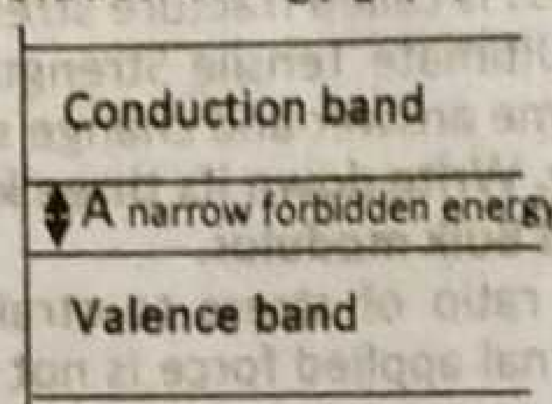
29. Distinguish between elastic deformation and plastic deformation.
Ans: If in deformed crystalline solid, the atoms return to their equilibrium position after the removal of external force then this is called **elastic deformation**.
If the dimensions of specimen change permanently and does not recover its original shape after the removal of strengthen this is called **plastic deformation**.

Topic III: Electrical Properties of Solids:

30. How the conductivity of a semi-conductor can be raised?
Ans: The conductivity of a semiconductor can be raised by the process of doping in which small number of impurity atoms are added to pure semiconductors.

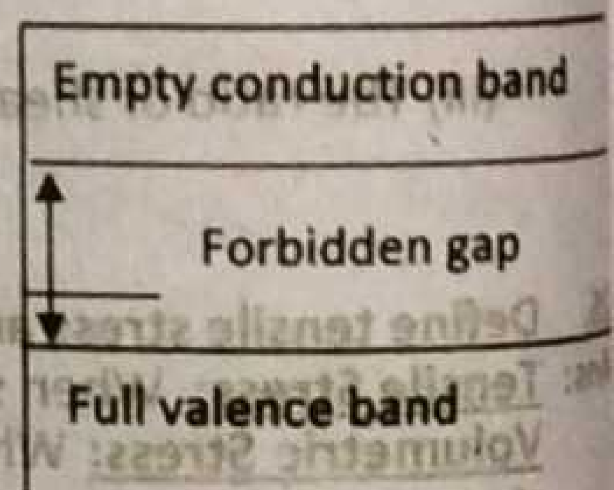
31. Compare the electrical behavior of conductor and semi-conductor in terms of energy band theory.
Ans: On the basis of energy band theory
In conductors, free electrons are available for conduction. Valence and conduction bands largely overlap each other.
And
In semiconductors, valence band and conduction band is partially filled and they have a very narrow forbidden energy gap.

32. Describe energy band picture of semi-conductors.
Ans: In semiconductors, valence band and conduction band is partially filled and they have a very narrow forbidden energy gap ($\approx 1eV$).



33. Distinguish between a valence and conduction band. (3 times)
Ans: **Valance band:** The energy band occupied by valance electrons is called the valance band.
The valance band may be either completely filled or partially filled with the electrons but can never be empty.
Conduction band: The energy band occupied by free electrons is called the conduction band.
The conduction band may be empty or partially filled.

34. Describe energy band picture of insulators?
Ans: **Insulators:** Insulators are those materials in which valance electrons are bound very tightly to their atoms and are not free. In terms of energy bands, it means that an insulator has:
a) An empty conduction band (no free electron)
b) A full valence band
c) A large energy gap (several eV) between them.



35. Differentiate between Insulators and Conductors. (C.W)
Ans: **Insulators:** Those substances which have valence electrons tightly bound to their atoms are called insulators. Almost they don't conduct electricity. e.g wood, glass, plastic, mica etc.
Conductors: Those substances which have plenty of free electrons for electrical conduction are called conductors. e.g. copper, gold, silver etc

36. What are the two main differences between conductors and semiconductors? (C.W)
Ans: **Conductors:** Those substances which have plenty of free electrons for electrical conduction are called conductors. E.g. copper, gold, silver etc. Conductors have conductivity of the order of $10^7\ (\Omega m)^{-1}$.
Semiconductors Those substances which have intermediate range of conductivities are called semiconductors e.g. germanium and silicon. Semiconductors can conduct electricity within conductivity order of 10^{-6} to 10^{-4} $(\Omega m)^{-1}$.

37. Carbon, Silicon and Germanium have four valence electrons. Why Carbon is insulator while Silicon and Germanium are Semiconductors?
Ans: Silicon and Germanium have the valence band much farther from the nucleus, where lesser energy is needed to exchange electrons. Carbon on the other hand, is close to the nucleus which creates insulator-like properties.
Carbon is not a semiconductor because the forbidden energy gap in carbon is around 7eV. This is far-much higher for it to be a semiconductor which has lower forbidden energy gaps.

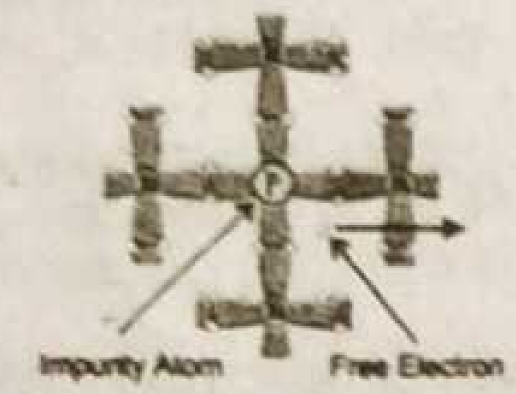
38. What is the difference between intrinsic and extrinsic semiconductors? (H.W)
Ans: **Intrinsic Semiconductor:**
A semiconductor in its extremely pure form is known as intrinsic semiconductors. Pure elements of silicon and germanium are intrinsic semiconductors. These semi-conductor elements have atoms with four valence electrons.
Extrinsic Semi-conductors:
The doped semi-conducting materials are called extrinsic semi-conductors. The electrical behavior of semiconductors is substantially changed on introducing a small impurity into pure semi-conductor, and this process is called doping.
P-type and N-type are extrinsic semi-conductors.

39. Discuss the mechanism of electrical conduction by holes and electrons in a pure semi-conductor. (3 times) (C.W)
Ans: At 0 K semiconductors are perfect insulators. However, at room temperature there are some free electrons in the conduction band and holes in the valance band. When a battery is connected to such a semi-conductor, the electrons drift towards the positive end whereas the holes drift towards the negative end of the semi-conductor. Hence, the current flowing through the semi-conductor is carried by both electrons and holes. It may be noted that the electronic current and charged hole current add up together to give the current I.

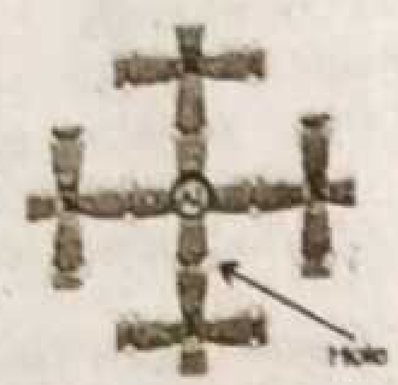
39. Distinguish between p-type semiconductor and n-type semiconductor. (H.W)
Ans: **p-type semiconductor:** When a trivalent impurity such as aluminium is added into the semi-conductor, holes are generated and p-type semi-conductor is formed. Holes are positive charge carriers.
n-type semiconductor: When a pentavalent impurity such as phosphorus is added into the semi-conductor, free electrons are generated and n-type semi-conductor is formed. Charge carriers in n-type are free electrons.

40. How would you obtain N – type and P – type material from pure silicon? Illustrate it by schematic diagram. (H.W)
Ans: When a silicon crystal is doped with a pentavalent element, four valence electrons of the impurity atom form covalent bond with the four neighbouring silicon atoms, while the fifth valence electron provides a free electron in the crystal. In this way, N – type material is formed.
When a silicon crystal is doped with a trivalent element, three valence electrons of the impurity atom form covalent bond with the three neighbouring silicon

atoms, while the one missing electron in the covalent bond with the fourth neighbouring silicon atom provides a hole. In this way, P – type material is formed.



N – type material



P – type material

Topic IV: Superconductors:

41. What is critical temperature in super conductivity?

Ans: The temperature below which the resistivity of a material falls to zero is called critical temperature. For example, mercury has T_c= 4.2 k.

42. What are super conductors? Write their uses. **(17 times) (H.W)**

OR Define super-conductor. Write down its two technological applications.

Ans: The materials whose resistivity becomes zero below a certain temperature called critical temperature are called superconductors.
For example, mercury becomes super conductor below 4.2 k temperature.
Superconductors can be used in
a) Magnetic Resonance Imaging (MRI) b) Magnetic Levitation Trains
c) Powerful but small electric motors d) Fast computer chips

43. Define (a) Super conductor (b) Critical temperature

Ans: __Super conductor:__ The materials whose resistivity becomes zero below a certain temperature are called superconductors. For example, mercury becomes super conductor below 4.2 k temperature.
__Critical temperature:__ The temperature below which the resistivity of a material falls to zero is called critical temperature. For example, mercury has T_c= 4.2 k.

44. What are superconductors? Write their types.

Ans: There are some materials whose resistivity becomes zero below a certain temperature, called critical temperatures. Below this temperature, such materials are called **super conductors**.
There are two types of super conductors
Super Conductors with a critical temperature above than 77K are high temperature super conductors and below 77K are called low temperature super conductors.

Topic V: Magnetic Properties of Solids:

45. What does area of hysteresis loop tell?

Ans: The area of the loop is the measure of the energy needed to magnetize and demagnetize the specimen during each cycle of the magnetizing current. This is the energy required to do work against internal friction of the domains. This work is dissipated as heat. It is called hysteresis loss.

46. Explain what is Curie temperature?

OR What is curie temperature? Writ the curie temperature of iron.

Ans: The temperature at which the dofmains of a ferromagnetic material start losing their orderliness is called Curie temperature.
For example the Curie temperature of iron is $750^o\ C$.

47. Define Dia and paramagnetic substance. Give one example of Dia and paramagnetic substance. **(4 Time) (H.W)**

Ans: In diamagnetic substance, there is no resultant field as the magnetic field produced by both orbital and spin motions of the electron might add up to zero. For example, the atoms of water, copper, bismuth etc.
And
The solids in which the orbital and spin axes of the electrons in an atom are so oriented that their fields support each other are called paramagnetic substances. In these solids, each atom behaves like a tiny magnet.
For example, ozone, platinum etc.

48. What is hysteresis loss? **(2 times)**

Ans: The area of the hysteresis loop is a measure of the energy needed to magnetize and demagnetize the material in each cycle. This is the energy required to do

work against the internal friction of the domains. This work is dissipated as heat and is called hysteresis loss.

49. Define coercivity of a material. **(2 times)**

Ans: To demagnetize the material, the magnetizing current is reversed and increased to reduce the magnetization to zero. This is known as coercive current. And this process is called coercivity.

50. What is meant by Ferromagnetic substances? **(2 Times) (H.W)**

Ans: In ferromagnetic substances, the atoms cooperate with each other in such a way so as to exhibit a strong magnetic effect. In ferromagnetic substance, there exist small regions called domains. For example Fe, Co and Ni are ferromagnetic substances.

51. What are Paramagnetic Substances? Give an example. **(2 times)**

Ans: The solids in which the orbital and spin axes of the electrons in an atom are so oriented that their magnetic fields support each other are called paramagnetic substances. In these solids, each atom behaves like a tiny magnet.
For example, ozone, platinum etc.

52. Differentiate between paramagnetic and ferromagnetic substances with examples. **(4 Times)**

OR What is meant by paramagnetic and Feromagnetic substances?

Ans: __Paramagnetic:__ The solids in which the orbital and spin axes of the electrons in an atom are so oriented that their magnetic fields support each other are called paramagnetic substances. In these solids, each atom behaves like a tiny magnet.
For example, ozone, platinum etc.
__Ferromagnetic:__ In ferromagnetic substances, the atoms cooperate with each other in such a way so as to exhibit a strong magnetic effect. In ferromagnetic substance, there exist small regions called domains. For example Fe, Co and Ni are ferromagnetic substances.

53. Define retantivity and coercivity. **(2 Times)**

Ans: __Retantivity:__ When the current is reduced to zero, the material still remains strongly magnetized which is known as remanence or retantivity
__Coercivity:__ The value of reverse current which is required by a substance for its demagnetization is called coercive current or coercivity.

54. Distinguish between critical and curie temperatures.

Ans: __Critical temperature:__ The temperature below which the resistivity of a material falls to zero is called critical temperature. For example, mercury has T_c= 4.2 k.
__Curie temperature:__ The temperature at which the domains of a ferromagnetic material start losing their orderliness is called Curie temperature.
For example the Curie temperature of iron is$750^o C$.

55. Distinguish between soft magnetic materials and hard magnetic materials. (2 Times)

Ans: __Soft magnetic:__ The materials in which their domains can be easily oriented on applying external magnetic field and also return to original positions when field is removed. E.g. iron.
__Hard magnetic:__ The materials in which their domains cannot be easily oriented on applying external magnetic field. But once the domains are lined up by a very strong magnetic field, they will restrain their positions after the removal of magnetic field. e.g., steel, alnico V etc.

56. Energy dissipated per cycle for steel is more as compared to iron. Why?

Ans: Steel is a material in which domains cannot be easily oriented on applying external magnetic field. But once the domains are lined up by a very strong magnetic field, they will restrain their positions after the removal of magnetic field. It is a hard magnetic material.
The area of loop is a measure of energy required to magnetize and demagnetize each cycle. As area of loop for steel is large as compared to the iron, so energy loss per cycle for steel is more than for iron

57. What is meant by Hysteresis loss? How is it used in the construction of transformer? **(3 times) (C.W)**

Ans: The area of the loop is the measure of the energy needed to magnetize and demagnetize the specimen during each cycle of the magnetizing current. This is the energy required to do work against internal friction of the domains. This work is dissipated as heat. It is called hysteresis loss.
Soft iron frame is used as the core of a transformer because it has a small hysteresis area which represents that small energy is lost during its magnetization and demagnetization. In this way, hysteresis loss is useful to decide either the material is suitable for construction of transformer or not.

58. Define Saturation and Remanence of Hysteresis Loop.

Ans: **Saturation:** The material is said to be magnetically saturated when magnetic flux density reaches a maximum value.
Remanence: When the current is reduced to zero, the material still remains strongly magnetized. It is due to the tendency of domains to stay partly in line, once they have been aligned. It is called remanence or relativity.

59. What is meant by Dia and Ferromagnetic substances? Give example for each. **(2 times)**

Ans: Substances in which the orbits and the spin axes of the electrons in an atom are so oriented that their magnetic fields add up to zero are called **Diamagnetic substances**. For example, Water, Copper, Bismuth etc.
Substances in which the atoms co-operate with each other in such a way so as to exhibit a strong magnetic effect are called **Ferromagnetic substances**. There exists small regions called domain. For example Fe, Co, Ni etc.

60. What do you mean by hysteresis and hysteresis loss?

Ans: From hysteresis loop, it may be noted that the value of flux density for any value of current is always greater when the current is decreasing than when it is increasing, i.e, magnetism lags behind the magnetizing current. This phenomenon is known as **hysteresis**.
The energy required to magnetize and demagnetize the specimen during each cycle of magnetizing current is dissipated as heat. This energy loss is called **hysteresis loss**.

61. Explain the term Hysteresis.

Ans: From Hysteresis loop, it may be noted that the value of flux density for any value of current is always greater when the current is decreasing than when it is increasing, i.e, magnetism lags behind the magnetizing current. This phenomenon is known as **Hysteresis**.

LONG QUESTIONS OF CHAPTER-17 ACCORDING TO ALP SMART SYLLABUS-2020

Topic II: Mechanical Properties of Solids:

1. What is meant by strain energy? Derive the relation for strain energy in a deformed material from the area under force extension graph. **(8 Times)**
2. Define Strain Energy. Derive a relation for Strain Energy in deformed materials. **(2 Times)**
3. Define extrinsic and intrinsic semi-conductors. How P-type and N-type semi-conductors are formed? Explain.
4. Define stress and strain. Write a note on Young's, Bulk and shear moules.

Topic III: Electrical Properties of Solids:

5. What is the energy band theory? How behaviors of electrical conductors, insulators and semi-conductors can be explained on the basis of energy band theory. **(12 Times)**
6. What is doping? Describe the formation of n-type and p-type semi-conductor. **(2 Times)**
7. What are semi-conductors? Discuss the formation of P-type and N-type material with their Schematic diagram.
8. Define extrinsic and intrinsic semiconductors. How can we obtain P-type and N-type substance? **(3 Times)**

NUMERICAL PROBLEMS OF CHAPTER-17 ACCORDING TO ALP SMART SYLLABUS-2020

Topic II: Mechanical Properties of Solids:

1. A $1.25\ cm$ diameter cylinder is subjected to a load of $2500\ kg$. calculate the stress on the bar in mega Pascal. **(16 Times) (H.W)**

Ans: Given that

$$diameter = d = 1.25\ cm$$
$$radius = r = \frac{d}{2} = \frac{1.25}{2} = 0.62\ cm$$
$$radius = r = 0.0062\ m$$
$$load = m = 2500\ kg$$
$$stress = \sigma = ?$$

As

$$\sigma = \frac{F}{A}$$
$$\sigma = \frac{mg}{\pi r^2}$$
$$\sigma = \frac{(2500)(9.8)}{(3.14)(0.0062)^2} = 200 \times 10^6\ Pa\ \boxed{= 200\ MPa}$$

2. A $1\ m$ long copper wire is subjected to stretching force and its length increase by $20\ cm$. Calculate the tensile strain and the percent elongation which the wire undergoes. **(4 times) (C.W)**

Ans: Given that

$$length\ of\ wire = l = 1\ m$$
$$elongation = \Delta l = 20\ cm = 0.2\ m$$
$$tensile\ strain = \varepsilon = ?$$
$$percent\ elongation = ?$$

Since

$$\varepsilon = \frac{\Delta l}{l} = \frac{0.2}{1}\ \boxed{= 0.2}$$

And

$$percent\ elongation = \frac{\Delta l}{l} \times 100\%$$
$$percent\ elongation = \frac{0.2}{1} \times 100\%$$
$$percent\ elongation = 0.2 \times 100\%\ \boxed{= 20\%}$$

3. A wire $2.5\ m$ long and cross-section area $10^{-5} m^2$ is stretched by $1.5\ mm$ by a force of $100\ N$. Calculate Young's modulus. **(2 Time) (C.W)**

Ans: Given that

$$l = 2.5\ m$$
$$\Delta l = 1.5\ mm = 1.5 \times 10^{-3}\ m$$
$$A = 10^{-5} m^2$$
$$F = 100\ N$$
$$Y = ?$$

Since

$$Young's\ modulus = \frac{stress}{strain}$$
$$Y = \frac{F/A}{\Delta l/l}$$
$$Y = \frac{Fl}{A\Delta l}$$
$$Y = \frac{(100)(2.5)}{(10^{-5})(1.5 \times 10^{-3})}\ \boxed{= 1.66 \times 10^{10}\ Pa}$$

4. The length of a steel wire is $1.0\ m$ and its cross sectional area is $0.03 \times$

$10^{-4}m^2$. Calculate the work done in stretching the wire when a force of 100 N is applied within the elastic region. Young's modulus of steel is $3.0 \times 10^{11} Nm^{-2}$. (3 times) (C.W)

Ans: Given that

$$l = 1.0\ m$$
$$A = 0.03 \times 10^{-4} m^2$$
$$F = 100\ N$$
$$Y = 3.0 \times 10^{11} Nm^{-2}$$
$$work\ done = W = ?$$

As
$$Young's\ modulus = \frac{stress}{strain}$$
$$Y = \frac{F/A}{\Delta l/l}$$
$$Y = \frac{Fl}{A\Delta l}$$
$$\Delta l = \frac{Fl}{AY}$$
$$\Delta l = \frac{(100)(1)}{(0.03 \times 10^{-4})(3.0 \times 10^{11 (2\ Times)})}$$
$$\Delta l = 1.1 \times 10^{-4}\ m$$

Now
$$work\ done = average\ force \times distance$$
$$W = \left(\frac{0+F}{2}\right)(\Delta l)$$
$$W = \frac{1}{2} F \Delta l$$
$$W = \frac{1}{2}(100)(1.1 \times 10^{-4}) \boxed{= 5.6 \times 10^{-3} J}$$

5. **What stress would cause a wire to increase in length 0.01 % if the young modulus of the wire is $12 \times 10^{10}\ Pa$? What force would produce this stress if the diameter of the wire is 0.56 mm?** (6 Times) (C.W)

Ans: Given that

$$l = 1\ m$$
$$\Delta l = 0.01\% = \frac{0.01}{100} = 10^{-4}\ m$$
$$Y = 12 \times 10^{10}\ Pa$$
$$d = 0.56\ mm = 0.56 \times 10^{-3}\ m$$
$$r = \frac{d}{2} = \frac{0.56 \times 10^{-3}}{2} = 0.28 \times 10^{-3}\ m$$
$$stress = \sigma = ?$$
$$force = F = ?$$

Since
$$Young's\ modulus = \frac{stress}{strain}$$
$$Y = \frac{\sigma}{\Delta l/l}$$
$$\sigma = Y\left(\frac{\Delta l}{l}\right)$$
$$\sigma = \frac{12 \times 10^{10} \times 10^{-4}}{1}$$
$$\sigma = 12 \times 10^{6} Pa \boxed{= 1.2 \times 10^{7}\ Pa}$$

And stress $= \frac{force}{area}$

$$\sigma = \frac{F}{A}$$
$$F = \sigma A$$
$$F = \sigma \pi r^2$$
$$F = (1.2 \times 10^{7})(3.14)(0.28 \times 10^{-3}) \boxed{= 2.96\ N}$$

2019

6. **A steel wire 12 mm in dimmeter is fastened to a log and is then pulled by tractor. The length of steel wire between the log and tractor is 11m. A force of 10,000 N is required to pull the log. Calculate** (Example No. 17.1)
a) the stress in the wire and
b) The strain in the wire. $(E = 200 \times 10^{9}\ Nm^{-2})$
c) How much does the wire stretch when the log is pulled?

Ans:
$$d = 12mm$$
$$r = \frac{d}{2} = \frac{12mm}{2} = 6mm = 6 \times 10^{-3} m$$
$$E = 200 \times 10^{9}\ Nm^{-2}$$
$$l = 11m$$
$$F = 10{,}000N$$

a) Stress $\sigma = ?$ Strain $\varepsilon = ?$ $\Delta l = ?$

a) **stress in given by**
$$\sigma = \frac{F}{A}$$
$$\sigma = \frac{F}{\pi r^2}$$

Putting values ,
$$\sigma = \frac{10{,}000}{(3.14)(6 \times 10^{-3})^2}$$
$$\sigma = 88.46 \times 10^{6}\ Pa$$
$$\sigma = 88.46\ MPa$$

b) As $E = \frac{stress}{strain}$
$$E = \frac{\sigma}{\varepsilon}$$
or $\varepsilon = \frac{\sigma}{E}$
$$\varepsilon = \frac{88.46 \times 10^{6}}{200 \times 10^{9}}$$
$$\varepsilon = \frac{0.442}{10^{3}}$$
$$\varepsilon = 4.42 \times 10^{-4}$$

b) As $\varepsilon = \frac{\Delta l}{l}$

or $\Delta l = \varepsilon l$
$$\Delta l = 4.42 \times 10^{-4} \times 11$$
$$\Delta l = 4.86 \times 10^{-3} m \quad = 4.86\ mm$$

OBJECTIVES (MCQ'S) OF CHAPTER-18 ACCORDING TO ALP SMART SYLLABUS-2020

Topic I: P-N Junction:

1. The potential barrier for Ge at room temperature is: **(4 Times)**
(A) 0.3 volt (B) 3 volt (C) 1 volt (D) 5 volt

2. The junction potential for Germanium is:
(A) 3 V (B) 0.3 V (C) 7 V (D) 0.7 V

3. In n-p-n transistor current does not flow in the direction from:
(A) Emitter to collector (B) Emitter to base
(C) Base to collector (D) Collector to emitter

4. A semi-conductor will behave as insulator when:
(A) High P.D is applied across it (B) When its temperature is 0 K
(C) Pentavalent impurity is added (D) Trivalent impurity is added

5. The characteristics curve of p-n junction is between:
(A) Voltage and current (B) Voltage and time
(C) Current and time (D) Power and current

6. The PN junction on forward biasing acts as:
(A) Capacitor (B) High resistor (C) Inductor (D) Low resistor

7. The reverse current in a p-n junction flows due to: **(2 Times)**
(A) Majority charge carriers (B) Minority charge carriers
(C) Both A and B (D) None of these

8. A pentavelent impurity is:
(A) Boron (B) Aluminum (C) Indium (D) Phosphorous

9. When a p-n junction is reverse biased the depletion region is:
(A) Widened (B) Narrowed (C) Normal (D) None of these

10. Depletion region carries:
(A) – ve charge (B) +ve charge (C) Ions (D) No charge

11. The potential barrier for silicon at room temperature is: **(3 Times)**
(A) 0.3 Volt (B) 0.4 Volt (C) 0.5 Volt (D) 0.7 Volt

12. SI unit of current gain is: **(2 Times)**
(A) Ampere (B) volt (C) coulomb (D) no unit

13. Which type of impurity is to be added to a pure semi-conductor crystal to provide holes:
(A) Monovalent (B) Trivalent (C) Tetravalent (D) Pentavalent

14. In p-type substances, the minority carries are: **(2 Times)**
(a) Electrons (b) protons (c) holes (d) neutrons

15. Which one pair belongs to accepter impurity?
(a) Arsenic, Phosphorus (b) Boron, Gallium
(c) Antimony, Indium (d) Arsenic, Antimony

16. Potential difference across two terminals of silicon diode at 300 k is:
(a) 0.3 V (b) 0.7 V (c) 0.9 V (d) 1.2 V

17. Which one is pentavalent impurity?
(a) Boron (b) Gallium (c) Antimony (d) Indium

18. Potential Difference Across Depletion Region in case of Silicon Diode at room temperature is:
(A) 0.3 V (B) 0.9 V (C) 0.7 V (D) Zero Volts

19. The size of base of transistor is **(2 Times)**
(A) 10^{-3}m (B) 10^{-4} m (C) 10^{-6}m (D) 10^{2}m

20. Which diode works at reverse biasing?
(A) LED (B) photovoltaic cell (C) photodiode (D) silicon diode

21. The number of terminals in a semiconductor diode are:
(A) 2 (B) 3 (C) 4 (D) 5

Topic II: Rectification:

22. Process of converting alternative current into direct current is called:

Topic II: Rectification:

22. Process of converting alternative current into direct current is called:
(A) Polarization (B) Modulation (C) Rectification (D) Amplification

23. The device used for rectification is called: **(2 Times)**
(A) Rectifier (B) Transformer (C) Thermistor (D) Wheat stone bridge

24. Pulsating DC can be made smooth by using a circuit known as: **(2 times)**
(A) Filter (B) Tank (C) Accepter (D) All

25. AC can be converted into DC by: **(2 Times)**
(A) Transformer (B) Rectifier (C) Motor (D) Capacitor

26. In full wave rectification no of diodes required are equal to:
(A) 3 (B) 4 (C) 5 (D) 1

27. The device used for converting A.C into D.C is called:
(A) Oscillator (B) Detector (C) Amplifier (D) Rectifier (or diode)

Topic III: Specially Designed P-n Function:

28.  **is the electrical symbol of:**
(A) Diode (B) Photodiode (C) Photo cell (D) LED

29. A diode characteristics curve is a graph plotted between: **(2 Times)**
(A) Current and time (B) Voltage and time
(C) Voltage and current (D) Forward voltage and reverse current

30. The automatic working of street lights is due to:
(A) Inductor (B) Capacitor (C) Comparator (D) Rectifier

31. A sensor of light is: **(3 Times)**
(A) Transistor (B) LED (C) Diode (D) Light dependent resistor

32. The colour of light emitted by a LED depends on: **(2 Times)**
(A) Its forward biasing (B) the type of semi conductor material use
(C) The amount of forward current (D) its reverse biasing

33. Automatic functioning of street light can be done by the use of:-
(a) Inductor (b) Capacitor (c) Comparator (d) Thermistor

34. The use of LDR is in the circuit of:
(a) night switch (b) logic gate (c) rectifier (d) oscillator

Topic IV: Transistor as an Amplifier:

35. If I_E.I_B and I_C are emitter current, base current and collector current respectively in a transistor then:
(A) $I_c = I_B.I_E$ (B) $I_B = I_E.I_C$ (C) $I_E = I_B + I_C$ (D) $I_c = I_E + I_B$

36. Transistors are made from: **(2 Times)**
(A) Plastics (B) Metals (C) Conductors (D) Dopped semiconductors

37. The thickness of the base of the transistor is of the order of:- **(2 Times)**
(a) 10^{6} m (b) 10^{-6} m (c) 10^{-3} m (d) $10^{-6}\mu$ m

38. The width of central region of base of a transistor is:
(a) $10^{-4} m$ (b) $10^{-6} m$ (c) $10^{-3} m$ (d) $10^{-9} m$

39. The term transistor stands for:
(A) Transfer of current (B) Transfer of voltage (C) Transfer of resistance (D) Transfer of charge

40. The central region of a transistor is called. **(3 Times)**
(A) Base (B) emitter (C) Collector (D) Neutral

41. Photo diode is used for detection of:
(A) Heat (B) Magnet (C) Current (D) Light

42. Voltage gain of the common emitter npn-transister as an amplifier is:
(A) $\beta \frac{rie}{Rc}$ (B) $\beta \frac{Ic}{Rc}$ (C) $\beta \frac{Ve}{Rc}$ (D) $\beta \frac{Rc}{rie}$

43. A transistor consists of:
(A) Three electrodes (B) Two electrodes (C) One electrode (D) Five electrodes

Topic V: Transistor:

44. Voltage gain of the transistor as an amplifier is negative because of:
(A) Input voltage is amplified (B) Phase shift of 180°
(C) Output voltage is amplified (D) Phase shift is 0°

45. The gain of transistor amplifier depends upon.

(A) Resistance connected with collector (B) Resistance connected at base
(C) Input voltage (D) Output voltage

46. The gain of amplifier is given as:
(a) $-\beta R_c / r_{ie}$ (b) $-\beta r_{ie} / R_c$ (c) $\frac{-R_2}{R_1}$ (d) $1+\frac{R_2}{R_1}$

Topic VI: Trasistor as a Switch:

47. Find the gain of inverting amplifier of external resistance $R_1 = 10K\Omega$ and $R_2 = 100K\Omega$: **(3 Times)**
(A) -5 (B) -10 (C) -2 (D) 50

Topic VII: Operational Amplifier:

48. Integrated amplifier is known as:
(A) Power amplifier (B) Pull-push amplifier(C) perational amplifier(D) current amplifier

49. Gain of operational amplifier is independent of:
(A) Internal structure (B) External structure (C) Batteries (D) Potential changes

50. The open loop gain of an operational amplifier is of the order of: (7 Times)
(A) 10^8 (B) 10^5 (C) 10^2 (D) 10^{-3}

51. The device which is used as amplifier and works with negative feedback is:
(A) Operational amplifier (B) n-p-n transistor(C) p-n-p transistor (D) Transistor

52. The input resistance of an op-amplifier is: **(2 Times)**
(A) Zero (B) Low (C) High (D) Equal to output resistance

Topic IX: Op. Amp as Non-Inverting Amplifier:

53. For non-inverting amplifier if $R_1 = \infty$ and $R_2 = 0$ ohm, the gain of non-inverting amplifier is: **(2 Times)**
(A) -1 (B) Zero (C) +1 (D) Infinite

54. The current gain β on a transistor is: **(2 times)**
(A) I_C/I_E (B) I_E/I_B (C) I_C/I_B (D) I_B/I_C

Topic X: Comparator at a Night Switch:

55. Automatic functioning of street light can be done by the use of: (4 times)
(A) Inductor (B) Capacitor (C) Emf (D) comparator

2018

56. Thickness of a base in a transistor is of the order of: **(3 Times)**
(a) 10^{-3} m (b) 10^{-9} m (c) 10^{-6} m (d) 10^{-6} mm

57. ________ is the building block of every complex electronic circuit.
(a) semiconductor diode (b) resistor (c) capacitor (d) amplifier

58. Photodiode is used for the detection of: **(2 Times)**
(a) light (b) thermal radiation (c) radio waves (d) sound waves

59. Which component of the transistor has greater concentration of impurity? (2 Times)
(a) Base (b) Emitter (c) Collector (d) Both emitter and collector

60. The Resistance between the inverting (-) and Non-inverting (+) inputs is called Input Resistance and is of the order of:
(A) Ohms (B) Kilo Ohms (C) Thousands Ohm (D) Mega Ohms

61. In put resistance of op-amplifier is of the order of:
(A) Few ohms (B) Mega ohms (C) Milli ohms (D) Micro ohms

62. Doping is made comparatively larger in:
(A) emitter (B) base (C) collector (D) P-type semi-conductors

63. Conversion of only one half of A.C. into D.C is called:
(A) half wave amplification (B) wave amplification
(C) half wave electrification (D) half wave rectification

64. In n-type substance, minority charge carries are:
(A) electrons (B) holes (C) protons (D) neutrons

2019

65. For normal operation of transistor, the Emitter-Base junction is always:
(A) Forward Biased (B) Reverse Biased (C) Unbiased (D) Grounded

66. If R_1 = 10 kΩ and R_2 = 1000 kΩ, then gain of inverting amplifier is:
(A) -11 (B) -10 (C) 10 (D) 11

67. A p-n junction cannot be used as:
(A) amplifier (B) rectifier (C) detector (D) LED

68. Photo diode can turn its current on and off in:
(A) Micro-sec (B) Nano-sec (C) Pico-sec (D) Femto-sec

69. Photovoltaic cell is formed from:
(A) Arsenic (B) Carbon (C) Germanium (D) Silicon

70. The Resistance between (+) and (-) inputs of Operational Amplifier is:
(A) Very Low (B) Very High (C) Zero (D) Infinity

71. In a comparator circuit, when intensity of light decreases,then resistance or LDR:
(A) R_L increases (B) R_L decreases (C) V_R decreases (D) V_- increses

72. The common emitter current amplification factor β is given by:
(A) $\frac{I_C}{I_E}$ (B) $\frac{I_C}{I_B}$ (C) $\frac{I_E}{I_B}$ (D) $\frac{I_B}{I_C}$

73. The gain of non-inverting amplifier is:
(A) $1+\frac{R_2}{R_1}$ (B) $1+\frac{R_1}{R_2}$ (C) $\frac{-R_2}{R_1}$ (D) $\frac{-R_1}{R_2}$

ANSWERS OF THE MULTIPLE CHOICE QUESTIONS

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
A	B	D	B	A	D	B	D	A	D	D	D	B	A	B	B
17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
C	C	C	C	A	C	A	A	B	B	D	B	C	C	D	B
33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
C	A	C	D	B	B	C	A	D	D	A	B	A	A	B	C
49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64
A	B	A	C	C	C	D	C	D	A	B	A	D	B	A	B
65	66	67	68	69	70	71	72	73							
A	B	A	B	D	B	A	B	A							

SHORT QUESTIONS OF CHAPTER-18 ACCORDING TO ALP SMART SYLLABUS-2020

Topic I: Brief review of PN Junction and its characteristics:

1. What is net charge on a n-type or p-type substances? (16 Times) (H.W)

Ans: Since they are electrically neutral substances. So the net charge on them is zero.

2. How does the motion of an electron in an n-type substance differ from the motion of holes in a p-type substance? (9 Times) (H.W)

Ans: Motion of electrons in n-type substance is more mobile and rapid than holes in p-type substance because electrons do not require holes for their motion but hole depend upon electrons for their motion. Both move in opposite direction.

3. Give four applications (or uses) of a photo diode. (2 Times)

Ans: It is used as
i. Detection of both visible and invisible radiations ii. Automatic switching
iii. Logic circuits iv. Optical communication equipment

4. The anode of a diode is 0.2V positive with respect to the cathode. Is it forward biased? (12 Times) (C.W)

Ans: Yes, when anode is 0.2 *V* positive with respect to cathode, it is forward biased. But the value of potential barrier for germanium is 0.3 *V* and for silicon is 0.7 *V*. Therefore there will be no conduction of current.

5. What is the potential barrier? What is the value of potential barrier of Si and Ge? (2 times)

Ans: The potential difference across the depletion region which acts as a barrier to the flow of charge carriers is called potential barrier.
The value of potential barrier for germanium is 0.3 *V* and for silicon is 0.7 *V*.

6. What is the effect of forward and reverse biasing of a diode on the width of depletion region? (8 Times)

Ans: When forward biased then the width of depletion region decreases and when reverse biased then the width of depletion region increases.

7. Define depletion region. (2 times)

Ans: A region in a semiconductor device, usually at the junction of p-type and n-type materials, in which there is neither an excess of electrons nor of holes is called depletion region. It is a charge less region.

8. How is p-n junction formed?

Ans: A p-n junction is formed when a crystal of germanium or silicon is grown in such a way that its one half is doped with a trivalent impurity and the other half with a pentavalent impurity.

9. What is semi-conductor diode?

Ans: p-n junction is called semi-conductor diode. The arrow head represents the p-region and is known as anode. The vertical line represents the n-region and is known as cathode.

The current flows in the direction of arrow when the diode is forward biased.

10. Differentiate between forward and reverse biasing. (3 Times)

Ans: (a) When p-side is positive and n-side is negative, the diode is forward biased. The width of depletion region reduces due to which more current is allowed to flow across the junction. The forward resistance is few ohms.

(a) When p-side is negative and n-side is positive, the diode is reversed biased. The width of depletion region is increased and a very small current flows across the junction due to flow of minority charge carriers. The resistance offered by the diode is several mega ohms.

11. Explain why an ordinary Silicon diode does not emit light. (21 Times) C.W

Ans: Ordinary silicon is opaque to light. So it does not emit visible light. It emits infra-red (invisible) light. To emit visible light, gallium arsenide or gallium arsenide phosphide are used as semiconductors.

12. Why charge carriers are not present in the depletion region? (4 times) H.W

Ans: This is due to the fact that when an electron from an n – region diffuses into the p – region, it leaves behind a positive ion. When this electron recombines with the hole in the p – region, a negative ion is formed. So, no charge carriers are available in this region, though it contains immobile positive and negative ions.

13. How the current flows in forward and reverse biased diode?

Ans: **In forward biasing**, the external potential difference supplies energy to free electrons in n-region and holes in p-region to overcome the potential barrier, a current of the order of a few mili-amperes begins to flow across the pn-junction.

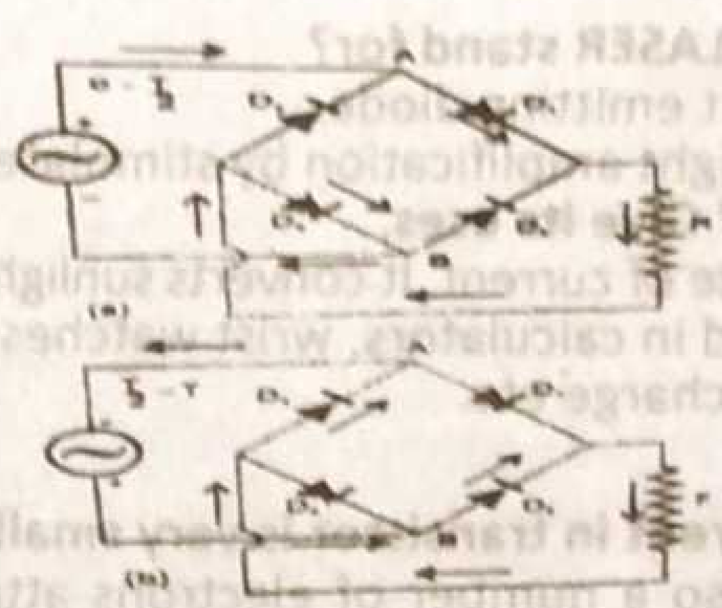
In reverse biasing, no current flows due to the majority charge carriers. However, a very small current, of the order of few micro-amperes flows across the junction due to minority charge carriers. It is known as reverse current or leakage current.

14. What is the role of potential barrier in a diode? How is it formed in a diode?

Ans: At the formation of p-n junction, the free electrons in n-region because of their random motion diffuse into the p-region. As a result of this diffusion, a region is formed around the junction consisting of positive and negative ions. Due to charge on these ions a potential difference develops across the depletion region. This potential difference called potential barrier, stops further diffusion of electrons into the p-region.

Topic II: Rectification:

15. Draw a circuit used to full wave rectification. Show direction of current in the circuit when positive half of input AC cycle passes through it.

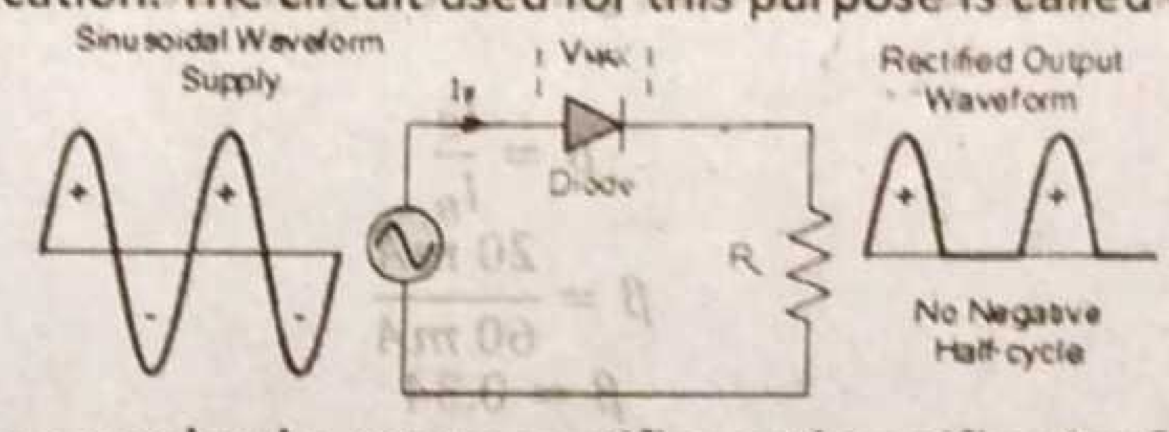


16. What is meant by rectification?

Ans: The conversion of alternating current signal into pulsating direct current signal is called rectification. The circuit used for this purpose is called rectifier circuit.

17. Define rectification. Draw a circuit diagram of half wave rectifier.

Ans: The conversion of alternating current signal into pulsating direct current signal is called rectification. The circuit used for this purpose is called rectifier.



18 What do you mean by the terms, rectifier and rectification?

Ans: Conversion of alternating current into direct current is called **rectification.** There are tow types of rectification.

(i) Half – wave rectification

(ii) Full – time rectification

The circuit used for rectification is called **rectifier**.

Topic III: Specially Designed P-n Function:

19. Why is the photo-diode operated in reserve biased state? (15 Times) C.W

Ans: Photodiode is used for the detection of light. So it is used in reverse biased state. Reverse current increases with the intensity of incident light. When no light incidents, then reverse current will be negligible.

20. What is photo-voltaic cell? Discuss its working.

Ans: It consists of a thick n-type region covered by a thin p-type layer. When exposed to light, it absorbs photon which generates electron-hole pairs. The electric field at the junction moves electrons and holes and a current flows through the external circuit. And this current is directly proportional to the intensity of light.

21. What do you know about Photo-voltaic Cell?

Ans: It consists of a thick n-type region covered by a thin p-type layer. When exposed to light, it absorbs photon which generates electron-hole pairs. The electric field at the junction moves electrons and holes and a current flow through the external circuit. And this current is directly proportional to the intensity of light.

22. What is photodiode? Write down its any two applications. (4 Times)

Ans: Photodiode is used for the detection of light. It is used in reverse biased state. Reverse current increases with the intensity of incident light. When no light incidents, then reverse current will be negligible. It is used as

i. Detection of both visible and invisible radiations ii. Automatic switching

23. Write a note on LED.

Ans: Light emitting diodes (LED) are made from special semi-conductors such as gallium arsenide and gallium arsenide phosphide in which the potential barrier between p & n sides is such that when electron combines with a hole during forward biased conduction, a photon of visible light is emitted.

LED's are used in 7 – segment display, small light sources etc.

24. What do LED and LASER stand for?

Ans: **LED** stands for light emitting diode.
LASER stands for light amplification by stimulated emission of radiation.

25 What is solar cell? Give its uses.

Ans: **Solar Cell** is a source of current. It converts sunlight directly into electrical energy. Solar cells are used in calculators, wrist watches, attached with nickel – cadmium batteries to store charge etc.

Topic IV: Transistor:

26. Why the base current in transistor is very small? **(15 Times) (H.W)**

Ans: Base is very thin so a number of electrons attracted by collector and very few enter into the base. And base current is very small.
That is $I_E = I_B + I_C$
As I_B is very small so it can be neglected $I_E \cong I_C$
Also $V_{BB} << V_{CC}$

27. In a certain circuit, the transistor has a collector current of 20 mA and base current 60 mA. What is the current gain of the transistor?

Ans: Since

$$\beta = \frac{I_C}{I_B}$$
$$\beta = \frac{20\ mA}{60\ mA}$$
$$\beta = 0.34$$

28. A transistor has I_C=10 mA and $I_B = 40\mu A$. Calculate current gain of transistor.

Ans: Since

$$\beta = \frac{I_C}{I_B}$$
$$\beta = \frac{10\ mA}{40\ \mu A}$$
$$\beta = \frac{10 \times 10^{-3}\ A}{40 \times 10^{-6}\ A}$$
$$\beta = 0.25 \times 10^{+3}$$
$$\beta = 250$$

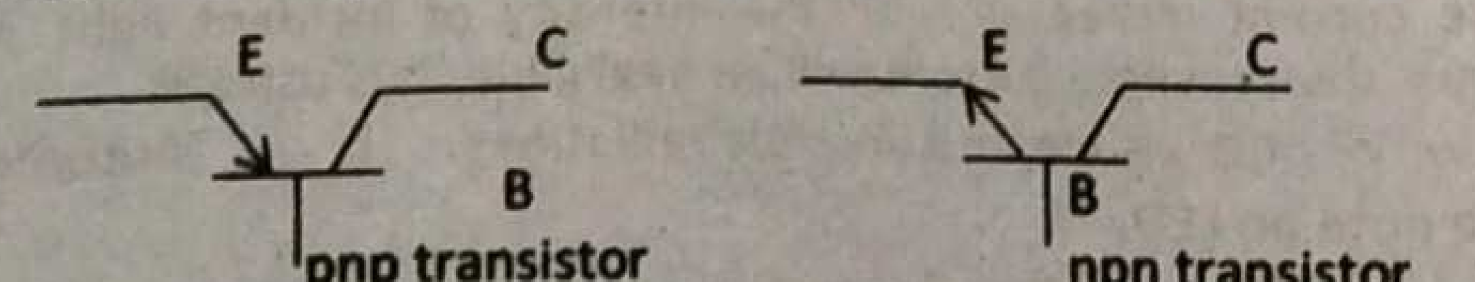
29. What is the biasing requirement of the junctions of a transistor for its normal operation? **(2 Time) (C.W)**

Ans: For the normal operation, the base-emitter junction of transistor is forward biased and collector-base junction is reverse biased.

30. How the normal operation of transistor is achieved? **(2 times)**

Ans: For the normal operation, the base-emitter junction of transistor is forward biased and collector-base junction is reverse biased.
In a common emitter amplifier, input signal is applied between base and emitter and output signal is taken across collector and emitter. Similarly, emitter-base junction is forward biased and collector-base junction is reverse biased.

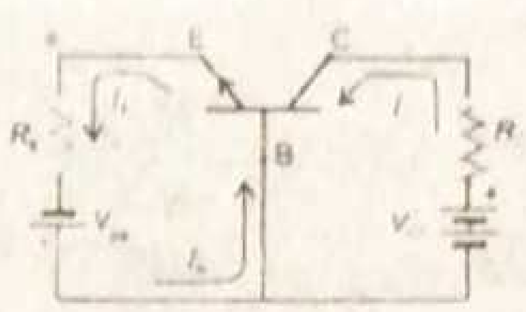
31. Draw symbols of two types of transistors.
OR Draw the symbols of pmp and npn transistors.



pnp transistor npn transistor

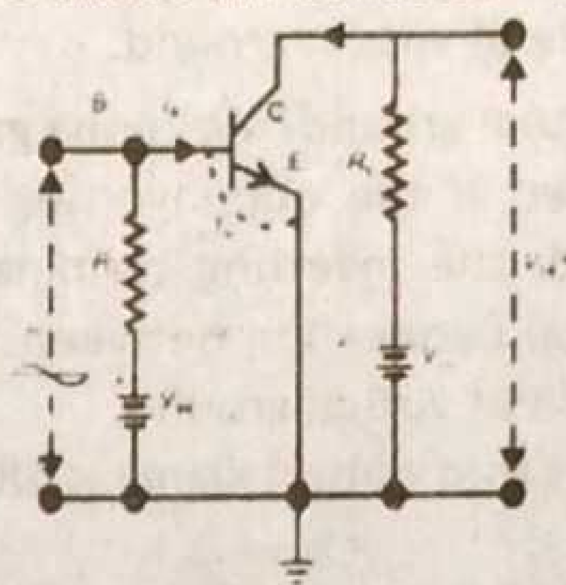
32. Describe by a circuit diagram, how current flows in a npn transistor.

Ans: Emitter – Base junction is forward biased, so emitter injects a large number of electrons in base region. These electrons can flow towards positive terminal of V_{BB} or V_{CC}. Almost all of these free electrons are attracted by the collector due to its large positive potential V_{CC}.
The flow of conventional current is shown in figure below:



33. What is the biasing requirement of the junctions of a transistor for its normal operation? Explain how these requirements are met in a common emitter amplifier.

Ans: For normal operation of a transistor, its emitter – base junction is forward biased and collector – base junction is reversed biased.
In a common emitter amplifier, the battery V_{BB} forward biases the emitter - base junction and V_{CC} reversed biases the collector – base junction as shown in figure.



Topic V: Transistor as an Amplifier:

34. Define current gain of a transistor. Give its mathematical expression. (3 Times)

Ans: The ratio of output current to input current is called current gain of a transistor.
Or The ratio of collector current to base current is called current gain of a transistor.

$$\beta = \frac{I_C}{I_B}$$

Topic VI: Operational Amplifier:

35. Give any two characteristics of an operational amplifier. **(8 Times)**

Ans: **Input Resistance:** It is the resistance between the (+) and (−) inputs of the amplifier. Whose value is of the order of several mega ohms.
Output Resistance: It is the resistance between the output terminal and ground. Its value is only a few ohms.

36. Define input and output resistance of an operational amplifier. **(2 times)**

Ans: The resistance between the (+) and(−) inputs of the amplifier is called input resistance. Whose value is of the order of several mega ohms. And The resistance between the output terminal and ground is called output resistance. Its value is only a few ohms.

37. Define Open Loop gain of operational amplifier. Also give its formula. (4 Times)

Ans: The ratio of output voltage to voltage difference between non-inverting and inverting inputs, when there is no external connection between the input and output is called open loop gain of operational amplifier.

$$A_{OL} = \frac{V_o}{V_+ - V_-} = \frac{V_o}{V_i}$$

38 Write briefly about Operational Amplifier.

Ans: The whole amplifier is integrated on a small silicon chip and enclosed in a capsule. Pins connected with working terminals project outside the capsule. It is some times used to perform mathematical operations electronically. It has two input terminals and a single output terminal. Its open loop gain is very high of the order of 10^5. It is used as inverting amplifier and non – inverting amplifier.

Topic VIII: Op. Amp as Inverting Amplifier:

39. If $R_1 = 10K\Omega$ and $R_2 = 100K\Omega$, Find the gain of inverting operational amplifier.

Ans: Since

$$G = -\frac{R_2}{R_1}$$

$$G = -\frac{100}{10}$$

$$G = -10$$

40. What is the principle of virtual ground? **(3 Time)**

Ans: In an operational amplifier, if the non-inverting terminal is grounded, by the concept of virtual ground, the inverting terminal is also at ground potential, through there is no physical connection between the inverting terminal and the ground. This is the principle of virtual ground.

41. What is the principle of virtual ground? Write the gain of inverting amplifier. **(C.W)**

Ans: In an operational amplifier, if the non-inverting terminal is grounded, by the concept of virtual ground, the inverting terminal is also at ground potential, though there is no physical connection between the inverting terminal and the ground. This is the principle of virtual ground.

The negative sign indicates that output signal is 180° out of phase with respect to input signal.

LONG QUESTIONS OF CHAPTER-18 ACCORDING TO ALP SMART SYLLABUS-2020

Topic I: P-N Junction:

1. What is P-n junction? How it is forward and reverse biased? Draw circuit and give characteristics.

Topic II: Rectification:

2. Define rectification and describe the working of half-wave and a full-wave rectifier.
3. Define rectification. What are its types? Discuss half wave rectification. **(4 times)**
4. Define rectification. Write a note on full wave rectification with diagram. **(3 times)**

Topic IV: Transistor:

5. Describe the flow of current in n-p-n transistor with the help of circuit diagram. Define current gain of a transistor.
6. Define depletion region, barrier potential and transistor. Discuss current through n-p-n transistor.

Topic V: Transistor as an Amplifier:

7. What is a transistor? Describe the use of transistor as a amplifier and calculate its voltage gain. **(12 Times)**

Topic VI: Operational Amplifier:

8. What is operational amplifier? Discuss the action of op amp as inverting and non-inverting amplifier. **(3 Times)**
9. What is operational amplifier? Describe operational amplifier as inverting amplifier. **(2 Times)**
10. Define inverter. Describe the working of operational amplifier as inverting amplifier.

Topic IX: OP-AMP as Non-Inverting Amplifier:

11. Draw the circuit diagram of non-inverting amplifier and label it. Evaluate the relations for its gain. **(7 Times)**

NUMERICAL PROBLEMS OF CHAPTER-18 ACCORDING TO ALP SMART SYLLABUS-2020

Topic IV: Transistor:

1. The current following into the base of a transistor is $100\,\mu A$. Find its collector current I_C, emitter current I_E and its ratio $\frac{I_C}{I_E}$ if the value of current gain $\beta = 100$. **(13 Times) (C.W)**

Ans:

Given that $I_B = 100\,\mu A = 100 \times 10^{-6}\,A$

$$\beta = 100$$

$$I_C = ?$$

$$I_E = ?$$

$$\frac{I_C}{I_E} = ?$$

Since

$$\beta = \frac{I_C}{I_B}$$

$$I_C = \beta I_B$$

$$I_C = (100)(100 \times 10^{-6})$$

$$I_C = 10^{4-6}\,A$$

$$I_C = 10^{-2}\,A$$

$$I_C = 10^{-2+3-3}\,A$$

$$I_C = 10 \times 10^{-3}\,A$$

$$\boxed{I_C = 10\,mA}$$

And

$$I_E = I_C + I_B$$

$$I_E = 10\,mA + 100\,\mu A$$

$$I_E = 10 \times 10^{-3} + 10 \times 10^{-6}$$

$$= 10.01 \times 10^{-3}\,A$$

$$\boxed{I_E = 10.01\,mA}$$

And

$$\frac{I_C}{I_E} = \frac{10}{10.01} \boxed{= 0.99}$$

2. In a certain circuit, the transistor has a collector current if $10\,mA$ and base current of $40\,\mu A$. What is the current gain of the transistor? **(6 Times)** **(Example No. 18.1)**

Ans: Given that

$$I_C = 10\,mA = 10 \times 10^{-3}\,A$$

$$I_B = 40\,\mu A = 40 \times 10^{-6}\,A$$

$$current\ gain = \beta = ?$$

Since

$$\beta = \frac{I_C}{I_B}$$

$$\beta = \frac{10 \times 10^{-3}}{40 \times 10^{-6}}$$

$$\boxed{\beta = 250}$$

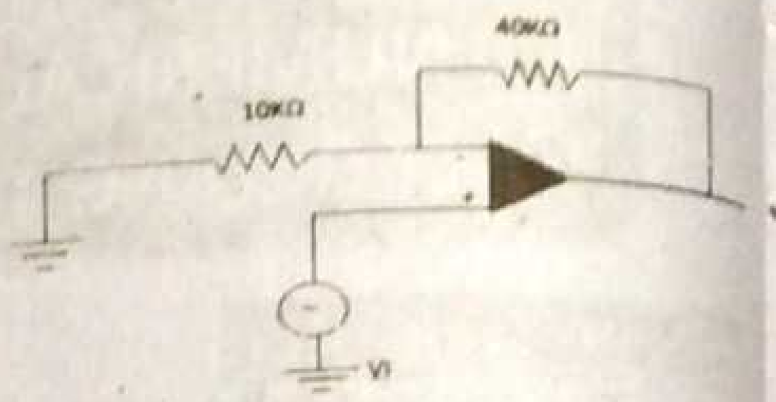
Topic IX: Op- amp as a noninverting amplifier:

3. Calculate the gain of non-inverting amplifier shown in fig. **(3 Times) (H.W)**

Sol:

$R_1 = 10K\Omega = 10\times10^3\Omega$

$R_2 = 40K\Omega = 40\times10^3\Omega$



Gain = ?

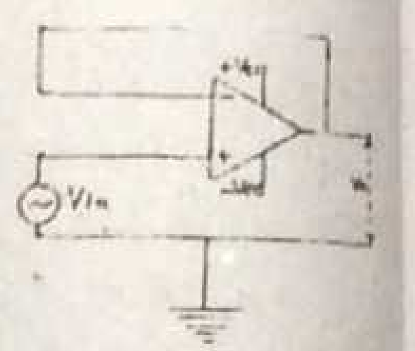
$$Gain = 1+\frac{R_2}{R_1} = 1+\frac{40\times10^3}{10\times10^3} = 1+4 = 5$$

(Example No. 18.2)

4. **Find the gain of the circuit shown in figure.**

Ans: Input signal V_{in} is connected to non-inverting input, so the operational amplifier is acting as a non-inverting amplifier.

Comparing it with the circuit of non-inverting amplifier, we get



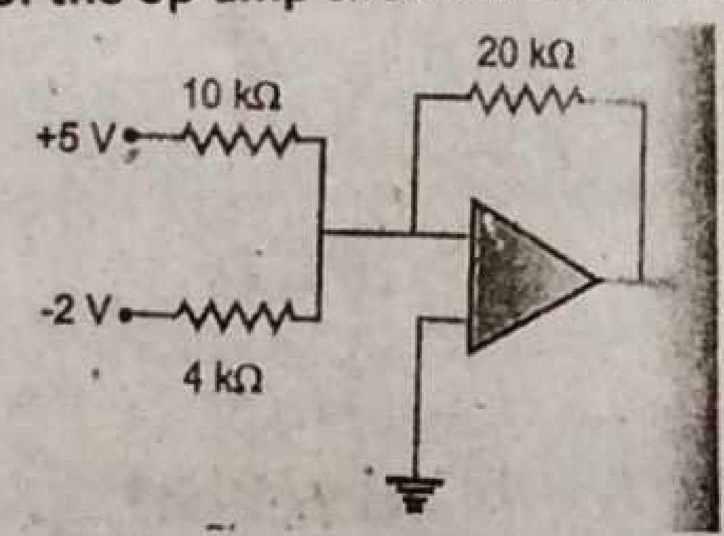
$R_1 = \infty$

$R_2 = 0$

Thus $Gain = 1+\frac{R_2}{R_1} = 1+\frac{0}{\infty} = 1+0 = 1$

ALP SMART SYLLABUS 2020

1. **Calculate the output of the op-amp circuit shown in Figure.** (C.W)



Sol:

$R_1 = 10\ k\Omega = 10 \times 10^3\Omega$

$R_2 = 4\ k\Omega = 4 \times 10^3\Omega$

$R_3 = 20\ k\Omega = 20 \times 10^3\Omega$

$V_1 = +5\ volts, V_2 = -2\ volts$

Output voltage $= V_o = ?$

Current through $R_1 = I_1 = \frac{V_1-0}{R_1} = \frac{5-0}{10\times10^3} = 0.5 \times 10^{-3}A$

Current through $R_2 = I_2 = \frac{V_2-0}{R_2} = \frac{-2-0}{4\times10^3} = -0.5 \times 10^{-3}A$

Current through $R_3 = I_3 = \frac{V_3}{R_3}\ I_3 = \frac{V_3}{R_3} = \frac{V_o-0}{R_3} = \frac{V_o}{20\times10^3}$

$= (0.05 \times 10^{-3}V_o)A$

Applying Kirchhoff's rule, at point P, we have

$I_1 + I_2 = I_3$

Putting the values, we get

$0.5 \times 10^{-3} + (-0.5 \times 10^{-3}) = 0.05 \times 10^{-3} \times V_o$

$0 = 0.05 \times 10^{-3}V_o$

or $V_o = 0$

OBJECTIVES (MCQ'S) OF CHAPTER-19 ACCORDING TO ALP SMART SYLLABUS-2020

Topic IV: Black Body Radiation:

1. At low temperature a body usually emits radiation of: **(2 times)**
(A) Long wavelength (B) Short wavelength (C) Infinite wavelength (D) None of these

2. Platinum wire becomes yellow at temperature of: **(2 times)**
(A) $900°C$ (B) $1300°C$ (C) $1600°C$ (D) $500°C$

3. Momentum of moving photon is given by:
(A) hc/λ (B) h/λ (C) h / f (D) $h\lambda/c$

4. An atom can reside in excited state for: **(2 times)**
(A) 10^{-8} sec (B) One second (C) 10^{-3} sec (D) 10^{-10} sec

5. In Stephen-Boltzmann's law $E = \sigma T^4$, the σ is called:
(A) Plank's constant (B) Stephen-Boltzmann's constant
(C) Stephen's constant (D) Boitzmann's constant

6. The value of Stefan's constant is: **(3 times)**
(A) $5.67 \times 10^{-6}\ wm^{-2}k^{-4}$ (B) $5.67 \times 10^{-10}wm^{-2}k^{-4}$
(C) $5.67 \times 10^{-8}Wm^{-2}k^{-4}$ (D) $5.67 \times 10^{-4}wm^{-2}k^{-4}$

7. Energy of black body radiations depends upon:
(A) Nature of surface of body (B) Nature of material body
(C) Shape and size of body (D) Temperature of the body

8. According to Stefan's Law about black body radiations is:
(A) $E\propto \frac{1}{T^2}$ (B) $E \propto T^2$ (C) $E\propto T^4$ (D) $E \propto T$

9. When platinum wire is heated it appears cherry red at temperature:
(A) 500 °C (B) 900 °C (C) 1100°C (D) 1300 °C

10. The platinum wire becomes white at a temperature of:
(A) 1600°C (B) 1100°C (C) 1000°C (D) 600°C

11. When Platinum is heater, it becomes orange at: **(2 times)**
(a) 500^0C (b) 900^0C (c) 1100^0C (d) 1300^0C

12. Potassium cathode in photocell emits electrons for a light:
(a) Visible (b) Infra-red (c) Ultra violet (d) X-rays

13. The energy of Photon is given by: **(2 times)**
(A) $\frac{mv^2}{2}$ (B) hf (C) $V_o e$ (D) $V_o e^2$

14. The frequency of a Micro – Wave with Wavelength 10 cm can be:
(A) 300 KHz (B) 300 μ Hz (C) 3×10^9 Hz (D) 30KHz

Topic V: Intraction of Electromagnetic Radiation with Matter:

15. The Compton shift in wavelength will be maximum when angle of scattering is: **(3 times)**
(A) 30° (B) 45° (C) 90° (D) 180°

16. The pair production is also called:
(A) Pair annihilation (B) Materialization of energy (C) Fusion reaction (D) Fission

17. The factor h/m_oc in Compton equation has the dimensions of: **(6 times)**
(A) Pressure (B) Length (C) Mass (D) Momentum

18. Each photon is associated with radiation of:
(A) Intensity (B) Frequency (C) Resistance (D) Momentum

19. Photoelectric current depends on:
(A) Frequency of light (B) Intensity of light (C) Speed of light (D) Polarization of light

20. Compton Effect observed with:
(A) X-rays (B) Visible light (C) Radio waves (D) All of these

21. Compton shift is equal to Compton wavelength when the scattered x-rays photons are observed at an angle of: **(2 times)**
(A) 0° (B) 30° (C) 60° (D) 90°

22. An electric eye operates because of:
(A) Compton effect (B) Photo refraction (C) Photo electric effect (D) I-Rradiations

23. Maximum kinetic energy of photoelectrons depend upon ____ of incident light:
(A) Frequency (B) Intensity (C) Brightness (D) Power

24. The amount of energy required to eject an electron from metal surface is called:
(A) Threshold frequency (B) Work function (C) Pair production (D) Compton Effect

25. Production of x-rays can be regarded as the reverse phenomenon of:
(A) Pair production (B) Photoelectric effect (C) Compton Effect (D) Annihilation effect

26. The maximum energy needed for a photon to create an electron-positron pair is: **(2 Times)**
(A) 1.02 Kev (B) 0.51 Kev (C) 0.51 Mev (D) 1.02 Mev

27. In photoelectric effect, if we increase the frequency of the incident light then____ of electrons increased:
(A) Number (B) K.E (C) P.E (D) Frequency

28. The condition $hf > 2m_oc^2$ refers to:
(A) Compton Effect (B) Pair production (C) Photoelectric effect (D) Annihilation of matter

29. The number of electrons emitted depends upon:
(A) Colour of target surface (B) Shape of surface
(C) Frequency of incident light (D) Intensity of incident light

30. At higher energies more than 1.02 Mev the dominant process is: **(3 Times)**
(A) Photoelectron effect (B) Compton Effect (C) Pair production (D) Nuclear fission

31. The unit of work function is: **(2 times)**
(A) eV (B) Volt (C) Farad (D) Hertz

32. The change in wavelength of scattered photon in Compton effect is:
(A) $\frac{h}{m_oc}$(1-cos θ) (B) $\frac{h}{m_oc^2}$(1-cos θ) (C) $\frac{m_o}{hc}$ (1 - cos θ) (D) $\frac{h}{m_0^2c^2}$ (1 − cosθ)

33. Compton's shift in Wave Length of ($\Delta\lambda$) is zero, when scattered angle of photon is:
(A) 90° (B) 180° (C) 0° (D) 45°

34. Compton Effect proves:
(A) Wave nature of radiation (B) Wave nature of particle
(C) Dual nature of particle (D) Particle nature of radiations

35. Disintegration of photon on striking a nucleus into an electron and positron is:
(A) Annihilation of matter (B) Compton effect
(C) Pair production (D) Photo electric effect

36. Two Photons approach each other, their relative speed will be:-
(a) 2 c (b) zero (c) less than c (d) c

37. Antiparticle of electron is:
(a) Proton (b) photon (c) neutron (d) positron

38. In order to increase the K.E of ejected photo electrons there should be an increase in:
(a) Intensity of radiations (b) wavelength of radiations
(c) Frequency of radiations (d) both as b and c

39. Compton's effect is associated with:
(a) Gamma rays (b) beta rays (c) x-rays (d) positive rays

40. The rest mass energy of an electron positron pair is:
(a) 0.51 MeV (b) 1.02Mev (c) 1.2 MeV (d) 1.00 MeV

41. Energy of each positron is given by:
(a) 2 MeV (b) 1.02 MeV (c) 0.51 MeV (d) 5 MeV

42. Pair production can take place only when energy of radiation is equal and greater than 1.02 MeV, thus correct option is:
(A) X- Rays (B) Heat radiation (C γ -rays (D) Ultrviolet Rays

43. The existence of Positron in 1928 was predicted by:
(A) Anderson (B) Dirac (C) Chadwick (D) Plank

44. The maximum Kinetic energy of emitted photoelectrons depends upon:
(A) the intensity of incident light (B) frequency of the incident light
(C) metal surface (D) both frequency of indident light and metal surface

45. The reverse process of photo – electric effect is called:
(A) Pair production (B) Compton effect (C) Annihilation of matter (D) X – Rays

46. Who explained the photo electric effect?
(A) Max plank (B) Einstein (C) Henry (D) Rutherford

Topic VI: Annihilation of matter:

47. The inverse of pair production is:
(A) Hertz effect (B) Compton Effect (C) Black body (D) Annihilation of matter

48.1 Kg mass will be equivalent to Energy: **(3 times)**
(A) 9×10^8 J (B) 9×10^{12} J (C) 9×10^{16} J (D) 9×10^{19} J

49. When an electron combines with a positron, we gain.
(A) One photon (B) three photons (C) two photons (D) four photons

50. In annihilation, emitted photons move in opposite directions to conserve.
(A) Mass (B) Charge (C) Energy (D) Momentum

Topic VII: Wave Nature of Particles:

51. Wave length 'λ' associated with the particle of mass m and moving with the velocity 'v' is:
(A) $\frac{mv}{h}$ (B) $\frac{hv}{m}$ (C) $\frac{h}{mv}$ (D) $\frac{m}{hv}$

52. Davisson and Germer indicates______ in their experiment:
(A) Electron reflection (B) Electron polarization
(C) Electron refraction (D) Electron diffraction

53. The principle regarding the dual nature of light was first discovered by:
(A) Campton (B) J.J Thomson (C) De-Broglie (D) Heisenberg

54. Which one experiment is the verification of wave nature of particle:
(A) Photo electric (B) Compton effect
(C) Pair production (D) Davisson and Germer exp.

55. We can find from de Broglie formula:
(A) Wavelength (B) Amplitude of wave (C) Speed of wave (D) Frequency of wave

56. Wave nature of light appears in: **(2 times)**
(A) Pair production (B) Compton Effect (C) Photo electric effect (D) interference

57.______ has the largest de Broglie wavelength at same speed.
(a) Proton (b) α– particle (c) Carbon Atom (d) Electron

58. If a Particle of mass "m" is moving with speed "v" then de – Broglie Wavelength λ associated with it will be:
(A) $\lambda = \frac{3h}{mv}$ (B) $\lambda = \frac{2h}{mv}$ (C) $\lambda = \frac{h}{mv}$ (D) $\lambda = \frac{h}{2mv}$

59. X – ray diffraction reveals that these are:
(A) Paticle type (B) Wave type (C) Both a wave and particle (D) None of above

Topic VIII: Uncertainty Principle:

60. For a nucleus Δx is given as 1.0×10^{-14} m. If the electron remain inside the nucleus then its vibrational velocity should be:
(A) Less than the speed of light (B) Equal to the speed of light
(C) Greater than the speed of light (D) Double than the speed of light

61. Using relativistic effects the location of an air craft after an hour's flight can be predicted about:
(a) 20 m (b) 50 m (c) 760 m (d) 780 m

2018

62. Application of wave nature of particle is:
(a) photodiode (b) simple microscope (c) compound microscope (d) electron microscope

63. The physical quantity related to photon, that does not change in Compton scattering is:
(a) Energy (b) Speed (c) Frequency (d) Wavelength

64. When a metal is heated sufficiently electrons are given off by the metal. This phenomenon is known as:
(a) photoelectric effect (b) Piezo electric effect
(c) Thermionic emission (d) Secondary emission

65. Compton shift in the wavelength will be minimum when angle of scattering is:
(A) 90^0 (B) 60^0 (C) 30^0 (D) 0^0

66. Which one is low energy photon:
(A) Visible light (B) Infrared light (C) Ultra violet light (D) X-rays

67. The maximum K.E. of Photoelectron depends upon:
(A) Intensity of Incident Light (B) Frequency of Incident Light
(C) Metal (D) Temp. of Metal

68. The materialization of energy takes place in the process of: (2 times)
(A) Photoelectric Effect (B) Compton Effect
(C) Pair Production (D) Annihilation of Matter

69. Light of 4.5ev is incident on a cesium surface and stoping potential is 0.25 V, maximum K.E of emitted electrons is:
(A) 4.5 ev (B) 4.25 ev (C) 4.75 ev (D) 0.25 ev

70. The value of planck's constant is:
(A) 8.85×10^{-34}Js (B) 1.6×10^{-19}Js (C) 6.63×10^{-34}Js (D) 6.62×10^{-23}Js

2019

71. The life time of an electron in an excited state is about 10^{-8}s. What is its uncertainty in energy during this time:
(A) 6.63×10^{-34}J (B) 9.1×10^{-31} J (C) 1.05×10^{-26}J (D) 7.2×10^{-15} J

72. If temperature is doubled for a black body, then energy radiated per second per unit area becomes:
(A) $\frac{1}{2}$ times (B) $\frac{1}{4}$ times (C) $\frac{1}{16}$ times (D) 16 times

73. The wave-length of emitted radiation of maximum intensity is inversely proportional to the absolute temperature. This is known as:
(A) Faraday's law (B) Rayleigh Jean's law
(C) Stefan's law (D) Wien's displacement law

74. Photoelectric effect shows.
(A) Corpuscular nature of light (B) Dual nature of light
(C) Electromagnetic nature of light (D) Wave nature of light

75. In the process of Annihilation of Matter, the two Photons produced move in opposite direction to conserve:
(A) Energy (B) Mass (C) Momentum (D) Charge

76. The most refined from of Matter by de-Broglie is:
(A) Smoke (B) Fog (C) Light (D) Protons

77. Compton wavelength is:
(A) $\frac{h}{m_0c^2}$ (B) $\frac{hc}{m_0}$ (C) $\frac{h}{m_0c}$ (D) $\frac{hc}{m_0\lambda}$

78. The enegy required for pair production is:
(A) 0.51 MeV (B) 1.02 MeV (C) 2.04 MeV (D) 3.06 MeV

ANSWERS OF THE MULTIPLECHOICE QUESTIONS

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
A	B	B	A	C	C	D	C	B	A	C	A	B	C	D	B
17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
B	B	B	A	D	D	A	B	B	D	B	B	D	C	A	A
33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
C	D	C	A	D	C	C	B	C	C	B	D	D	A	D	C
49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64
C	D	C	D	C	D	A	D	D	C	B	C	B	D	B	C
65	66	67	68	69	70	71	72	73	74	75	76	77	78		
D	B	B	C	D	C	C	D	D	A	C	C	C	B		

SHORT QUESTIONS OF CHAPTER-19 ACCORDING TO ALP SMART SYLLABUS-2020

Topic IV: Black Body Radiation:

1. Photon A has twice the energy of photon B. What is the ratio of the momentum of A to that of B? (5 Time)

Ans: As the energy of photon A is twice the energy of photon B, so

$$E_a = 2E_b$$
$$P_a c = 2E_b$$
$$P_a = 2\frac{E_b}{c}$$
$$P_a = 2P_b$$

It means that if the energy of photon A is twice the energy of photon B then the momentum of photon A is twice the momentum of photon B.

2. As a solid is heated and begins to glow, why does it first appear red? (8 times) (C.W)

Ans: Since the red light has longest wavelength, so it will be emitted first and solid appears red first.

3. What happens to the total radiations from a black body if its absolute temperature is doubled? (8 times)

Ans: Stefan-Boltzmann law is $E = \sigma T^4$

So by doubling temperature $E' = \sigma(2T)^4$

$$E' = 16\sigma T^4$$
$$E' = 16E$$

That is, total radiation energy will become sixteen times.

4. Which photon red, green or blue carries the most (a) energy (b) momentum? (10Times) (C.W)

Ans: Since $E = hf = \frac{hc}{\lambda}$

$$E \propto \frac{1}{\lambda}$$

As $\lambda_{red} > \lambda_{green} > \lambda_{blue}$

Hence blue light has most energy.

And since $p = \frac{h}{\lambda}$

$$p \propto \frac{1}{\lambda}$$

As $\lambda_{red} > \lambda_{green} > \lambda_{blue}$

Hence blue light has most momentum.

5. Which photon red or blue has greater energy?

Ans: Since $E = hf = \frac{hc}{\lambda}$

$$E \propto \frac{1}{\lambda}$$

As $\lambda_{red} > \lambda_{blue}$

Hence blue light photon has greater energy.

6. Which has the lower energy quanta, radio waves or X-rays? (8 times) (C.W)

Ans: Since $E = hf = \frac{hc}{\lambda}$

$$E \propto \frac{1}{\lambda}$$

As $\lambda_{radio\ waves} > \lambda_{X-rays}$

So radio waves have lower energy quanta.

7. If the following particles have same energy which has the shortest wavelength

alpha particle or neutron?

Ans: α-particle will have the shortest wavelength.
As we know

$$\lambda = \frac{h}{mv}$$

Also, the energy of moving particle is,

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

Or $K.E. = \frac{m^2v^2}{2m}$

Or $m^2v^2 = 2m\,(K.E.)$

Or $mv = \sqrt{2m\,(K.E.)}$

So, $\lambda = \frac{h}{\sqrt{2m\,(K.E.)}}$

As all given particles have same energy, therefore

$$\lambda \propto \frac{1}{\sqrt{m}}$$

As α-particle has greatest mass, therefore, it will have the shortest wavelength.

8. Why can red light be used in a photographic dark room when developing films, but a blue or white light cannot? (2 times)

Ans: As we know red light has longest wavelength in visible spectrum, therefore it has less energy than that of blue or white light. So red light is least scattered on account of its large wavelength. Hence, photographic films and the materials concerned are less affected in the presence of red light than high energy blue or white light.

9. When light shines on surface, is momentum transferred to metal surface? (4 times) (C.W)

Ans: Yes, when light shines on surface, momentum is transferred to metal surface and also the energy. So metal is heated up.

$$E = hf$$

And $p = \frac{h}{\lambda}$

10. If an electron and proton have the same de-Broglie wavelength which particle has greater speed? Explain. (3 times)

Ans: From de-Broglie hypothesis

$$\lambda = \frac{h}{mv}$$

or $v = \frac{h}{m\lambda}$

Since wavelength is given same and h is Plank's constant. So,

$$v \propto \frac{1}{m}$$

Hence an electron being a lighter one will have greater speed.

11. We do not notice the de-Broglie wavelength for a pitched cricket ball. Explain why? (2 times) (H.W)

Ans: According to de-Broglie hypothesis

$$\lambda = \frac{h}{mv}$$

As cricket ball has large mass, therefore wavelength "λ" of wave associated with it is so small that is not detectable.

12. Which has the lower energy quanta, radio waves or x-rays? Explain. (2 times)

Ans: Energy of quanta is given as

$$E = hf = \frac{hc}{\lambda}$$

Or $E = \frac{\text{constant}}{\lambda}$

Or $E \propto \frac{1}{\lambda}$

Radio waves has longer wavelength. Therefore, radio waves has lower energy quanta.

13. What are black body radiations and how can you get a black body? (2 times)

Ans: An object that absorbs all radiation falling on it, at all wavelengths is called a **black body**.
When a body is heated, it emits radiation. Its emission is called **black body radiation**.
Black body is a solid that has a hollow cavity within it and a small hole through which radiation can enter or escape. The inside is blackened with suit to make it as good an absorber and as bad a reflector as possible.

14. Define work function and threshold frequency.

Ans: The minimum amount of energy required to remove electrons from a metal surface is called **work function** of this metal.
The minimum frequency below which photoelectric effect cannot occur from a metal surface is called **threshold frequency** of this metal.

15. Is it possible to create a single electron from energy? Explain.

Ans: No, it is not possible to create a single electron from energy.
Creation of single electron will be against the law of conservation of charge and the law of conservation of momentum. In pair production an electron – positron pair is produced.

16. Does brightness of beam of light primarily depends upon the frequency of photons or on the number of photons. (C.W)

Ans: The brightness of beam of light primarily depends upon number of photons.
It is the energy which depends upon frequency of photon.

17. Find the energy of photon in radiowave of wavelength 100m.

Ans:

$\lambda = 100m$

$h = 6.63\times10^{-34}\,Js$

$c = 3\times10^{8}\,m/s$

$E = ?$

We know that

$$E = \frac{hc}{\lambda}$$

$$E = \frac{6.63\times10^{-34}\times3\times10^{8}}{100}$$

$$E = 19.89\times10^{-28}\,J$$

Topic V: Interaction of Electromagnetic Radiation with Matter:

18. Why don't we observe a Compton Effect with visible light? (15 times) (C.W)

Ans: The frequency of visible light is less than x-rays. And the wavelength of visible light is much greater than Compton wavelength of electron. So Compton effect cannot be observed with visible light.

19. Will higher frequency light eject greater number of electrons than low frequency light? (4 Times) (H.W)

Ans: No, it will not. The number of ejected electrons depend upon the intensity of light. They are independent of frequency.

20. Define ionization potential and excitation potential. (4 times)

Ans: __Ionization potential:__ The potential necessary to remove an electron from the atom is called ionization potential. It is expressed in volts.
__Excitation potential:__ The potential required to raise orbital electron in atom from one energy level to another is called excitation potential.

21. Is it possible to create a single electron from energy? (6 times)

Ans: No, it is possible to create a single electron from energy. Because electron has negative charge and photon has no charge. So the emittance of positron (anti-particle of electron) is necessary. Otherwise it will be the violation of law of conservation of charge.

22. Will the bright light eject more electrons from a metal surface then dimmer light of the same colour? **(4 times) C.W**

Ans: Since $intensity \propto number\ of\ electrons$
And bright light is more intense than dimmer one. So bright light will eject more electrons than dimmer light.

23. Photoelectric effect gives the evidence of the particle nature of light. Explain it how?

Ans: Since $E = hf$
If light were simple a wave-like phenomenon, then increasing the intensity and thereby increasing the total energy falling on the surface would be expected to eventually provide enough energy to release electrons no matter what the frequency. Furthermore, in the classical picture one would expect the maximum energy of the emitted electrons to depend on the intensity of the light -- but it does not.
So this is evidence that light behaves as if it were a particle.

24. Distinguish between photoelectric effect and Compton Effect. **(2 times)**

Ans: The emission of electrons from a metal surface when exposed to suitable frequency light is called photoelectric effect.
And
When X-rays are scattered by loosely bound electrons from a graphite target, the phenomenon of change in wavelength is known as Compton effect.

25. Define pair production and annihilation of matter. **(2 times)**

Ans: **Pair production:** The change of very high energy photon into an electron, positron pair is called pair production.
Annihilation of matter: When a positron comes close to an electron, they annihilate and produce two photons in the gamma rays range. It is called annihilation of matter.

26. A beam of red light and a beam of blue light having exactly the same energy. Which beam contains the greater number of photon? **(2 times) C.W**

Ans: Energy of photon is $E = hf = hc/\lambda$

Or $E_n = \frac{nhc}{\lambda}$ Or $n = E_n\lambda/hc$

As $E_n, h\ \&\ c\ are\ same\ so$ $n \propto \lambda$

Since $\lambda_{red} > \lambda_{blue}$ so red beam will have greater number of photons.

27. What do you understand by work function and stopping potential?

Ans: The minimum amount of energy required to remove an electron from the surface of a metal is called work function.
And the Stopping Potential is the potential difference applied to stop the electrons from being ejected from the surface when the light falls on it.

28. What are the conclusions made from pair production?

Ans: Pair production is the creation of an elementary particle and its antiparticle.
Pair production often refers specifically to a photon creating an electron-positron pair near a nucleus but can more generally refer to any particle-antiparticle pair creation.
Energy can be converted into mass according to $E = mc^2$

29. Define Compton Effect. Write formula of Compton shift for scattering angle θ **(2 times).**

Ans: When X-rays are scattered by loosely bound electrons from a graphite target, the phenomenon of change in wavelength is known as Compton Effect.
Compton shift for scattering angle θ is given as

$$\Delta\lambda = \frac{h}{m_o c}(1 - cos\theta)$$

30. Define Stopping potential and Threshold frequency.

Ans: **Stopping potential:** The Stopping Potential is the potential difference applied to stop the electrons from being ejected from the surface when the light falls on it.
Threshold frequency: The minimum value of frequency of incident light at which electrons are emitted from a surface is called threshold frequency.

31. Define Compton Effect.

Ans: The phenomenon of increase in wavelength of x-ray photon, scattered by loosely bound electrons from a graphite target is called Compton Effect.

32. Define Compton Effect and pair production.

Ans: When x-rays are scattered by loosely bound electrons from a graphite target, wavelength of the scattered x-rays is larger than the wavelength of the incident x-rays, it is known as **Compton Effect**.

$$\Delta\lambda = \frac{h}{m_o c}(1 - \cos\theta)$$

The change of very high energy $(\gamma - ray)$ photon into an electron, positron pair is called **pair production**.

33. Can pair production take place in vacuum? Explain. **(2 times) H.W**

Ans: No, pair production cannot take place in vacuum.
In order to conserve the momentum and energy, the presence of heavy nucleus is essential. The vacuum has no particle or heavy nucleus. Therefore, pair production cannot take place in vacuum.

34. State and write formula for Compton's effect.

Ans: When x-rays are scattered by loosely bound electrons from a graphite target, wavelength of the scattered x-rays is larger than the wavelength of the incident x-rays, it is known as **Compton effect**.

$$\Delta\lambda = \frac{h}{m_o c}(1 - \cos\theta)$$

35. What is the condition of pair production? Briefly explain.

Ans: The change of very high energy (such as γ – ray) photon into an electron-position pair is called pair production.
In order to conserve energy & momentum, the presence of heavy nucleus is essential.

36. Why must the rest mass of photon be zero?

Ans: Light consists of small packets of energy called photon. Photon always moves with the speed of light and its mass is in the form of energy. Photons are never at rest.

37. Calculate the value of Compton wavelength of electron.

Ans: We know that

$$Compton\ Wavelength = \frac{h}{m_0 c}$$

Rest mass of electron $m_0 = 9.1 \times 10^{-31}\,Kg$
Putting values,

$$Compton\ wavelength = \frac{6.63 \times 10^{-34}}{9.1 \times 10^{-31} \times 3 \times 10^{8}} = 2.43 \times 10^{-12}\,m$$

38. Define Compton Effect. At what angle Compton shift becomes equal to the Compton wave length?

Ans: When X – rays are scattered by loosely bound electrons from a graphite target, wavelength of the scattered x – rays is larger than the wavelength of the incident x – rays, it is known as **Compton Effect**.

$$\Delta\lambda = \frac{h}{m_0 c}(1 - \cos\theta)$$

Where $\Delta\lambda$ is Compton Shift and $\frac{h}{m_0 c}$ is Compton wavelength.

If $\theta = 90^0$ then

$$\Delta\lambda = \frac{h}{m_0 c}(1 - \cos 90^0)$$
$$= \frac{h}{m_0 c}(1 - 0)$$
$$\Delta\lambda = \frac{h}{m_0 c}$$

Topic VI: Annihilation of matter:

39. What do you mean by annihilation of matter?

Ans: Annihilation of matter: When a positron comes close to an electron, they annihilate and produce two photons in the gamma rays range. It is called annihilation of matter.

Topic VII: Wave nature of particle:

40. What is wave particle duality? Give its one practical use.

Ans: It says that light has dual nature; it travels in the form of waves but interacts with matter in the form of energy particles called as photons.
e.g., In interference, refraction, reflection and polarization it shows the properties of wave nature but in phenomena like pair production and Compton's effect light acts as energy particles.

41. Write at least two justifications for light to behave as wave and as a particle.

Ans: Interference and diffraction confirms wave nature of light while photoelectric effect and Compton's effect confirms particle nature of light.

42. When does light behave as a wave? When does light behave as a particle? (2 times) (H.W)

Ans: Light behave as a wave when it propagates from one place to other and light behave as a particle when it interacts with matter.
Light behaves as a wave in interference and diffraction.
Light behaves as a particle in photoelectric effect and Compton's effect.

Topic VIII: Uncertainty Principle:

43. State uncertainty principle. Give its two mathematical forms.

Ans: The product of uncertainty in the measurement of momentum and uncertainty in the measurement of position of an electron is approximately equal to Planck's constant. $(\Delta p)(\Delta x) \approx h$
The product of uncertainty in the measurement of energy and uncertainty in the measurement of time of an electron is approximately equal to Planck's constant.

$$(\Delta E)(\Delta t) \approx h$$

44. What advantages an electron microscope has over an optical microscope? (4 Times) (H.W)

Ans: (i) Resolving power of electron microscope is 1000 times greater than that of optical microscope.
(ii) Magnification of an electron microscope is also about 1000 times greater than that of optical microscope.
(iii) 3 – D image of remarkable quality can be obtained by electron microscope (SEM).

45. The life time of an electron in an excited state is 10^{-8}s. What is its uncertainity in energy during this time.

Ans: From uncertainity principle

$$\Delta E.\Delta t \approx \hbar$$

Or

$$\Delta E = \frac{\hbar}{\Delta t} = \frac{1.05\times10^{-34}}{10^{-8}}$$

$$\Delta E = 1.05\times10^{-26} J$$

LONG QUESTIONS OF CHAPTER-19 ACCORDING TO ALP SMART SYLLABUS-2020

Topic IV: Black Body Radiation:

1. What is the black body radiation? Explain intensity distribution diagram.
2. Explain black body also gives the explanation of intensity distribution diagram with facts.

Topic V: Intraction of Electromagnetic Radiation with Matter:

3. Define photoelectric effect. Give its explanation on the basis of Quantum theory.
4. What is photoelectric effect? How its different results were successfully explained by Einstein?
5. Define Compton Effect. Find the expression for Compton shift. Draw its scattering diagram and label it.
6. Write a note on Compton Effect.
7. Define and explain Compton Effect.
8. Explain the photoelectric effect. What is the effect of frequency of light on photoelectric current and energy of photoelectrons?
9. What is photoelectric affect? How its different results were successfully explained by Einstein?

Topic VII: Wave Nature of Particles:

10. State de Broglie hypothesis, give its formula. Also explain an electron microscope.
11. Explain de Broglie hypothesis. How Davisson and Germer experimentally verified the de Broglie hypothesis? **(5 times)**
12. Describe Davisson and Germer experiment to confirm the wave nature of electron. Also derive an expression for wave length.

Topic VIII: Uncertainty Principle:

13. What is Uncertainty Principle? Explain it.

NUMERICAL PROBLEMS OF CHAPTER-19 ACCORDING TO ALP SMART SYLLABUS-2020

Topic IV: Black Body Radiation:

1. What is the energy of photon in a beam of infrared radiations having wavelength 1240 nm? (3 Time) (Example No. 19.5)

Ans: Given that

$$\lambda = 1240\ nm = 1240 \times 10^{-9}\ m$$
$$c = 3 \times 10^{8}\ ms^{-1}$$
$$h = 6.63 \times 10^{-34}\ Js$$
$$E = ?$$

Since $E = hf$

$$E = \frac{hc}{\lambda}$$

$$E = \frac{6.63 \times 10^{-34} \times 3 \times 10^{8}}{1240 \times 10^{-9}}$$

$$E = 1.6 \times 10^{-19}\ J$$

$$\boxed{E = 1.0\ eV}$$

2. Assuming you radiate as does a black body at your body temperature about 37° C, at what wavelength do you emit the most energy? (Example No. 19.4)

Sol: T = 37°C = (37 + 273) K = 310 K
Wien's Constant = 2.9×10^{-3} mk
$\lambda_{max} = ?$

As we know that

$$\lambda_{max} \times T = \text{Constant}$$

$$\lambda_{max} = \frac{\text{Constant}}{T}$$

$$\lambda_{max} = \frac{2.9\times10^{-3}}{310} = 9.35\times10^{-6} m$$

$$\lambda_{max} = 9.35 \mu m$$

Topic V: Intraction of Electromagnetic Radiation with Matter:

3. X-rays of wavelength 22 pm are scattered from a carbon target. The scattered radiation being viewed at 85^o to the incident beam. What is Compton shift? (2 times) (C.W)

Ans: Given that

$$m_o = 9.1 \times 10^{-31}\ kg$$
$$c = 3 \times 10^8\ ms^{-1}$$
$$h = 6.63 \times 10^{-34}\ Js$$
$$\theta = 85^o$$
$$\Delta\lambda = ?$$

Since $\Delta\lambda = \frac{h}{m_o c}(1-\cos\theta)$

$$\Delta\lambda = \frac{6.63 \times 10^{-34}}{9.1 \times 10^{-31} \times 3 \times 10^8}(1-\cos 85^o)$$
$$\boxed{\Delta\lambda = 2.2 \times 10^{-12}\ m}$$

4. A 50 KeV photon is Compton scattered by a quasi-free electron. If the scattered photon comes off at 45⁰. What is its wavelength? (Example No. 19.7)

Sol: E = 50 KeV = 50 × 10³ eV
= 50 × 10³ × 1.6 × 10⁻¹⁹ J
= 80 × 10⁻¹⁹ J
C = 3 × 10⁸ m/s , θ = 45⁰ , h = 6.63 × 10⁻³⁴J.s

Scattered wavelength $\lambda' = ?$

As $E = hf = \frac{hc}{\lambda}$

Or $\lambda = \frac{hc}{E} = \frac{6.63\times10^{-34}\times3\times10^8}{80\times10^{-16}}$

$\lambda = 0.248\times10^{-10}m = 0.0248\,nm$

5. A 90KeV x-ray photon is fired at a carbon target and Compton scattering occurs. Find wavelength of incident photon and the wavelength of scattered photon for scattering angle of 60^0. (C.W)

Sol: E = 90 KeV = 90 × 10³ × 1.6 × 10⁻¹⁹ J
E = 1.44 × 10⁻¹⁴ J
h = 6.63 × 10⁻³⁴ Js
C = 3 × 10⁸ m/s , θ = 60⁰
$\lambda = ?$, $\lambda' = ?$

As $E = \frac{hc}{\lambda}$ or $\lambda = \frac{hc}{E} = \frac{6.63\times10^{-34}\times3\times10^8}{1.44\times10^{-14}}$

$\lambda = 13.81\times10^{-12}m = 13.81\ pm$

We know that

$$\Delta\lambda = \lambda' - \lambda = \frac{h}{m_0 c}(1-\cos\theta)$$

Or $$\lambda' = \lambda + \frac{h}{m_0 c}(1-\cos\theta)$$

$$\lambda' = 13.81\times10^{-12} + \frac{6.63\times10^{-34}}{9.1\times10^{-31}\times3\times10^8}(1-\cos 60^0)$$

$$\lambda' = 15.02\times10^{-12}m = 15.02\ pm$$

Topic VII: Wave Nature of Particles:

5. What is the de-Broglie wavelength of an electron whose kinetic energy is 120 eV? (4 Times) (H.W)

Ans: Given that

$$K.E. = 120\ eV = 120 \times 1.6 \times 10^{-19}\ J$$
$$mass\ of\ electron = m = 9.1 \times 10^{-31}\ kg$$
$$Planck's\ constant = h = 6.63 \times 10^{-34}\ Js$$
$$de-Broglie\ wavelength = \lambda = ?$$

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

$$v = \sqrt{\frac{2K.E.}{m}}$$
$$v = \sqrt{\frac{2(120 \times 1.6 \times 10^{-19})}{9.1 \times 10^{-31}}}$$
$$v = 6.65 \times 10^6\ ms^{-1}$$

Now $\lambda = \frac{h}{mv}$

$$\lambda = \frac{6.63 \times 10^{-34}}{9.1 \times 10^{-31} \times 6.65 \times 10^6}\boxed{= 1.12 \times 10^{-10}\ m}$$

6. An electron is accelerated through a potential difference of 50 V. Calculate its de-Broglie wavelength. (6 Times) (Example No. 19.9)

Ans: Given that

$$mass\ of\ electron = m = 9.1 \times 10^{-31}\ kg$$
$$potential\ difference = V_o = 50\ V$$
$$charge\ on\ an\ electron = e = 1.6 \times 10^{-19}\ C$$
$$Planck's\ constnat = h = 6.63 \times 10^{-34}\ Js$$
$$de-Broglie\ wavelength = \lambda = ?$$

Since $\frac{1}{2}mv^2 = V_o e$

$$\frac{1}{2m}m^2v^2 = V_o e$$
$$(mv)^2 = 2mV_o e$$
$$p^2 = 2mV_o e$$
$$p = \sqrt{2mV_o e}$$
$$p = \sqrt{2(9.1 \times 10^{-31})(50)(1.6 \times 10^{-19})}$$

Now $\lambda = \frac{h}{mv}$

$$\lambda = \frac{h}{p}$$

$$\lambda = \frac{6.63 \times 10^{-34}}{\sqrt{2(9.1 \times 10^{-31})(50)(1.6 \times 10^{-19})}}\boxed{= 1.74 \times 10^{-10}\ m}$$

Topic VIII: Uncertainty Principle:

7. An electron is placed in a box about the size of an atom that is about 1.0 × 10^{-10} m. What is the velocity of the electron? (6 times) (C.W)

Ans: Given that

$$m = 9.1 \times 10^{-31}\ kg$$
$$h = 6.63 \times 10^{-34}\ Js$$
$$\Delta x = 1.0 \times 10^{-10}\ m$$
$$\Delta v = ?$$

Using uncertainty principle, $\Delta p \Delta x \approx h$

$$m\Delta v\Delta x \approx h$$

$$\Delta v = \frac{h}{m\Delta x}$$

$$\Delta v = \frac{6.63\times10^{-34}}{9.1\times10^{-31}\times1.0\times10^{-10}}$$

$$\boxed{\Delta v = 7.29\times10^{6}\ ms^{-1}}$$

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8. An electron is to be confined to a box of the size of the nucleous $(1.0\times10^{-14}m)$. What would the speed of electron be if it were so confined? (Example No. 19.11)

Sol: $\Delta x = 1.0\times10^{-14}m$

$m = 9.1\times10^{-31}kg$

$h = 6.63\times10^{-34}Js$

$\Delta v = ?$

According to uncertainty principle,

$\Delta\times\Delta P \approx h$

or $\Delta\times m\Delta v \approx h$

$$\Delta v = \frac{h}{m\Delta x}$$

Putting values,

$$\Delta v = \frac{6.63\times10^{-34}}{9.1\times10^{-31}\times1.0\times10^{-14}}$$

$\Delta v = 7.29\times10^{10}m/s$

9. The life time of an electron in an excited state is about $10^{-8}s$. What is its uncertainty in energy during this time? (Example No. 19.10)

Sol: $\Delta t = 10^{-8}s$

$h = 6.63\times10^{-34}Js$

$\Delta E = ?$

According to uncertainty principle

$\Delta E\Delta t \approx h$

or $\Delta E \approx \frac{h}{\Delta t} \rightarrow (i)$

where $h = \frac{h}{2\pi} = \frac{6.63\times10^{-34}}{2(3.14)} = 1.05\times10^{-34}Js$

putting values in eq. (i) , we get

$$\Delta E = \frac{1.05\times10^{-34}}{10^{-8}}$$

$\Delta E = 1.05\times10^{-26}J$

10. What is the maximum wavelength of the two photons produced when positron annihilats an electron? The rest mass energy of each is $0.51\ MeV$. (H.W)

Sol: $E = 0.51MeV$

$E = 0.51\times10^{6}ev$

$E = 0.51\times10^{6}\times1.6\times10^{-19}J$

$E = 8.16\times10^{-14}J$

$c = 3\times10^{8}m/s$

$h = 6.63\times10^{-34}Js$

$\lambda = ?$

as $E = \frac{hc}{\lambda}$

or $\lambda = \frac{hc}{E}$

$$= \frac{6.63\times10^{-34}\times3\times10^{8}}{8.16\times10^{-14}}$$

$\lambda = 2.437\times10^{-12}m$

or $\lambda = 2.44\times10^{-12}m$

ALP SMART SYLLABUS 2020

1. A sodium surface is illuminated with light of wavelength 300 nm. The work function of sodium metal.

(a) Find the maximum K.E. of the ejected electron.

(b) Determine the cut off wavelength for sodium. (Example 19.6)

Sol:

$\lambda = 300\ nm,\quad \phi = 2.46eV$

(a) Energy of incident photon $E = hf = \frac{hc}{\lambda}$

or $E = \frac{6.63\times10^{-34}\ Js\times3\times10^{8}ms^{-1}}{300\times10^{-9}m} = 6.63\times10^{-19}J$

$E = 4.14\ eV$

Now $K.E_{max} = hf - \emptyset = 4.14\ ev - 2.46\ ev = 1.68ev$

(b) $\emptyset = 2.46\ eV = 3.94\times10^{-19}J$

Using $\emptyset = hf_o = \frac{hc}{\lambda_o}$

or $\lambda_o = \frac{hc}{\phi} = \frac{6.63\times10^{-34}\ Js\times3\times10^{8}\ ms^{-1}}{3.94\times10^{-19}\ J} = 5.05\times10^{-7}m$

$\lambda_o = 505\ nm$

2. A particle of mass 5.0 mg moves with speed of 8.0 ms^{-1}. Calculate its de Broglie wavelength. (Example 19.8)

Sol:

$m = 5.0\ mg = 5.0\times10^{-6}\ kg$

$v = 8.0\ ms^{-1}$

$h = 6.63\times10^{-34}\ Js$

Using $\lambda = \frac{h}{mc} = \frac{6.63\times10^{-34}\ Js}{5.0\times10^{-6}\ kg\times8.0\ ms^{-1}} = 1.66\times10^{-29}m$

3. Find the energy of photon in

(a) Radiowave of wavelength 100 m

(b) Green light of wavelength 550 nm

(c) X-ray with wavelength 0.2 nm (H.W)

Sol:

Wavelength of radio waves = $\lambda_1 = 100m$

Wavelength of green light = λ_2 = 550 nm = $550 \times 10^{-9}m$
Wavelength of x-rays = λ_3 = 0.2 nm = $0.2 \times 10^{-9}m$

(a) Energy of photon in radio waves = E_1 =?
(b) Energy of photon in green light = E_2 =?
(c) Energy of photon in x – rays = E_3 =?

$$As \quad E = hf$$
$$E = \frac{hc}{\lambda} \qquad (\because c = f\lambda \Rightarrow f = \frac{c}{\lambda})$$

(a) Energy of photon in radio waves

$$E_1 = \frac{hc}{\lambda_1}$$

Putting the values, we get

$$E_1 = \frac{6.63 \times 10^{-34} \times 3 \times 10^8}{100}$$
$$E_1 = \frac{19.89}{100} \times 10^{-26}$$
$$E_1 = 19.89 \times 10^{-28} J$$
$$E_1 = \frac{19.89 \times 10^{-28}}{1.6 \times 10^{-19}} eV \qquad (\because 1eV = 1.6 \times 10^{-19}J)$$
$$E_1 = 1.24 \times 10^{-8} eV$$

(b) Energy of photon in green light

$$E_2 = \frac{hc}{\lambda_2}$$

Putting the values, we get

$$E_2 = \frac{6.63 \times 10^{-34} \times 3 \times 10^8}{550 \times 10^{-9}}$$
$$E_2 = \frac{19.89 \times 10^{-26}}{550 \times 10^{-9}}$$
$$E_2 = 0.036 \times 10^{-17} J$$
$$E_2 = \frac{0.036 \times 10^{-17}}{1.6 \times 10^{-19}} eV$$
$$E_2 = 2.25 eV$$

(c) Energy of photon in X-rays

$$E_3 = \frac{hc}{\lambda_3}$$

Putting the values, we get

$$E_3 = \frac{6.63 \times 10^{-34} \times 3 \times 10^8}{0.2 \times 10^{-9}}$$
$$E_3 = \frac{19.89 \times 10^{-26}}{0.2 \times 10^{-9}} = 99.45 \times 10^{-17} J$$
$$E_3 = \frac{99.45 \times 10^{-17}}{1.6 \times 10^{-19}} eV$$
$$E_3 = 62.156 \times 10^2 eV$$
$$E_3 = 6215.6 eV$$

4. Yellow light of 577 nm wavelength is incident on a cesium surface. The stopping voltage is found be 0.25 V. Find (H.W)
(a) the maximum K.E. of the photoelectrons
(b) the work function of cesium
Sol:

Wavelength of yellow light = $\lambda = 577\ nm = 577 \times 10^{-9}m$
Stopping voltage = $V_o = 0.25 V$
Planck's constant = h = $6.63 \times 10^{-34} Js$
Charge on electron = e = $1.6 \times 10^{-19}C$

(a) Max. K.E of photelectrons = $(K.E)_{max}$ =?
(b) Work function of cesium = $\emptyset$ = ?

(a) As
$$(K.E)_{max} = V_o e$$
$$(K.E)_{max} = 0.25 \times 1.6 \times 10^{-19}$$
$$(K.E)_{max} = 0.4 \times 10^{-19}$$
$$(K.E)_{max} = 4 \times 10^{-20} J$$

(b) For work function using Einstein's equation
$$hf = (K.E)_{max} + \emptyset$$
$$or \qquad \emptyset = \frac{hc}{\lambda} - (K.E)_{max}$$

Putting the values, we get

$$\emptyset = \frac{6.63 \times 10^{-34} \times 3 \times 10^8}{577 \times 10^{-9}} - 4 \times 10^{-20}$$
$$\emptyset = 34.4 \times 10^{-20} - 4 \times 10^{-20}$$
$$\emptyset = 30.4 \times 10^{-20} J$$
$$\emptyset = \frac{30.4 \times 10^{-20}}{1.6 \times 10^{-19}} eV$$
$$\emptyset = 1.9 eV$$

OBJECTIVES (MCQ'S) OF CHAPTER-20 ACCORDING TO ALP SMART SYLLABUS-2020

Topic II: Bohr's Model of the Hydrogen Atom:

1. The total energy of electron in the state n = ∞ of the hydrogen atom is:
(A) Zero (B) 3.2 ev (C) 10.2 ev (D) 13.6 ev

2. The name electron was suggested by:
(A) Chadwick (B) Niel bohr (C) stoney (D) J.J Thomson

3. Bohr's second postulate ($mvr = n\frac{h}{2\pi}$) was justified by:
(A) Bohr himself (B) de Broglie (C) Plan (D)Davission and Germer

4. The radius of 10th orbit in hydrogen atom is:
(A) 0.053nm (B) 0.053m (C) 5.3nm (D) 53nm

5. The energy of electron in the 4th orbit of hydrogen atom is: (3 times)
(A) -2.51 ev (B) -3.50 ev (C) -13.6 ev (D) -0.85 ev

6. The orbital angular momentum in the allowed stationary orbits of hydrogen atom is given by:
(A) $\frac{2\pi}{nh}$ (B) $\frac{nh}{2\pi}$ (C) $\frac{2h}{n\pi}$ (D) $\frac{h}{\pi}$

7. When an electron absorbs energy it jumps to:
(A) Lower energy state (B) Higher energy state
(C) Ground state (D) Remains in the same state

8. Speed of electron in first Bohr's orbit is:
(A) $2.19 \times 10^6 ms^{-1}$ (B) $2.19 \times 10^{-6} ms^{-1}$ (C) $2.19 \times 10^6 cms^{-1}$ (D) $2.19 \times 10^{-6} cms^{-1}$

9. Hydrogen atom spectrum does not lie in:
(A) Ultraviolet region (B) Visible region (C) Infra and region (D) X-ray region

10. The radius of first Bohr orbit in hydrogen atom is:
(A) 0.53 Cm (B) 0.53 nm (C) 0.053 nm (D) 0.0053 nm

11. If electrons jumps from second orbit to first orbit in hydrogen atom it emits photon of: (2 times)
(a) 3.40 eV (b) 10.20 eV (c) 13.6 eV (d) 3.8 eV

12. The speed of an electron in nth orbit is given as:
(a) $4\pi^2 Ke^2 / nh$ (b) $2\pi Ke^2 / nh$ (c) $2\pi Ke / n^2h^2$ (d) $2\pi^2 Ke^2 / nh$

Topic III: Inner Shed Transition and Characteristics of X-Rays:

13. Which one of the following radiation is extremely penetrating:
(A) Y-rays (B) β -rays (C) a-rays (D) None of these

14. In an electronic transition, an atom cannot emit: **(4 Times)**
(A) $\gamma-rays$ (B) Infrared rays (C) UV-rays (D) X-rays

15. The potential required to remove an electron from the atom is called:
(A) Critical potential (B) Ionization potential (C) Absolute potential (D) Excitation potential

16. The numerical value of ground state energy for hydrogen atom in electron volt is:
(A) -10 (B) 13.6 (C) 10 (D) -13.6

17. If an electron jumps from nth orbit of energy E_n to pth (lower) orbit of energy Ep and a photon of frequency 'f' and wavelength 'λ' is thus emitted then:
(A) $f\lambda = E_n.E_p$ (B) $\frac{hc}{\lambda} = E_n - E_p$ (C) $hf = E_p.E_n$ (D) $h\lambda = E_p.E_n$

18. X-rays photon moves with a velocity of:
(A) Light (B) Less than velocity of light
(C) Greater than velocity of light (D) Sound

19. The charge on an Alpha particle is equal to:
(a) + e (b) - e (c) 2e (d) -2e

20. Photons emitted in inner shell transition are: **(2 Times)**
(a) Continuous X-rays (b) discontinuous X-rays (c) Characteristic X-rays (d) energetic X-rays

21. X – Rays are electromagnetic radiations having wavelength in the range:
(A) Proton (B) Electron (C) Baryon (D) Neutron

22. Radiations emitted by human body at normal temperature 37°C lies in:
(A) X-rays region (B) Infra red region (C) Visbile region (D) Ultraviolet region

Topic IV: Uncertainty with the Atom:

23. The following gas was identified in the sun using spectroscopy:
(A) Hydrogen (B) Helium (C) Carbon (D) Nitrogen

Topic V: Laser:

24. The population inversion is, in which:
(A) All electrons are in excited state (B) Some electrons are in excited state
(C) Majority of electrons are in excited state (D) Some electrons are in ground state

25. A finally focused beam of laser used to destroy:
(A) Cancerous cells (B) Pre-cancerous cells (C) Living cells (D) Both A and B

26. Helium-Neon laser discharge tube contains neon: **(2 Times)**
(A) 82% (B) 15% (C) 25% (D) 85%

27. For Holography we use
(A) X-rays (B) Laser (C) γ-rays (D) β- rays.

28. The inverse phenomena to x-rays emission is: **(4 Times)**
(A) Diffraction (B) Polarization (C) Interference (D) Photoelectric effect

29. What is the more careful calculation by Warner Heisenberg:
(A) $\Delta E.\Delta t \approx \hbar$ (B) $\Delta X.\Delta p \approx \hbar$ (C) $\Delta X.\Delta p \geq \hbar$ (D) $\Delta m.\Delta v \approx \hbar$

30. The uncertainty principle relates uncertainties in the measurements of energy and:
(A) Velocity (B) Momentum (C) Time (D) Mass of particle

31. Laser light has the property of:
(A) Coherent waves (B) Non-coherent waves (C) Sound waves (D) Water waves

32. Laser can only be produced if an atom is in its:
(A) Normal state (B) Excited state (C) Ionized state (D) De-excited state

33. According to uncertainty principle the quantitates which cannot be simultaneously measured with accuracy are:
(A) Energy ad momentum (B) Position and momentum
(C) Position and energy (D) Momentum and time

34. In Helium-Neon laser, the discharge tube is filled with: **(2 times)**
(A) 8% He, 20% Neon (B) 85% He, 15% Neon (C) 83% He, 17% Neon (D) 90% He, 10% Neon

35. Laser is beam of light which is:
(A) Monochromatic (B) Coherent (C) Unidirectional (D) All of these

36. Helium Neon laser beam emitted from a discharge tube has a colour:
(A) Blue (B) Green (C) Red (D) Black

37. Laser can be made by creating:

(A) Meta stable state (B) Population inversion (C) Excited state (D) All of these

38. Which is not characteristic of LASER?
(A) Monochromatic (B) Coherent (C) Intense (D) Multi directional

39. Life time of excited state (meta stable) is: **(2 Times)**
(A) 10^{-2} s (B) 10^{-3} s (C) 10^{-5} s (D) 10^{-8} s

2018

40. An electron in H atom is excited from ground state to n = 4. How many spectral lines are possible in this case? **(2 Times)**
(a) 6 (b) 5 (c) 4 (d) 3

41. The meta-stable state is .... than normal excited state. **(2 Times)**
(a) 10^{5} times larger (b) 10^{-8} times smaller (c) 10^{5} times larger (d) 10^{-3} times larger

42. Radiation produced from TV picture tube is:
(A) Gamma rays (B) X-rays (C) Infrared light (D) Ultra violet light

43. The Rest Mass of X-ray photon is:
(A) 9.1×10^{-31} Kg (B) 1.67×10^{-27} Kg (C) 1.6×10^{-19} Kg (D) Zero

44. The wavelength associated with the proton moving at a speed of 40 m/s is:
(a) 7.20 nm (b) 9.02 nm (c) 15.7 nm (d) 17.3 nm

45. Then energy of the photon of wavelength 500 nm is:
(a) 3.10 eV (b) 2.49 eV (b) 1.77 eV (d) 1.52 eV

46. X – rays are similar in nature to:
(a) $\gamma-rays$ (b) $\beta-rays$ (c) $\alpha-rays$ (d) Cathode rays

2019

47. The diameter of an atom is of order of:
(A) 10^{-8} m (B) 10^{-10}m (C) 10^{-12}m (D) 10^{-14} m

48. X-rays eject electrons from matter by:
(A) Pair Production (B) Annihilation of Matter (C) Compton Effect (D) Photoelectric Effect

49. X-rays are the electromagnetic radiations having the wavelength in range:
(A) 10^{-12}m (B) 10^{-10}m (C) 10^{-8}m (D) 10^{-6}m

ANSWERS OF THE MULTIPLE CHOICE QUESTIONS

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
A	C	B	C	D	B	B	A	D	C	B	B	A	A	B	D	B
18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
A	C	C	B	B	B	C	D	B	B	D	C	C	A	B	B	B
35	36	37	38	39	40	41	42	43	44	45	46	47	48	49		
D	C	D	D	B	A	D	B	D	B	B	A	B	D	B		

SHORT QUESTIONS OF CHAPTER-20 ACCORDING TO ALP SMART SYLLABUS-2020

Topic I: Atomic Spectra:

1. What do we mean when we say that the atom is excited? **(16 times) (H.W)**

Ans: When energy from some external source is provided to an atom in its normal state, then its electrons will jump from lower energy state to higher energy states. And atom is said to be excited.

2. How can spectrum of hydrogen contain so many lines, whereas hydrogen atom contains one electron? **(7 times)**

Ans: The single electron in hydrogen atom occupies ground state but it can be excited to several states by absorbing energy. During de-excitation, it can emit several lines of different wavelengths.

3. Can the electron in the ground state of hydrogen atom absorb a photon of energy 13.6 eV and greater than 13.6 eV? **(4 times) (C.W)**

Ans: Yes, an electron in the ground state of hydrogen atom can absorb a photon of energy 13.6 eV and greater than 13.6 eV.
Ionization energy of hydrogen atom in ground state is 13.6 eV. So if hydrogen absorbs a photon of energy greater than 13.6 eV then the surplus energy of photon appears as K.E of electron.

4. What is meant by line spectrum? How line spectrum can be used for the identification of elements? (6 times)

Ans: When an electron jumps from higher energy state to lower energy state then it emits energy and makes a spectral line.

$$E_2 - E_1 = hf$$

This is called line spectrum.
And Different elements emit line spectrum of different wavelengths. So they can be identified easily.

5. List of colours of line spectra of an excited hydrogen atom.

Ans: The colours of line spectrum of hydrogen atom are
i. Red ii. Blue iii. Blue-Green iv. Violet v. Ultraviolet

6. Differentiate between Line and Band spectrum.

Ans: <u>Line spectrum:</u> When electron jumps from higher orbit to lower orbit, it emits energy. This emission of energy constitutes spectral lines. This is called line spectrum.
<u>Band spectrum</u> is produced by molecules. They are the groups of lines which are closely spaced to one another.

7. In which region of electromagnetic spectrum does the following series fall (a) Lyman series (b) Balmer series?

Ans: Balmer series falls in the visible region.
Lyman series falls in the ultraviolet region.

8. Explain how line spectrum can be used for the identification of elements.

Ans: When a gas at much low pressure is excited by passing an electric current through it, the spectrum of emitted radiation is in the form of discrete sharp parallel lines. This type of spectrum is called line spectrum. In it each line corresponds to a definite wavelength and frequency. As each element has its own set of wavelengths in the line spectrum, so electrons of atoms in different element have different energy in their orbits and hence line spectrum can be used to identify the elements.

9. What is fluorescence?

Ans: Fluorescence is a property of absorbing radiant energy of high frequency and re emitting energy of low frequency in the visible region of electromagnetic spectrum.

10. Define continuous spectra and line spectra.

Ans: <u>Line spectrum:</u> When the atoms of a gas at much low pressure are excited by passing an electric current through it, the spectrum of emitted radiation is in the form of discrete sharp parallel lines. This type of spectrum is called line spectrum.
<u>Continuous spectrum:</u> The radiations emitted by continuous media such as 'Black Body' forms a continuous spectrum. In continuous spectrum wavelengths of radiations cannot be observed in discrete lines.

Topic II: Bohr's Model of the Hydrogen Atom:

11. Bohr's theory of hydrogen atom is based upon several assumptions. Do any of these assumptions contradict classical physics? (3 times) (C.W)

Ans: Bohr's first postulate contradicts classical physics. Bohr said that electron do not radiate energy during revolving while according to classical physics, electron radiates energy during revolving and fall into the nucleus, which is impossible.

12. Write two postulate of Bohr's model of H-atom. (7 Time)

Ans: i. An electron, bound to the nucleus in an atom, can move around the nucleus in certain circular orbits without radiating. These orbits are called the discrete stationary orbits.
ii. Only those stationary orbits are allowed for which orbital angular momentum is equal to an integral multiple of $\frac{h}{2\pi}$ i.e.

$$mvr = \frac{nh}{2\pi}$$

13. Find speed of electron in the 1st Bohr orbit.

Ans: The speed of electron in the nth Bohr's orbit is given by:

$$v_n = \frac{2\pi Ke^2}{nh}$$

For 1st orbit n = 1 and

$$v_1 = \frac{2\pi Ke^2}{h}$$

$$v_1 = \frac{2(3.14)(9\times10^9)(1.6\times10^{-19})^2}{6.63\times10^{-34}}$$

$$v_1 = 2.19\times10^6 m/s$$

Topic III: Inner Shed Transition and Characteristics of X-Rays:

14. What do you mean by inner shell transition?

Ans: A transition in which an electron from higher orbit, emits energy and accommodates a hole in the lower orbit. Such a transition is called inner shell transition. The photons emitted in such transitions are called characteristic x-rays.

15. Write four uses of X-rays. (3 times)

Ans: X-rays are used
i. To visualize the interiors of the materials opaque to ordinary light
ii. In computerized axial tomography iii. In photographic films

16. Briefly describe continuous x-rays.

Ans: Continuous X-rays is due to an effect known as Bremsstrahlung effect when fast moving electrons bombarded at the target, they are suddenly slowed down on impact with the target. And due to deceleration their kinetic energy is converted into X-Ray photons.

17. How does a K_α X-rays differ from K_β X-rays? (3 times)

Ans: When an electron form $L - shell$ jumps to occupy the hole in $K - shell$, K_α X-rays is emitted.
And
When an electron form $M - shell$ jumps to occupy the hole in $K - shell$, K_β X-rays is emitted.

18. Can x-ray be reflected, refracted, diffracted polarized just like any other waves? Explain. (4 Time) (C.W)

Ans: Yes, x-ray can be reflected, refracted, diffracted by crystals only and polarized just like any other waves.

19. What is Spectroscopy? OR Define spectroscopy.

Ans: It is that branch of physics which deals with the production, measurement and interaction of electromagnetic radiation emitted or absorbed by atoms is called spectroscopy.

20. Define characteristic X-rays and continuous X-rays.

Ans: <u>Characteristic X-rays:</u> The x-rays emitted from inner shell transitions are called characteristic x-rays and their energy depends on the type of target material.
<u>Continuous X-rays:</u> The x-rays emitted having continuous ranges of frequencies due to bremsstrauhlung effect are called continuous X-rays.

21. Write two properties of x-rays. (2 times)

Ans: Properties of x-rays
(i) They have a very short wavelength ($\approx 10^{-10}$m).
(ii) They cause ionization.
(iii) They affect photographic film in the same way as visible light.
(iv) They can penetrate several centimeters into a solid matter.

22. How K_α and K_β X – rays are emitted?

Ans: When fast moving electron strikes a target made of heavy element. Suppose, one of the electrons in the K – shell is removed, thereby producing a hole in that shell.
If electron from the L – shell jumps to occupy the hole in the K – shell then emitted radiations are called K_α X – rays.
If electron from M – shell jumps to occupy the hole in the K – shell then emitted radiations are called K_β X – rays.

Topic IV: Uncertainty with the Atom:

23. Give two forms of Uncertainty Principle.

Ans: The product of uncertainty in the measurement of momentum and uncertainty in the measurement of position of an electron is approximately equal to Planck's constant.

$$(\Delta p)(\Delta x) \approx h$$

The product of uncertainty in the measurement of energy and uncertainty in the measurement of time of an electron is approximately equal to Planck's constant.

$$(\Delta E)(\Delta t) \approx h$$

24. Can electron reside inside the nucleus? Explain.

Ans: No, electron cannot reside inside the nucleus. If electron resides inside nucleus then uncertainty in position = size of nucleus = 10^{-14}m.
From Heisenberg uncertainty principle.

$$\Delta P \geq \frac{h}{\Delta x}$$

$$\geq \frac{6.63\times10^{-34}}{10^{-14}} = 6.63\times10^{-20}\ kgm/s$$

As $\Delta P = m\Delta v$

$$\Delta v = \frac{\Delta P}{m}$$

$$\Delta v = \frac{6.63\times10^{-20}}{9.1\times10^{-31}} \geq 7.3\times10^{10}\ m/s$$

This speed is impossible. Hence, electron cannot reside inside the nucleus.

Topic V: Laser:

25. Is energy conserved when an atom emits a photon of light? (14 times) (H.W)

Ans: Yes, energy is conserved when an excited atom emits a photon of light. When atom is excited, energy is supplied. The same energy is emitted in the form of photon when it returns back to its ground state.

26. What are the advantages of Lasers over ordinary lights? (12 Times) (H.W)

Ans: Laser light has many advantages over ordinary light such as laser light is
i. Coherent ii. Intense iii. Monochromatic iv. Unidirectional

27. Explain why laser action could not occur without population inversion between atomic levels? (8 times) (C.W)

Ans: When a large percentage of atom or sample are in population inversion, then large number of coherent photons along same direction of motion could be obtained to form laser light. It is impossible without population inversion.

28. Give two uses of laser in medicine and industry.

Ans: LASER is used
i. For welding detached retinas
ii. To destroy cancerous and pre-cancerous cells.

29. Define population inversion and meta stable state.

Ans: A condition of matter in which more electrons are in a high energy state than in a lower energy state is called population inversion.
And
A particular excited state of an atom that has longer lifetime ($\approx 10^{-3}s$) than the ordinary excited states ($\approx 10^{-8}s$) is called metastable state.

30. What are the differences between laser light and ordinary light? (2 Times)

Ans: The laser light is intense, unidirectional and phase coherent, so it does not spread as compared to ordinary light.
The energy of laser can be focused at a point to get enough heat for welding which is not possible with ordinary light.
A laser beam is used as a surgical tool for welding detached retina which ordinary light can't do.
Laser can induce fusion reaction which is impossible by common light.

31. Distinguish between stimulated emission and spontaneous emission. (3 times)

Ans: **Stimulated Emission:** If atom is excited for a longer life time of about 10^{-3} sec then an incident photon of energy equal to the difference of two energy levels induces the atom to decay by emitting a photon that travels in the direction of incident photon. This process is called stimulated or induced emission.
Spontaneous Emission: As excited is highly unstable state with life time of 10^{-8} sec, so electron will de-excite itself with emission of a photon in any arbitrary direction is called spontaneous emission.

32. Write down two uses of LASER in medicine. (2 Times)

Ans: For welding detached retinas.
To destroy cancerous and pre-cancerous cells.

33. Write down two uses of LASER in industry.

Ans: It can be used for telecommunication in fiber optics
It is used to read bar codes
It is used to generate 3D image of objects by holography.

34. Write down the two uses of LASER. (2 times)

Ans: LASER is used to destroy cancerous and pre-cancerous cells.
It is used to generate 3D image of objects by holography.

35. Define Ionization and Excitation Potential.

Ans: **Ionization Potential:** The potential (energy) required to completely remove an electron from the atom is called ionization potential. e.g., The ionization energy of Hydrogen atom in ground energy state is -13.6 eV.
Excitation Potential: The potential (energy) required to lift an electron from ground state to any higher allowed state is called excitation potential.

36. What is meant by Population Inversion and Lasing Action?

Ans: **Population Inversion:** A condition of atom in which more electrons are in a high energy state than in a lower energy state is called population inversion.
Lasing action: When a large percentage of atom or sample is in population inversion, then large number of coherent photons along same direction of motion could be obtained to form laser light. The combination of spontaneous emission first and then stimulated emission causes the laser to generate coherent beam of light at a single frequency which is called lasing action.

37. What is meant by Population Inversion? Explain.

Ans: **Population Inversion:** A condition of atom in which more electrons are in a high energy state than in a lower energy state is called population inversion.

38. Define metastable state.

Ans: **Metastable state:** A particular excited state of an atom that has longer lifetime ($\approx 10^{-3}s$) than the ordinary excited states ($\approx 10^{-8}s$) is called metastable state.

39. What is meant by stimulated emissions?

Ans: **Stimulated Emission:** If atom is excited for a longer life time of about 10^{-3}s then an incident photon of energy equal to the difference of two energy levels induces the atom to decay by emitting a photon that travels in the direction of incident photon. This process is called stimulated or induced emission.

40. Define spectroscopy, holography.

Ans: The branch of physics that deals with the investigation of wavelengths and intensities of electromagnetic radiation emitted or absorbed by atoms is called **spectroscopy**.
Laser beam is used to generate three – dimensional images of objects in a process called **holography**.

41. What is a CAT scanner? (2 Times)

Ans: A vastly improved x-ray technique is computerized axial tomography; the corresponding instrument is called CAT scanner.
In CAT scanning a "fanned-out" array of x-ray beams is directed through the patient from a number of different orientations. Computer is attached to construct picture. Density differences of the order of one percent can be detected.
Tumours, and other anomalies much too small to be seen with older techniques can be detected.

42. Define normal population and population inversion.
Ans: **In normal population**, the lower energy state has a greater population than the higher energy state.
Population inversion occurs when more electrons are in a higher energy state than in a lower energy state.

43. How LASER is used in medical? Give two uses only.
Ans: Two uses of LASER in medical are:
(i) For welding detached retinas.
(iii) To destroy cancerous and pre-cancerous cells.

44. Write down four applications of laser.
Ans: Laser is used:
(i) For welding detached retinas.
(ii) to destroy cancerous and pre-cancerous cells.
(iii) for telecommunication in fibre optics.
(iv) to generate 3D image of objects by holography.

45. Why does laser usually emit only one particular colour of light?
Ans: Laser is produced by the transition of electrons from metastable state E_2 to lower energy state E_1. By this stimulated emission the energy of all the emitted photons is

$$hf = E_2 - E_1$$

Therefore, emitted light is of one particular wavelength or colour.

LONG QUESTIONS OF CHAPTER-20
ACCORDING TO ALP SMART SYLLABUS-2020

Topic II: Bohr's Model of the Hydrogen Atom:

1. State the postulates of Bohr model of hydrogen atom and explain De-Broglie's interpretation of Bohr's orbit to show that $mvr = \frac{nh}{2\pi}$. **(3 Times)**
2. Write three postulates of Bohr atomic model. Derive expression for radii of quantized orbit of hydrogen atom. **(2 Times)**
3. What are postulates of Bohr's model of the hydrogen atom? Show that radii of hydrogen atom are quantized? **(4 Times)**
4. According to Bohr's theory find the radii of different stationary orbits of an electron in hydrogen atom and also find Quantized Energies?
5. Write down the postulates of Bohr's atomic model. Show that Bohr radii and their energies are quantized. **(2 times)**
6. Write own the postulates of Bohr's atomic model. Show that Bohr radii and their energies are quantized.

Topic III: Inner Shed Transition and Characteristics of X-Rays:

7. What are X-rays? How are they produced? Give their two applications. **(2 times)**
8. What are the inner shell transitions and characteristics x-rays. Describe the production of x-rays.

9. Explain inner shell transitions and X-rays production. emission spectrum and also draw energy level diagram.
10. What do you mean by inner shell transitions? Also explain the production of x – rays.
11. What are the inner shell transitions and characteristics of x – rays? Describe the production of x – Rays.
12. Explain inner shell transitions and production of x – rays.
13. What do you mean by inner shell transitions? Also explain the production of x – rays.
14. What are inner shell transitions & characteristics of x –rays? Describe production of x – Rays. **(5 times)**
15. Explain inner shell transition and production of x – rays.

Topic V: Laser:

16. What is laser? Explain the terms population inversion and laser action.
17. Define spontaneous and stimulated emissions. Explain laser action in detail. **(2 times)**
18. What is LASER? Write down its properties. Explain how Helium-neon laser works?
19. What is Laser? Describe its working and action.
20. Define LASER and explain population inversion and laser action.
21. Explain the terms Metastable state, stimulated emission and population inversion which are necessary for LASER production.
22. Define LASER and explain population inversion and laser action.
23. Explain the terms Meta stable state, stimulated emission and population inversion which are necessary for LASER production.

NUMERICAL PROBLEMS OF CHAPTER-20
ACCORDING TO ALP SMART SYLLABUS-2020

Topic I: Atomic Spectra:

1. An electron jumps from a level $E_1 = -3.5 \times 10^{-19}$ J to $E_2 = -1.20 \times 10^{-18}$ J. What is the wavelength of the emitted light? **(C.W)**

Ans:

Given that

$$E_i = -3.5 \times 10^{-19}$$
$$E_f = -1.20 \times 10^{-18}$$
$$h = 6.63 \times 10^{-34}\ \text{Js}$$
$$c = 3 \times 10^{8}\ \text{ms}^{-1}$$
$$\lambda = ?$$

We know

$$hf = E_f - E_i$$

Or

$$\frac{hc}{\lambda} = E_f - E_i$$

$$\lambda = \frac{hc}{E_f - E_i}$$

Putting the values,

$$\lambda = \frac{6.63 \times 10^{-34} \times 3 \times 10^{8}}{-1.20 \times 10^{-18} - (-3.5 \times 10^{-19})}$$

$$\lambda = \frac{19.89 \times 10^{-26}}{-1.20 \times 10^{-18} + 3.5 \times 10^{-19}}$$

$$\lambda = \frac{19.89 \times 10^{-26}}{0.85 \times 10^{-18}}$$

$$\lambda = 23.4 \times 10^{-8}\ \text{m} = 234 \times 10^{-9}\ \text{m} \boxed{= 234\ \text{nm}}$$

2. Compute the shortest wavelength radiation in Balmer. What value of n must be used? (6 times)

Ans:

For Balmer series $p = 2$

For shortest wavelength $n = \infty$

and Rydberg constant $= R_H = 1.0974 \times 10^7 \text{m}^{-1}$

Since $\frac{1}{\lambda} = R_H\left(\frac{1}{p^2} - \frac{1}{n^2}\right)$

$$\frac{1}{\lambda} = 1.0974 \times 10^7 \times \left(\frac{1}{(2)^2} - \frac{1}{(\infty)^2}\right)$$

$$\frac{1}{\lambda} = 1.0974 \times 10^7 \times \left(\frac{1}{4} - 0\right)$$

$$\frac{1}{\lambda} = 0.27435 \times 10^7$$

Thus $\lambda = \frac{1}{0.27435 \times 10^7}$

$$\lambda = 3.6449 \times 10^{-7}\ \text{m}$$

$$\lambda = 364.5 \times 10^{-9}\ \text{m} \boxed{= 364.5\ \text{nm}}$$

Topic II: Bohr's Model of the Hydrogen Atom:

3. Find the speed of electron in the First Bohr Orbit. (3 times) (Example No. 20.1)

Ans: Given that

$n = 1$

$v = ?$

We know,

$$v_n = \frac{2\pi k e^2}{nh}$$

As for first orbit n=1, so

$$v_1 = \frac{2\pi k e^2}{h}$$

Here,

$k = 9 \times 10^9\ \text{Nm}^2\text{C}^{-2}$

$e = 1.6 \times 10^{-19}\ \text{C}$

$h = 6.63 \times 10^{-34}\ \text{Js}$

Putting the values,

$$v_1 = \frac{2 \times 3.14 \times 9 \times 10^9 \times (1.6 \times 10^{-19})^2}{6.63 \times 10^{-34}}$$

$$v_1 = \frac{2 \times 3.14 \times 9 \times 10^9 \times 2.56 \times 10^{-38}}{6.63 \times 10^{-34}}$$

$$v_1 = \frac{144.69 \times 10^{-29}}{6.63 \times 10^{-34}} \boxed{= 2.18 \times 10^6\ \text{ms}^{-1}}$$

Topic III: Inner Shed Transition and Characteristics of X-Rays:

4. Electron in x-ray tube is accelerated through a potential difference of 3000 V. If these electrons were slowed down in a target. What will be the minimum wavelength of the x-rays produced? (2 times) (C.W)

Ans: Given that

$$V = 3000\ V$$

$$\lambda_{min} = ?$$

Since

$$(K.E.)_{max} = hf_{max}$$

$$Ve = hf_{max}$$

For maximum frequency, wavelength will be minimum, so

$$\frac{hc}{\lambda_{min}} = Ve$$

$$\lambda_{min} = \frac{hc}{Ve}$$

$$\lambda_{min} = \frac{6.63 \times 10^{-34} \times 3 \times 10^8}{3000 \times 1.6 \times 10^{-19}} \boxed{= 4.14 \times 10^{-10}\ m}$$

5. A tungsten target is struck by electrons that have been accelerated from rest through 40 kV potential differences. Find the shortest wavelength of the bremsstrahlung. (2 times) (H.W)

Sol: $V = 40KV = 40 \times 10^3$ Volts

$\lambda = ?$

$h = 6.63 \times 10^{-34}\ Js \quad C = 3 \times 10^8\ ms^{-1}$

$e = 1.6 \times 10^{-19} C$

As

$$\frac{hc}{\lambda} = Ve$$

Or $\lambda = \frac{hc}{Ve}$

$$\lambda = \frac{6.63 \times 10^{-34} \times 3 \times 10^8}{40 \times 10^3 \times 1.6 \times 10^{-19}}$$

$$\lambda = \frac{19.89 \times 10^{-26}}{64 \times 10^{-16}}$$

$$\lambda = 0.31 \times 10^{-10} m$$

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6. The wavelength of $K\ X-ray$ from copper is $1.377 \times 10^{-10} m$, what is the energy difference between the two levels from which this transition results? (C.W)

Sol: $\lambda = 1.377 \times 10^{-10} m$

$h = 6.63 \times 10^{-34} Js$

$c = 3 \times 10^8 m/s$

$\Delta E = ?$

We know that

$$\Delta E = \frac{hc}{\lambda}$$

$$\Delta E = \frac{6.63 \times 10^{-34} \times 3 \times 10^8}{1.377 \times 10^{-10}}$$

$$\Delta E = 14.44 \times 10^{-16} J$$

$$\Delta E = \frac{14.44 \times 10^{-16}}{1.6 \times 10^{-19}} eV$$

$$(\because 1eV = 1.6\times10^{-19} J)$$

$$\Delta E = 9.025\times10^{3} eV$$
$$\Delta E = 9.025 KeV$$
Or $$\Delta E = 9.03 KeV$$

7. What is the energy in eV of quanta of wavelength of $\lambda = 500nm$? (H.W)

Sol:
$$\lambda = 500nm$$
$$\lambda = 500\times10^{-9} m$$
$$h = 6.63\times10^{-34} Js$$
$$c = 3\times10^{8} m/s$$
$$E = ?$$

As $$E = \frac{hc}{\lambda}$$

Putting values,

$$E = \frac{6.63\times10^{-34}\times3\times10^{8}}{500\times10^{-9}}$$
$$E = 3.98\times10^{-19} J$$
$$E = \frac{3.98\times10^{-19}}{1.6\times10^{-19}} eV$$
$$E = 2.49 eV$$

ALP SMART SYLLABUS 2020

1. The orbital electron of a hydrogen atom moves with a speed of $5.456\times10^{5} ms^{-1}$.
(a) Find the value of the quantum number n associated with this electron?
(b) Calculate the radius of this orbit.
(c) Find the energy of the electron in this orbit? (C.W)

Sol:

Speed of electron in nth orbit = $v_n = 5.456\times10^{5} m/sec$

(a) Value of quantum number = n = ?
(b) Radius of nth orbit = ?
(c) Energy of electron in nth orbit = E_n = ?

(a) Value of quantum number

As $$v_n = \frac{2\pi ke^2}{nh}$$
or $$n = \frac{2\pi ke^2}{v_n h}$$

Putting the values, we get

$$n = \frac{2\times3.14\times9\times10^{9}\times(1.6\times10^{19})^2}{5.456\times10^{5}\times6.63\times10^{-34}}$$
$$n = \frac{144.69\times10^{-29}}{36.173\times10^{-29}} = 3.999$$
or $$n = 4$$

(b) Radius of nth orbit

As $$r_n = \frac{n^2h^2}{4\pi^2ke^2m}$$
As $$n = 4$$
So $$r_4 = \frac{(4)^2h^2}{4\pi^2ke^2m}$$

Putting the values, we get

$$r_4 = \frac{16\times(6.63\times10^{-34})^2}{4\times(3.14)^2\times9\times10^{9}\times9.1\times10^{-31}\times(1.6\times10^{-19})^2}$$
$$r_4 = \frac{16\times43.956\times10^{-68}}{4\times9.859\times9\times10^{9}\times9.1\times10^{-31}\times2.56\times10^{-38}}$$
$$r_4 = \frac{703.296\times10^{-68}}{8268.309\times10^{-60}}$$
$$r_4 = 0.085\times10^{-8} = 0.85\times10^{-9} m$$
$$r_4 = 0.85 nm$$

(c) Energy of electron in nth orbit

As $$E_n = \frac{2\pi^2k^2me^4}{n^2h^2}$$ But $n = 4$
$$E_n = \frac{2\pi^2k^2me^4}{(4)^2h^2}$$

Putting the values we get

$$E_4 = \frac{2\times(3.14)^2\times(3\times10^{9})^2\times9.1\times10^{-31}\times(1.6\times10^{-19})^4}{(4)^2\times(6.63\times10^{-34})^2}$$
$$E_4 = \frac{2\times9.859\times81\times10^{18}\times9.1\times10^{-31}\times6.4\times10^{-76}}{16\times43.956\times10^{-68}}$$
$$E_4 = \frac{93018.48\times10^{-89}}{703.296\times10^{-68}}$$
$$E_4 = \frac{93018.48}{703.296}\times10^{-21}$$
$$E_4 = 132.26\times10^{-21} Joules$$
or $$E_4 = \frac{132.26\times10^{-21}}{1.6\times10^{-19}} eV$$
$$E_4 = 82.66\times10^{-2} eV$$
$$E_4 = 0.826 eV$$
$$E_4 = 0.83 eV$$

OBJECTIVES (MCQ'S) OF CHAPTER-21 ACCORDING TO ALP SMART SYLLABUS-2020

Topic III: Mass Defect and Binding Energy:

1. When a β particle is emitted, out of any nucleus, then its mass number:
(A) Increased (B) No changes (C) Decrease (D) Infinity **(2 times)**

2. 1 U (unified mass scale) is equal to:
(A) 880 Mev (B) 931 Mev (C) 931 ev (D) 931 Kev **(2 Times)**

3. The mass of beta particle is equal to mass of:
(A) Proton (B) Electron (C) Neutron (D) Boron

4. 1 a.m.u is equal to:
(A) 1.66×10^{-19} kg (B) 1.66×10^{-24} kg (C) 1.66×10^{-27} kg (D) 1.66×10^{-34} kg

Topic IV: Radioactivity:

5. Neutron was discovered by:
(A) Rutherford (B) Chadwick (C) Becquerel (D) Curie **(2 times)**

6. Which of the following is similar to electron:
(A) α-particle (B) β -particle (C) Neutrino (D) Photon

7. The rate of decay of a radioactive substance:
(A) Remains constant with time (B) Increase with time
(C) Decrease with time (D) May increase or decrease with time

8. Colour television (while operating) emits:
(A) $\alpha - rays$ (B) $\beta - rays$ (C) $\gamma - rays$ (D) X-rays

9. Which is the equation of beta decay:
(A) ${}^{A}_{Z}X \rightarrow {}^{A}_{Z+1}Y + {}^{0}_{-1}e$ (B) ${}^{A}_{Z}X \rightarrow {}^{A-1}_{Z}Y + {}^{0}_{-1}e$ (C) ${}^{A}_{Z}X \rightarrow {}^{A+1}_{Z+1}Y + {}^{0}_{-1}e$ (D) ${}^{A}_{Z}X \rightarrow {}^{A-1}_{Z-1}Y + {}^{0}_{-1}e$

10. By emitting β particle and γ particle simultaneously the nucleus changes its charge by:

(A) Losses by 1 (B) Increases by 1
(C) Increases by 2 (D) No change will be observed

11. Radioactivity happens due to disintegration of:
(A) Nucleus (B) Mass (C) Electrons (D) Protons

12. An α particle contains:
(A) "1" proton and "1" neutron (B) "2" proton and "2" neutron
(C) "3" proton and "3" neutron (D) "4" proton and "4" neutron

13. Which one is more energetic:
(A) γ -rays (B) X-rays (C) Ultra violet rays (D) Visible light

14. γ rays emitted from radioactive elements have speed: **(2 times)**
(A) $1\times10^{7}ms^{-1}$ (B) $1\times10^{8}ms^{-1}$ (C) $3\times10^{8}ms^{-1}$ (D) $4\times10^{9}ms^{-1}$

15. Which of the following has no charge:
(A) Alpha rays (B) Beta rays (C) Gamma rays (D) Cathode rays

16. The units of decay constant is: **(2 times)**
(A) Second (B) $(Second)^{-1}$ (C) m^{-1} (D) mk

17. Speed of β particles is nearly equal to:
(A) 1×10^{8} m/s (B) 10^{7} m/s (C) 3×10^{8} m/s (D) 10^{6} m/s

18. The number of Neutrons in $^{238}_{92}U$ is:
(a) 92 (b) 238 (c) 146 (d) 330

19. Which particle has larger range in air?
(a) $\alpha - particle$ (b) $\gamma - particle$ (c) $\beta - particle$ (d) Neutron

20. α − particles carry a charge:
(a) −e (b) +2e (c) -2e (d) no charge

21. Engegy released by conversion of 1 amu is
(A) 1-6 x 10^{-19} ev (B) 1-6 x 1-6 x 10^{-19}Mev (C) 200 Mev (D) 931 Mev

22. How many times, the α − Particle is more massive than electron?
(A) 6332 (B)7332 (C) 8332 (D)9332

23. When a nucleus emits alpha particle, its atomic mas decreases by: **(2 times)**
(A) 3 (B) 2 (C) 4 (D) 1

24. The amount of energy required to break the nucleus is called its:
(A) Nuclear energy (B) Kinetic energy (C) Potential energy (D) Binding energy

25. The decy constant of a radioactive element depends upon:
(A) Nature of material (B) Temperature of material (C) Pressure on material (D) all of these

26. Marie curie and pierre curie discovered:
(A) Uranium (B) Uranium and radium (C) Polonium and radium (D) Radium

Topic V: Half Life:

27. Half-life of radium -226 is: **(3 times)**
(A) 1820 years (B) 1940 years (C) 1620 years (D) 1680 years

28. Half life of the iodine -131 is 8 days and its weight 20 mg. After 4 half-lives, the amount left undecayed will be: **(2 times)**
(A) 2.5 mg (B) 1.25 mg (C) 0.625 mg (D) 0.3112 mg

29. Cancer of the Thyroid gland is curved by: **(5 Times)**
(A) Carbon-14 (B) Sodium-24 (C) Iodine-131 (D) Cesuium-137

30. A sample contains N radioactive nuclei. After 4 half-lives number of nuclei decayed is:
(A) $\frac{4}{16}$ (B) $\frac{15N}{16}$ (C) $\frac{N}{8}$ (D) $\frac{7N}{8}$

31. After two half – lives, the number of decayed nuclei of an element are:
(A) N (B) $\frac{N}{2}$ (C) $\frac{N}{4}$ (D) $\frac{3N}{4}$

32. The element formed by radioactive dacay is called:
(A) Father element (B) Mother element (C)Parent element (D)Daughter element

Topic VI: Interaction of Radiation with matter:

33. For holography we use a beam of:
(A) γ -rays (B) X-rays (C) β -rays (D) Laser

34. Dr. Abdus Salam unified electromagnetic force and:
(A) Weak nuclear force (B) Strong nuclear force (C) Magnetic force (D) Gravitational force

35. The ionizing power of β particle is:
(A) Equal to α particle (B) Equal to γ particle
(C) Greater then α particle (D) Less than α particle

36. When Nitrogen is Bombarded Alpha Particle, then Nitrogen Nucle change into —— Nuclie:
(A) Oxygen (B) Carbon (C)Heluim (D) Beryllium

Topic VII: Radiation Detectors:

37. A devise which shows the visible path of ionizing particle is called:
(A) G.M counter (B) Solid detector (C) Scalar (D) Wilson-cloud Chamber

38. In Nuclear reactor, Uranium is enriched upto:
(A) (1-2)% (B) (1-3)% (C) (2-3)% (D) (2-4)%

39. In a fast (nuclear) reactor $^{238}_{92}U$ nucleus absorbs a fast neutron and is ultimately transformed into _____ by emitting two β particles:
(A) $^{235}_{92}U$ (B) $^{239}_{94}Pu$ (C) $^{208}_{82}Pb$ (D) $^{232}_{90}Th$

40. Geiger counter can be used to detect:
(A) Charge (B) Mass (C) $\frac{charge}{mass}$ ratio (D) Nuclear radiation

41. β particles in Wilson cloud chamber gave:
(A) Zigzag or erratic path (B) Curved path (C) Circular path (D) Elliptical path

42. A high potential difference of_____ is used in G.M counter:
(A) 400 volts (B) 1000 volts (C) 5000 volts (D) 4000 volts

43. The total amount of energy radiated per unit orific area of cavity radiator per unit time proportional to:
(A) T (B) T^2 (C) T^3 (D) T^4

44. A detector can count fast and operate low voltage is:
(A) G.M counter (B) Solid state detector
(C) Wilson cloud chamber (D) Bubble chamber

45. To shut down the nuclear reactor _____ are inserted into the reactor:
(A) Uranium rod (B) Cadmium rod (C) Plutonium rod (D) Iron rod

46. The dead time of Geiger Muller counter is of the order of: **(2 times)**
(A)$10^{-1}s$ (B) $10^{-2}s$ (C) $10^{-3}s$ (D) $10^{-4}s$

47. The average of the background radiation to which we are exposed per year: **(2 times)**
(A) 2 mSv (B) 1 mSv (C) 3 mSv (D) 0.01 Sv

48. Dead time of G.M Counter is: **(2 times)**
(A) 10^{-5} Sec (B) 10^{-4} Sec (C) 10^{-3} Sec (D) 10^{-2} Sec

49. A device that shows the visible path of ionizing particle is called
(A) GM Counter (B)Solid state detector (C) Scalar (D) Wilson Cloud Chamber

50. GM-counter uses
(A) Alcohol only (B) Bromine (C) Argon (D)Neon and bromine

Topic VIII: Nuclear Reactions:

51. The maximum safe limit weekly dose for persons working in a nuclear reactor is:
(A) 1 mSv (B) 2 mSv (C) 3 mSv (D) 5 mSv

52. Which nuclear reaction takes place in the sun and stars:
(A) Fission (B) Chemical (C) Fusion (D) Mechanical

Topic IX: Nuclear Fission:

53. Nuclear fission chain reaction is controlled by using:
(A) Steel rods (B) Graphite rods (C) Cadimum rods (D) Platinum rods

54. Energy liberated when one atom of $^{235}_{92}U$ undergoes fission reaction:
(A) 140 Mev (B) 28 Mev (C) 200 Mev (D) 60 Mev

Topic X: Fusion Reaction:

55. The energy emitted from sun is due to:
(A) Fission reaction (B) Fusion reaction (C) Chemical reaction (D) Pair production

56. The energy released by fusion of two deuterons into a Helium nucleus is about:
(A) 24 Mev (B) 200 Mev (C) 1.02 Mev (D) 7.2 Mev

Topic XIV: Basic Forces of Nature:

57. A particle is made up of two up quarks and one down quark is: **(2 Times)**
(A) Proton (B) Neutron (C) Boson (D) Lepton

58. Three up quarks combine to form a new particle, the charge on this particle is:
(A) 1 e (B) 2 e (C) 3 e (D) 4 e
59. Which of the following belong to "hadrons" group:
(A) Proton (B) Electron (C) Muons (D) Neutrinos
60. Curie is large unit which equals to ______ disintegration per second: (2 Times)
(A) 3.7×10^{10} (B) 3×10^{8} (C) 3.7×10^{8} (D) 3×10^{6}
61. Particles that experience the strong nuclear force:
(A) Hadrons (B) Leptons (C) Photons (D) Quarks
62. The particles equal in mass or greater than protons are called: (2 Times)
(A) Leptons (B) Baryons (C) Mesons (D) Mouns
63. A pair of quark and anti-quark make a: (3 Times)
(A) Meson (B) Harden (C) Lepton (D) Baryon
64. Every particle has corresponding antiparticle with:
(A) Same mass (B) Different mass
(C) Opposite charge (D) Same mass and opposite charge
65. Which group belongs to Hadrons: (3 times)
(A) Protons and neutrons (B) Muons and neutrons
(C) Photons and electrons (D) Positrons and electrons
66. The number of types of quarks is: (3 times)
(A) 6 (B) 5 (C) 4 (D) 3
67. Which of the followings are not hadrons?
(A) Muons (B) Mesons (C) Protons (D) Neutrons
68. One gray (Gy) is equal to:
(A) 1.6×10^{-19} J (B) $1.6\times10^{-10}\frac{J}{kg}$ (C) $1\frac{J}{kg}$ (D) $4\frac{J}{kg}$
69. Absorbed Dose "D" is defined as: (4 times)
(a) M/E (b) E/C (c) C/m (d) E/M
70. Two down and one up quark make:
(a) Proton (b) Neutron (c) Photon (d) Positron
71. A proton consists of quarks which are: (3 times)
(a) 2 up, 1 down (b) 1 up, 2 down (c) all up (d) all down
72. Which one is a better shield against $\gamma-rays$: (2 times)
(A) Wood (B) Lead (C) Aluminum (D) Water
73. The range of weak nuclear force is of the order of.
(A) 10^{-10} m (B) 10^{-14} m (C) 10^{-17} m (D) 10^{-22} m
74. The building blocks of protons and neutrons are called:
(A) Ions (B) Electrons (C) Positrons (D) Quarks

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75. The bombardment of nitrogen with α-particle will produce: (2 times)
(A) Neutron (B) Proton (C) Electron (D) Positron
76. In Liquid Metal Fast Breeder reactor, the type of Uranium used is: (2 times)
(A) $^{235}_{92}U$ (B) $^{238}_{92}U$ (C) $^{234}_{92}U$ (D) $^{239}_{92}U$
77. If we have N_0 number of atoms of any Radioactive Element, then after four half lives, the number of atoms left behind is:
(A) $\frac{1}{4}N_0$ (B) $\frac{1}{8}N_0$ (C) $\frac{1}{16}N_0$ (D) $\frac{1}{2}N_0$
78. The half-life of radon gas is:
(A) 3.8 hours (B) 3.8 minutes (C) 3.8 days (D) 3.8 years
79. The particles which do not experience strong force are called:
(a) baryons (b) hadrons (c) mesons (d) leptons
80. The force which is responsible for the breaking up of the radioactive element, is: (2 times)

(a) weak nuclear force (b) strong nuclear force
(c) electromagnetic force (d) gravitational force
81. Hydrogen bomb is an example of:
(a) nuclear fission (b) Nuclear fusion (c) Chain reaction (d) Chemical reaction
82. Various types of cancer are treated by:
(a) carbon – 14 (b) Nickel – 63 (c) Cobalt – 60 (d) Strontium – 90
83. The Rest Mass Energy of an electron positron pair is:
(a) 0.51 Mev (b) 1.02 Mev (c) 1.2 Mev (d) 1.00 Mev

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84. In the reaction, X+$^{17}_{8}O \rightarrow ^{14}_{7}N + ^{4}_{2}He$, X is:
(A) $^{1}_{1}H$ (B) $^{2}_{1}H$ (C) $^{0}_{1}e$ (D) $_{-1}^{0}e$
85. Binding energy per nucleus is maximum for:
(A) Helium (B) Iron (C) Radium (D) Polonium
86. 0.1 Kg mass will be equivalent to energy:
(A) 5×10^{8} J (B) 9×10^{15} J (C) 6×10^{16} J (D) 9×10^{16} J
87. The specially designed solid state detector can be used to detect:
(A) α-rays only (B) β–rays only (C) γ-rays only (D) X-rays only
88. Radio Therapy is often used in the treatment of Cancer with.
(A) Iodine-131 (B) Sodium-34 (C) Carbon-12 (D) Cobalt-60
89. The existence of Positron was predicted by:
(A) G.P. Thomson (B) Dirac (C) Germer (D) Newton
90. 1 rem is equal to:
(A) 0.1 Sv (B) 0.01 Sv (C) 10 Sv (D) 100 Sv
91. Subatomic particles are divided into:
(A) Six groups (B) Five groups (C) Foru groups (D) Three groups
92. The quantity called the absorbed dose "D" is:
(A) E/m (B) E/C (C) m/C (D) C/E
93. Number of neutrons in $^{235}_{92}U$:
(A) 92 (B) 235 (C) 143 (D) 237

ANSWERS OF THE MULTIPLE CHOICE QUESTIONS

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
B	B	B	C	B	B	C	D	A	B	A	B	A	C	C	B
17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
A	C	D	B	D	B	C	D	A	C	C	B	C	B	D	D
33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
D	A	D	A	D	D	B	D	A	A	D	B	B	D	A	B
49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64
D	D	A	C	C	C	B	A	A	B	A	A	A	B	A	D
65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
A	A	A	C	D	B	A	B	C	D	B	B	C	C	D	A
81	82	83	84	85	86	87	88	89	90	91	92	93			
B	C	B	A	B	D	C	D	B	B	D	A	C			

SHORT QUESTIONS OF CHAPTER-21
ACCORDING TO ALP SMART SYLLABUS-2020

Topic III: Mass Defect and Binding Energy:

1. What do you mean by critical mass and critical volume? (8 times)
Ans. The mass of uranium in which one neutron out of all neutron out of all neutron produced in one fission reaction produces further fission reactions is called critical mass.
2. Define mass defect and binding energy. (10 times)
Ans: **Mass defect:** The mass of the nucleus is always less than the total mass of the protons and neutrons that make up the nucleus. The difference of the two masses is called mass defect.

Binding energy: The missing mass is converted into energy at the formation of the nucleus and is called binding energy.

3. **Show that $1\ u = 931\ MeV$ by using the relation $E = (\Delta m)c^2$.** **(3 times)**

Ans: Since $1\ u = 1.66 \times 10^{-27} kg$

So

$$E = (\Delta m)c^2$$
$$E = (1.66 \times 10^{-27})(3 \times 10^8)^2$$
$$E = 14.94 \times 10^{-11}\ J$$
$$E = \frac{14.94 \times 10^{-11}}{1.6 \times 10^{-19}}\ eV$$
$$E = 931 \times 10^6\ eV$$
$$E = 931\ MeV$$

Hence $1\ u = 931\ MeV$

4. **Explain the term mass defect.** **(3 times)**

Ans: **Mass defect:** The mass of the nucleus is always less than the total mass of the protons and neutrons that make up the nucleus. The difference of the two masses is called mass defect.

5. **How much energy released when 1 amu converted into energy?**

Ans:
$$1\ amu = 1.66\ \times 10^{-27}\ kg$$
The energy of $1\ amu$ is $1\ amu = 1.494 \times 10^{-10}\ J$
$$1\ amu = 931\ MeV$$

Topic IV: Radioactivity:

6. **Why are heavy nuclei unstable?** **(18 times) (H.W)**

Ans: Heavy nuclei are unstable because their binding energy per nucleon is less than lighter nuclei. So less energy is required to break heavy nuclei and they become unstable.

7. **What do you understand by Radio Activity?**

Ans: The elements having charge number Z > 82 are unstable and they emit invisible radiations which affect the photographic plate. Such elements are called radioactive elements and this process is called radioactivity.

8. **Differentiate between parent and daughter element.**

Ans: The change of an element into a new element due to emission of radiation is called radioactive decay. The original atoms is called parent element and the element formed due to this decay is called daughter element.

9. **If U^{233}_{92} decays twice by α - emission what is the resulting isotope?**

Ans: As

$$^{233}_{92}U \longrightarrow {}^{229}_{90}Th + {}^{4}_{2}He$$
$$^{229}_{90}Th \longrightarrow {}^{225}_{88}Rn + {}^{4}_{2}He$$

So, If $^{233}_{92}U$ decay twice by $\alpha -$ emission then it will be converted into $^{225}_{88}Rn$.

10. **A particle, which produces more ionization, is less penetrating. Why?(11 times) (H.W)**

Ans. A particle with greater power loses large amount of energy for small distances. That is, it produces more ionization but is less penetration.

11. **What is radioactive decay? Give an example.** **(2 Time)**

Ans: The emission of radiations (such as α, β and γ) from elements having charge number Z greater than 82 is called radioactivity or **radioactive decay.**
The emission of an $\alpha -$ particle from radium $-$ 226, results in the formation of radon gas $^{222}_{86}Rn$.

$$^{226}_{88}Ra \rightarrow {}^{222}_{86}Rn + {}^{4}_{2}He$$

12. **What is natural radioactivity? Name types of radiations emitted from radioactive elements.**

Ans: The emission of radiations from elements having charge number 'Z' greater than 82 is called **natural radioactivity.**
$\alpha -$ particle, $\beta -$ particle and $\gamma -$ rays are emitted from radioactive elements.

13. **What will be the change in mass number and charge number during alpha decay?**

Ans: The mass number of the nucleus decreases by 4, and the change number decreases by 2 during the emission of $\alpha -$ particle from any nucleus.
It is given by the equation.

$$^{A}_{Z}X \longrightarrow {}^{A-4}_{Z-2}Y + {}^{4}_{2}He$$

Topic V: Half Life:

14. **Define decay constant.** **(3 times)**

Ans: Decay constant of any element is equal to the fraction of the decaying atoms per unit time.

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

Its unit is s^{-1}.

15. **What fraction of radioactive sample decays after two half-lives have elapsed?** **(6 times) (H.W)**

Ans: $number\ of\ atoms\ at\ initial\ stage = N_o$

$$number\ of\ atoms\ decayed\ after\ first\ half-life = \frac{1}{2}N_o$$
$$number\ of\ atoms\ decayed\ after\ two\ half-lives = \frac{1}{2}\left(\frac{1}{2}N_o\right)$$
$$number\ of\ atoms\ decayed\ after\ two\ half-lives = \frac{1}{4}N_o$$
$$So\ total\ number\ of\ atoms\ decayed = \frac{1}{2}N_o + \frac{1}{4}N_o = \frac{3}{4}N_o$$
$$fraction\ of\ atoms\ decayed = \frac{3}{4}N_o \times 100\% = 75\%$$

16. **If nucleus has a half-life of one year, does this mean that it will be completely decayed after two years? Explain.** **(4 times) (C.W)**

Ans: No, it will not decay completely after two years.

$$number\ of\ atoms\ at\ initial\ stage = N_o$$
$$number\ of\ atoms\ decayed\ after\ first\ year = \frac{1}{2}N_o$$
$$number\ of\ atoms\ decayed\ after\ two\ years = \frac{1}{2}\left(\frac{1}{2}N_o\right)$$
$$number\ of\ atoms\ decayed\ after\ two\ years = \frac{1}{4}N_o$$

17. **What are the relation between decay constant λ and half-life $(T_{1/2})$ of a radioactive element?**

Ans: The relation between decay constant (λ) and half-life $\left(T_{\frac{1}{2}}\right)$ is $\lambda T_{\frac{1}{2}} = 0.693$

18. **Define half-life of a radioactive element and write its formula.**

OR

Define Half Life of a Radioactive Element. What is the Relation between Half Life and Decay Constant?

Ans: The half-life $T_{\frac{1}{2}}$ of a radioactive element is that period in which half of the atoms decay. The relation between half-life and decay constant is

$$T_{\frac{1}{2}}\lambda = 0.693$$

19. **Define half-life and discuss its dependence.**

Ans: **Definition:** The half-life $T_{1/2}$ of a radioactive element is that period in which half of the atoms decay.
Dependence: The number of decaying atoms is proportional to the number of atoms present in the beginning of the period and is proportional to time interval.

20. **Define half-life of radioactive element. How is it related with decay constant λ ?**

Ans: **Half-life** $T_{1/2}$ is the period in which half of the atoms of a radioactive element decay.
It is related with a decay constant λ by formula

$$T_{1/2} = \frac{0.693}{\lambda}$$

Topic VI: Interaction of Radiation with matter:

21. How α and β particles may ionize an atom without directly hitting the electrons? Explain. **(3 times) C.W**

Ans: As alpha and beta are electrically charged particles, so they can cause ionization without hitting an atom either by repelling or attracting the electron of target particles.

22. Define fluorescence. Name two fluorescence substances.

Ans: **Fluorescence:** Fluorescence is a property of absorbing radiant energy of high frequency and re-emitting energy of low frequency in the visible region of electromagnetic spectrum.

Some substances like zinc sulphide, sodium iodide and barium platinocyanide produce fluorescence.

23. Describe a brief account of interaction of various types of radiations with matter.

Ans: **Interaction of α – particles with matter:** **C.W**

i. An α – particle has a well-defined range in a medium, before coming to rest, which is called range of α – particle.
ii. It loses its energy (in medium) due to excitation and ionization of atoms and molecules in matter.
iii. α – particle ionizes by direct elastic collision or by electrostatic attraction.
iv. The range of α – particles depends upon the charge, mass, energy of the particle, density of the medium and ionization potentials of the atoms of the medium.
v. α – particle is about 7000 times massive than an electron, so it moves in a straight path.
vi. After coming to rest, α – particle captures two electrons from the medium and becomes a neutral helium atom.

Interaction of β-particles with matter:

i. The ionizing ability of β-particles is about 100 times less than that of α - particles.
ii. The range of β-particles is 100 times more than that of α – particles.
iii. Path of β-particles while passing through the matter is not straight.
iv. The range of β-particles depends upon the density of the matter. The more dense the matter is, shorter the range.
v. β-particles when slowed down by electric field of particles radiate energy as X-ray photons.
vi. B-particles produce fluorescence or glow on striking some substance like zinc sulphide, sodium iodine or barium platinocyanide coated screens.

Interaction of γ-rays with matter:

i. γ-raysare uncharged having zero rest mass, so they can't be stopped easily.
ii. Their ionizing power is very small but penetrating power is very high.
iii. γ-rays interact with matter in three different ways depending upon their energy.

Topic VII: Radiation Detectors:

24. Describe principle of operation of solid state detector. **(2 Times) C.W**

OR Describe the principle of operation of a solid state detector of ionization radiation in terms of generation and detection of charge carriers.

Ans: The principle of operation of solid state detector is based upon the production of electron-hole pair to cause a pulse of current.

25. Write down two advantages of solid state detector over Geiger Muller Counter.

Ans: Solid state detector can count very fast than gas filled detector. **(3 Times)**
Solid state detector is much smaller in size.
It operates at low voltage.

26. What do you understand by "background radiation"? State two sources of this radiation. **(12 times) H.W**

Ans: When no radioactive source is placed near the radiation detector, it records radiations. These radiations are called background radiations.
Its sources are i. Cosmic rays
ii. Presence of radioactive substances in Earth's crust and atmosphere

27. Why moderators are used in the core of nuclear reactor? **(2 Time)**

Ans: The moderators are used in the core to slow the neutrons down so that they can be captured and keep the chain reaction going.

28. What information if revealed by the length and shape of track of an incident particle in Wilson Cloud Chamber? **(4 times) C.W**

Ans: In a Wilson Cloud Chamber

i. Alpha particles have larger mass and greater ionizing power, so its path is straight.
ii. Beta particles have less mass and less ionizing power, so its path is thinner, shorter and discontinuous.
iii. Gamma particles have no mass and high penetrating power, so its leaves no definite track along its path.

29. Briefly give the uses of (a) Wilson cloud chamber (b) G.M counter

Ans: **Wilson Cloud Chamber**

i. It provides information about the change in mass and energy of radiating particles.

G.M. Counter

i. It is used to determine the range and penetrating power of ionizing particles.

30. What is self-quenching in Geiger Muller Counter? **(2 Time)**

Ans: A small amount of gas (bromine or ethanol) is added into the GM counter is called self-quenching or internal quenching.
In GM counter the phenomenon of quenching is to save the counter from spurious or false counts.

31. What are thermal reactors?

Ans: The thermal reactors are called "thermal reactors" because the neutrons must be slowed down to thermal energies to produce further fission. They use natural uranium or slightly enriched uranium as fuel.

32. Why Geiger counter is not suitable for fast counting?

Ans: Geiger counter is not suitable for fast counting because of its longer dead time ($\approx 10^{-4}s$). The positive ions take several time as long to reach the outer cathode, because positive ions are very massive than the electrons. During this time further incoming particles cannot be counted. This time is called as the dead time of counter which delays fast counting system.

33. What is the function of control rods in nuclear reactor?

Ans: Control rods made of Cadmium or Boron are used for the control of number of neutrons, so that of all the neutrons produced in fission, only one neutron produces further fission reaction.
In case of emergency or for repair purposes control rods are used to stop the chain reaction and shut down the reactor.

34. Why does a Geiger Muller Tube for detecting γ – rays not need a window at all?

Ans: For detecting γ – rays, a thin end window becomes useless because of the high penetrating power of γ – rays.

35. Write a short note on Geiger Muller Counter.

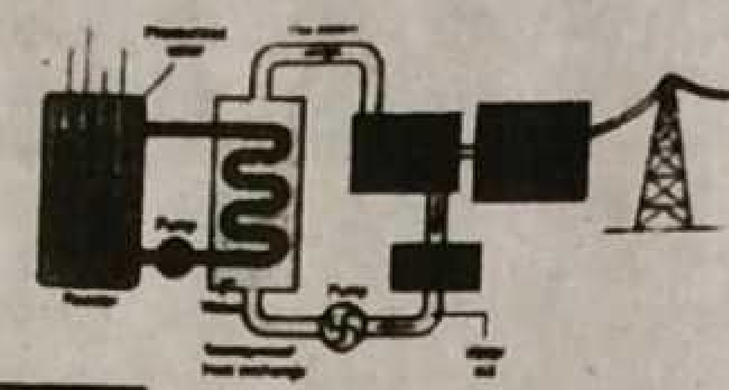
Ans: Geiger Muller Counter is a well known radiation detector. A high potential difference is applied between cathode and anode to attract ions produced by the interaction of radiation with principal or inert gas. Current pulse is amplified and registered electronically. Its dead time is equal to 10^{-4}s. A small amount of quenching gas having ionization potential lower than principal gas is mixed with principal gas to prevent the emission of secondary electrons when positive ions strike the cathode.
It is used to determine the range and penetrating power of ionizing particles.

36. Briefly explain what is meant by Quenching?

Ans: In G.M tube, a small amount of quenching gas (e.g bromine) having ionization potential lower than principal gas is mixed with the principal gas to prevent the emission of secondary electrons when positive ions strike the cathode. This is self – quenching. Electronic quenching is also in common practice.

37. What is the use of nuclear reactor and draw its diagram.

Ans: In a nuclear reactor fission reaction produces heat. This heat is used to produce steam which in turn rotates the turbine. Turbine rotates the generator which produces electricity.



Topic VIII: Nuclear Reactions:

38. Discuss the advantages and disadvantages of nuclear power compare to the use of fossil fuel generated power. (H.W)

Ans: Advantages and disadvantages of nuclear power are given below compared to the use of fossil fuel generated power,

Advantages:

i. Much more energy is produced (i.e. 1kg of uranium = 2×10^7 kWh)
ii. Produces no environmental pollution.
iii. Electricity produced in this way is far cheaper than fossil fuel generated power.
iv. Nuclear waste can be re-used whereas used fossil fuel can't.

Disadvantages:

i. Uranium mining is more dangerous than coal mining.
ii. Nuclear waste can't be transported through areas of population whereas fossil fuel can be.
iii. Nuclear waste is very injurious and harmful to living things.

Topic IX: Nuclear Fission:

39. Define nuclear fission. Give two examples of such two reactions.

Ans: Such a reaction in which a heavy nucleus like that of uranium splits up into two nuclei of roughly equal size along with the emission of energy is called fission reaction.

For example $^{235}_{92}U + ^{1}_{0}n \rightarrow ^{132}_{50}Sn + ^{101}_{42}Mo + 3^{1}_{0}n + Q$

and $^{235}_{92}U + ^{1}_{0}n \rightarrow ^{140}_{54}Xe + ^{94}_{38}Sr + 3^{1}_{0}n + Q$

40. Differentiate between controlled and un-controlled chain reaction.

Ans: To maintain a sustained controlled nuclear reaction, for every 2 or 3 neutrons released, only one must be allowed to strike another uranium nucleus, it is called controlled chain reaction.

But if more than one neutron produces further fission then it will grow uncontrolled and called as uncontrolled chain reaction.

41. What do you mean by the term critical mass? (4 times) (H.W)

Ans: The mass of uranium in which one neutron out of all neutron produced in one fission reaction produces further fission reactions is called critical mass. The volume of this mass of uranium is called critical volume.

42. Define fission and fusion reaction.

OR Distiguish between nuclear fission and fusion reaction.

Ans: **Fission:** Such a reaction in which a heavy nucleus like that of uranium splits up into two nuclei of roughly equal size along with the emission of energy is called fission reaction.

Fusion: A reaction in which two light nuclei merge to form a heavy nucleus is called fusion reaction. It requires very high temperature.

43. Discuss the advantages of fission power from the point of view of safety, pollution and resources. (C.W)

Ans: Advantages of nuclear power are given below

(i) Nuclear fission energy, releases a highly reduced amount of the gases into the air, resulting in a slower rate of global warming and pollution.

(ii) The energy is quick to create; meaning that they are able to make a large amount of some form of emergency required it.

(iii) While the initial building costs may be very high, the costs to operate a nuclear power plant are minimal.

(iv) Much more energy is produced

44. Write down two expected nuclear reactions for fission to indicate daughter nucleii.

Ans: $^{235}_{92}U + ^{1}_{0}n \rightarrow ^{132}_{50}Sn + ^{101}_{42}Mo + 3^{1}_{0}n + Q$

$^{235}_{92}U + ^{1}_{0}n \rightarrow ^{140}_{54}Xe + ^{94}_{38}Sr + 2\,^{1}_{0}n + Q$

Here the products are daughter nucleii.

45. Explain briefly fission chain reaction.

Ans: If only one neutron out of all the neutrons created in one fission reaction becomes the cause of further fission reaction. The other neutrons either escape out or are absorbed in any other medium except uranium. In this way, the fission chain reaction proceeds with its initial speed.

Topic X: Fusion Reaction:

46. What factors make a Fusion reaction difficult to achieve? (17 times) (H.W)

OR It is more difficult to start a fusion reaction than a fission reaction. Why?

Ans: A fusion reaction requires large energy and temperature, up to million degrees centigrade. So a fusion reaction is difficult to achieve.

47. Distinguish between nuclear fission and nuclear fusion.

Ans: **Nuclear Fission:** Such a reaction in which a heavy nucleus like that of uranium splits up into two nuclei of roughly equal size along with the emission of energy is called fission reaction.

For example

$$^{235}_{92}U + ^{1}_{0}n \longrightarrow ^{132}_{50}Sn + ^{101}_{42}Mo + 3^{1}_{0}n + Q$$

And

$$^{235}_{92}U + ^{1}_{0}n \longrightarrow ^{140}_{54}Xe + ^{94}_{38}Sr + 3^{1}_{0}n + Q$$

Nuclear Fusion: A reaction in which two light nuclei merge to form a heavy nucleus is called fusion reaction. It requires very high temperature.

48. What is fusion reaction?

Ans: **Nuclear Fusion Reaction:** A reaction in which two light nuclei merge to form a heavy nucleus is called fusion reaction. It requires very high temperature.

Topic XI: Radiation Exposure:

49. State the advantages and disadvantages of nuclear power.

Ans: Advantages and disadvantages of nuclear power are given below

Advantages:

i. Much more energy is produced (i.e. 1kg of uranium = 2×10^7 kWh)
ii. Produces no environmental pollution.
iii. Electricity produced in this way is far cheaper than fossil fuel generated power.
iv. Nuclear waste can be re-used whereas used fossil fuel can't.

Disadvantages:

iv. Uranium mining is more dangerous than coal mining.
v. Nuclear waste can't be transported through areas of population whereas fossil fuel can be.
vi. Nuclear waste is very injurious and harmful to living things.

50. Write any two uses of radiography.

Ans: (i) The γ – rays radiographs are used in medical diagnosis such as to determine precisely the size and location of a tumor in brain or other parts of body.

(iii) Cracks or cavities in castings or pipes can be detected by scanning.

51. What is radioactive tracer? Describe one application in medicine and agriculture.

Ans: Radioactive tracer is a radioactive isotope which acts as an indicator or tracer that makes it possible to follow the course of a chemical or biological process. They are used in

(i) Medicine to detect malignant tumors.
(ii) Agriculture to study the uptake of a fertilizer by a plant.

Topic XIV: Basic Forces of Nature:

52. Differentiate between Baryons and Mesons. (3 times)

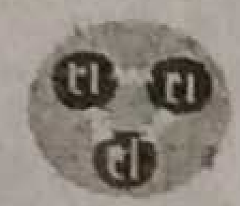
Ans: **Baryons:** The particles equal in mass or greater than protons are called baryons. It is made by 3 quarks.

Mesons: The particles which are lighter in mass than protons are called mesons. A pair of quark and an antiquark makes a meson.

53. Give the names and charges of Quarks.
OR Name different quarks according to Gell-Mann and G.Zweig quark theory.
Ans: The names and charges of quarks are as follows

Name	Symbol	Charge
Up	u	$+\frac{2}{3}e$
Down	d	$-\frac{1}{3}e$
Strange	s	$-\frac{1}{3}e$
Charm	c	$+\frac{2}{3}e$
Top	t	$+\frac{2}{3}$
Bottom	b	$-\frac{1}{3}e$

54. Protons and neutrons are formed by what type of quarks? Show the diagram.
Ans: Proton is formed by two up and one down quarks.



Neutron is formed by two down and one up quarks.

55. Name the basic forces of nature. **(10 times)**
Ans: The basic forces of nature are
i. Gravitational force ii. Electromagnetic force iii. Weak nuclear force
iv. Strong nuclear force

56. What do you mean by quark?
Ans: Quark is the basic building block of mesons and baryons. In actual, it is the basic building block of matter. It is proposed by Murray Gell-Mann and G. Zweig. It is of six types: up, down, strange, charm, bottom and top.

57. Define (a) Absorbed dose (b) Gray **(2 Time)**
Ans: **Absorbed dose:** it is defined as the amount of energy absorbed from an ionizing radiation per unit mass of the absorbing body i.e.

$$Absorbed\ Dose = \frac{energy\ absorbed}{mass} \quad , \quad D = \frac{E}{m}$$

Gray: it is defined as the amount of energy equal to one joule absorbed by a body of mass 1kg. i.e.,

$$1\ \text{Gray} = \frac{1\ \text{Joule}}{1\ \text{kg}} \quad , \quad 1\ \text{Gy} = 1\ \text{J kg}^{-1}$$

58. Write down the names of different Quarks.
Ans: The names of quarks are as follows
Up, Down, Strange, Charm, Top, Bottom

59. Define Hadrons and Leptons. **(4 times)**
Ans: **Hadrons:** These are not elementary particles. They are composed of other elementary particles called quarks. The examples of hadrons are protons, neutrons, mesons etc. They experience strong nuclear force.
Leptons: These are elementary particles. They do not experience strong nuclear force. The examples of leptons are electrons, muons and neutrinos etc.

60. What are hadrons? Give one example.
Ans: **Hadrons:** These are not elementary particles. They are composed of other elementary particles called quarks. The examples of hadrons are protons, neutrons, mesons etc. They experience strong nuclear force.

61. What are Hadrons and Leptons? Explain with examples.

OR Differentiate between Hadrons and Laptons.
Ans: **Hadrons:** These are not elementary particles. They are composed of other elementary particles called quarks. The examples of hadrons are protons, neutrons, mesons etc. They experience strong nuclear force.
Laptons: These are elementary particles. They do not experience strong nuclear force. The examples of laptons are electrons, muons and neutrinos etc.

62. What is meant by dose of radiation? What is its SI unit?
Ans: Radiation dose is a measure of the amount of exposure to radiation. There are three kinds of dose:
(i) **Absorbed dose:** It is the amount of energy deposited by radiation in a mass.

$$D = E/m.$$

Its SI unit is Gy.
(ii) **Equivalent dose:** It is calculated for individual organ.

$$D_e = D \times RBE$$

Its SI unit is Sv.
(iii) **Effective dose:** It is calculated for the whole body. It is also measured in Sv.

63. What are Leptons? Write its examples.
Ans: Leptons are elementary particles. They do not experience strong nuclear force. The examples of Leptons are electrons, muons, and neutrinos etc.

64. Define hadrons. Also differentiate between baryons and mesons.
Ans: **Hadrons** are composed of other elementary particles which are called quarks. They experience strong nuclear force. Protons, neutrons, mesons etc. are all hadrons.
The particles equal in mass or greater than protons are called **baryons**. They are made by three quarks.
The particles which are lighter in mass than protons are called **mesons**. A pair of quark and an antiquark makes a meson.

LONG QUESTIONS OF CHAPTER-21 ACCORDING TO ALP SMART SYLLABUS-2020

Topic IV: Radioactivity:
1. What is radioactivity? Explain the nuclear transmutation.
2. What is radioactivity? Discuss emission of α, β and γ particles from radioactive nuclei. **(4 Times)**

Topic VII: Radiation Detectors:
3. Describe the construction and working of Geiger Muller Counter.
4. What is nuclear reactor? Draw its diagram and describe function of its main parts.
5. Describe the principle, construction and working of a Wilson cloud chamber.
6. Define and explain the principle, construction and working of a solid state detector.
7. What is nuclear reactor? Explain different parts of power reactor.
8. Explain principle, construction and working of a Nuclear reactor. **(3 times)**
9. What is a nuclear reactor? Describe its four important parts. **(3 times)**

Topic IX: Nuclear Fission:
10. What is Nuclear Fission? Explain Fission Chain Reaction in detail.
11. Why nuclear fission reaction considered as a chain reaction? How can it be controlled?
12. What is fission chain reaction? Describe controlled and uncontrolled fission chain reaction.

Topic X: Fusion Reaction:
13. What is nuclear fusion? Why this reaction has not been brought under control? How sun is issuing out tremendous amount of energy?
14. Define and explain the Fusion Reaction with examples.

NUMERICAL PROBLEMS OF CHAPTER-21 ACCORDING TO ALP SMART SYLLABUS-2020

Topic III: Mass Defect and Binding Energy:

1. Find the mass defect and binding energy of Tritium, if the atomic mass of Tritium is $3.016049\,u$. **(6 Time) (C.W)**

Ans: Given that $atomic\ mass\ of\ tritium = m_t = 3.016049\,u$

$atomic\ mass\ of\ proton = m_p = 1.007276\,u$

$atomic\ mass\ of\ neutron = m_n = 1.008665\,u$

$mass\ defect = \Delta m = ?$

$binding\ energy = B.E. = ?$

Since $\Delta m = Zm_p + (A - Z)m_n - m_t$

$$\Delta m = 1(1.007276) + (3 - 1)(1.0086) - 3.016049 \boxed{= 0.008557\,u}$$

And $B.E. = \Delta m \times 931\,MeV = 0.008557 \times 931\,MeV \boxed{= 7.97\,MeV}$

2. Find the mass defect and binding energy of the deuteron nucleus. The experimental mass of deuteron is $3.3435 \times 10^{-27}\,kg$. **(3 times) (Example No. 21.1)**

Ans: Given that $mass\ of\ proton = m_p = 1.6726 \times 10^{-27} kg$

$mass\ of\ neutron = m_n = 1.6749 \times 10^{-27} kg$

$mass\ of\ deutron = m_d = 3.3435 \times 10^{-27} kg$

$mass\ defect = \Delta m = ?$

$binding\ energy = B.E. = ?$

Since $\Delta m = m_p + m_n - m_d$

$$\Delta m = 1.6726 \times 10^{-27} + 1.6749 \times 10^{-27} - 3.3435 \times 10^{-27}$$

$$\boxed{= 3.9754 \times 10^{-30}\,kg}$$

And $B.E. = \Delta m\, c^2$

$$B.E. = (3.9754 \times 10^{-30})(3 \times 10^8)^2$$

$$\boxed{B.E. = 3.5729 \times 10^{-13}\,J}$$

$$B.E = \frac{3.5729\times10^{-13}}{1.6\times10^{-19}}\,eV$$

$= 2.33 \times 10^6\,eV = 2.33$ MeV

Topic IV: Radioactivity:

3. If $^{233}_{92}U$ decays twice by α –emission, what is the resulting isotope? **(4 Time) (C.W)**

Ans: As

$$^{233}_{92}U \rightarrow {}^{229}_{90}Th + {}^{4}_{2}He$$

Semantically

$$^{229}_{90}Th \rightarrow {}^{225}_{88}Rn + {}^{4}_{2}He$$

If $^{233}_{92}U$ decays twice by α – emission then it will be converted into $^{225}_{88}Rn$.

Topic V: Half Life:

4. A sheet of lead 5.0 mm thick reduces the intensity of a beam of γ-rays by a factor 0.4. Find half value thickness of lead sheet which will reduce the intensity to half of its initial value. **(6 Times) (C.W)**

Sol:

$x_1 = 5.0mm = 5\times10^{-3}m$

$I_1 = 0.4I_0$, $I_2 = 0.5I_0$, $x_2 = ?$

As $I = I_0 e^{-\mu x}$

Thus $I_1 = I_0 e^{-\mu x_1}$

$0.4I_0 = I_0 e^{-\mu x_1}$

$0.4 = I_0 = I_0 e^{-\mu x_1}$

Taking ln on both sides, we get

$\ln(0.4) = \ln e^{-\mu x_1}$

$\ln(0.4) = -\mu x_1$

$-\mu x_1 = -0.916$

$\mu x_1 = 0.916$ ______ (i)

$I_2 = I_0 e^{-\mu x_2}$ = $0.5I_0 = I_0 e^{-\mu x_2}$

$0.5 = e^{-\mu x_2}$

$\ln(0.5) = \ln(e^{-\mu x_2})$

Similarly $-0.693 = -\mu x_2$

$\mu x_2 = 0.693 \rightarrow (ii)$

Dividing equation (i) by (ii)

$$\frac{\mu x_1}{\mu x_2} = \frac{0.916}{0.693}$$

$$\frac{x_2}{x_1} = \frac{0.693}{0.916}$$

$$x_2 = \frac{0.693}{0.916}x_1 = \frac{0.693}{0.916}\times5\times10^{-3} = 3.79\times10^{-3}m = 3.79mm$$

ALP SMART SYLLABUS 2020

1. Iodine-131 is an artificial radioactive isotope. It is used for the treatment of human thyroid gland half-life is 8 days. In the drug store of a hospital 20 mg of iodine-131 is present. It was received from the laboratory 48 days ago. Find the quantity of iodine-131 in the hospital after this period. **(Example 21.2)**

Sol: As the half-life of iodine is 8 days therefore in 8 days half of the iodine decays. Given below in the table is the amount of iodine present after every 8 days.

Interval in days	Quantity of iodine
0	20 mg
8	10 mg
16	5 mg
24	2.5 mg
32	1.25 mg
40	0.625 mg
48	0.3125 mg

Thus 48 days after the receipt, the amount of iodine 131 left behind is only 0.3125 mg.

2. The element $^{231}_{91}$Pa is unstable and decays by β – emission with a half-life 6.66 hours. State the nuclear reaction and the daughter nuclei. **(C.W)**

Sol: Half life = $T_{1/2}$ = 6.66 hours=6.66 × 60 × 60 sec = 23976 sec

(a) Nuclear reaction = ? (b) Daughter nuclei = ?

In case of β emission the charge number increase by 1 and its mass number remains the same, then nuclear reaction.

$$^{A}_{Z}X \rightarrow {}^{A}Y + {}^{0}_{-1}\beta$$
$$^{234}_{91}P \rightarrow {}^{234}_{92}U + {}^{0}_{-1}\beta$$
$$^{234}_{91}P = \text{Parent element}$$
$$and \quad ^{234}_{92}U = \text{Daughter element}$$

3. Find the energy associated with the following reaction

$$^{14}_{7}N + {}^{4}_{2}He \rightarrow {}^{17}_{8}O + {}^{1}_{1}H$$

What does negative sign indicate? (C.W)

Sol: The given reaction is

$$^{14}_{7}N + {}^{4}_{2}He \rightarrow {}^{17}_{8}O + {}^{1}_{1}H$$

Energy required for reaction $= \Delta E = Q = ?$

The given reaction is

$$^{14}_{7}N + {}^{4}_{2}He \rightarrow {}^{17}_{8}O + {}^{1}_{1}H$$

Now

Mass defect $= \Delta m =$ (Mass of $^{14}_{7}N$ + Mass of $^{4}_{2}He$)−(Mass of $^{17}_{8}O$+ Mass of $^{1}_{1}H$)

$$\Delta m = (14.0031 + 4.00264) - (16.9991) + 1.0073)$$
$$\Delta m = 18.0057 - 18.0069$$
$$\Delta m = 0.0012\, u$$

Now energy is

$$\Delta E = \Delta m\,(931\ Me\,V) \qquad As\ 1u = 931\ Me\,V$$
$$\Delta E = -0.0012 \times 931$$
$$\Delta E = -1.12\ Me\,V$$

The negative sign shows that this energy is required to start this reaction.

4. Calculate the energy (in MeV) released in the following fusion reactiom? (C.W)

$$^{2}_{1}H + {}^{3}_{1}H \rightarrow {}^{4}_{2}He + {}^{1}_{0}n$$

Sol:

The given reaction is $^{2}_{1}H + {}^{3}_{1}H \rightarrow {}^{4}_{2}He + {}^{1}_{0}n$

Energy released $= \Delta E = ?$

The given reaction is

$$^{2}_{1}H + {}^{3}_{1}H \rightarrow {}^{4}_{2}He + {}^{1}_{0}n + Q$$

As Mass defect $= \Delta m =$ (Mass of $^{2}_{1}H$+Mass of $^{3}_{1}H$) − (Mass of $^{4}_{2}He$ + Mass of $^{1}_{0}n$)

$$= (2.014102 + 3.016050) - (4.002603 + 1.008665)$$
$$= 5.030152 - 5.011268$$
$$= 0.018884\ u$$
$$\Delta E = \Delta m \times 931\ MeV$$
$$\Delta E = 17.6\ MeV$$

5. The radiactive element $^{226}_{88}Ra$ has a half-life of 1.6×10^{3} years. Since the Earth is about 5 billion years old, how can you explain why we still can find this element in nature? (C.W)

Ans.

According to radioactive decay law

$$N = N_o e^{-\lambda t}$$

This equation shows that an infinite time (t) is required for an element to decay completely. That is why we still can find $^{226}_{88}Ra$ in nature.

6. Why must a Geiger Muller tube for detecting α −particles have a very thin end window? Why does a Geiger Muller tube for detecting γ −rays not need a window at all? (C.W)

Ans: α −particles

As the penetrating power of α −particles , due to its greater mass, is very small so a very thing windows is kept in GM-tube so that α −particles can penetrate into the tube.

γ −particle

Since the penetrating power of γ −particle is much greater so there is no need to keep window in the tube.

7. If you swallowed an α −source and a β −source, which would be the more dangerous to you? Explain why? (C.W)

Ans: α −source will be more dangerous than β −source.

Reason

It is because that the ionizing power of α − particle is greater than β −particle. So α − particle can cause more damage to our body.

Full Book Model Paper (Specimen)

(Class 12^{th}) Time : 20 Minutes

Objective Marks : 17

Note: You have four choices for each objective type question as A, B, C and D. The choice which you think is correct; fill that circle in front of that question numbr with marker or pen. Cutting of filling two or more circles will result in zero mark in that question.

1. Electric lines of forces are parallel and equally spaced, then electric field is:(2 times)

(A) Weak (B) Strong (C) Non-uniform (D) Uniform

2. IF a charged body is moved against the electric field, it will gain: (2 times)

(A) P.E (B) K.E (C) Mechanical energy (D) Electrical potential energy

3. $mho\ m^{-1}$is the SI unit of: (3 times)

(A) Conductivity (B) Conductance (C) Resistance (D) Capacitance

4. Temperature co-efficient of resistivity is measured in: (3 Times)

Ωk (B) Ωm (C) K^{-1} (D) K

5. The magnetic force is simply a: (4 Times)

(A) Reflecting force (B) Deflecting force (C) Restoring force (D) Gravitational force

6. Tesla can be written as: (3 times)

(A) NAm^{-1} (B) $NA^{-1}m^{-1}$ (C) $N^{-1}Am^{-1}$ (D) $NA^{-1}m$

7. The SI unit if induced emf is:

(A) Ohm (B) Tesla (C) Henry (D) Volt

8. If we make magnetic field stronger the value of induced current: (2 times)

(A) Decrease (B) Increase (C) Vanishes (D) Remains constant

9. The most common source of alternating voltage is: (2 Times)

(A) Motor (B) Transformer (C) AC generator (D) All of these

10. The sum of positive and negative peak values is called: (2 times)

(A) Average value (B) r m s value (C) peak value (D) P- P value

11. Curie temperature for iron is: (4 Times)

(A) 0 K (B) 750 k (C) 1023 k (D) 378 k

12. Out of the following which material is brittle: (2 Times)

(A) High carbon steel (B) Aluminum (C) Copper (D) Tungsten

13. The potential barrier for Ge at room temperature is: (4 Times)

(A) 0.3 volt (B) 3 volt (C) 1 volt (D) 5 volt

14. The potential barrier for silicon at room temperature is: (3 Times)

(A) 0.3 Volt (B) 0.4 Volt (C) 0.5 Volt (D) 0.7 Volt

15. The value of Stefan's constant is: (3 times)

(A) $5.67 \times 10^{-6}\ wm^{-2}k^{-4}$ (B) $5.67 \times 10^{-10}wm^{-2}k^{-4}$

(C) $5.67 \times 10^{-8}Wm^{-2}k^{-4}$ (D) $5.67 \times 10^{-4}wm^{-2}k^{-4}$

16. The energy of electron in the 4^{th} orbit of hydrogen atom is: (3 times)

(A)-2.51 ev (B) -3.50 ev (C) -13.6 ev (D) -0.85 ev

17. 1 U (unified mass scale) is equal to: (2 times)

(A)880 Mev (B) 931 Mev (C) 931 ev (D) 931 Kev

Full Book Model Paper (Specimen)

(Class 12th)
Subjective

Time : 2:40 Hours
Marks : 68

2. **Write short answers to any EIGHT parts.** (7 Times)
   - i. Write characteristics of electric field lines.
   - OR Write two properties of electric field lines. (24 times)
   - ii. Electric lines of force never cross why?
   - OR Comment on the uni-direction of electric lines of force.
   - iii. Define electric field intensity. What is its unit and direction? (2 times)
   - iv. Distinguish between electric field and field intensity. (2 times)
   - v. Why does the resistance of a conductor rise with a temperature? (11 times)
   - vi. Do bends in a wire effect its electrical resistance? (10 times)
   - vii. What is thermistor? Describe its two uses. (2 times)
   - viii. What is thermistor? Give its two applications. (2 Times)
   - ix. Define Tesla and write its formula. (2 times)
   - x. Define magnetic flux give its unit. (2 times)
   - xi. Define magnetic flux and magnetic flux density. (4 times)
   - xii. Define magnetic flux and solenoid.
3. **Write short answer to any EIGHT parts.**
   - i. Does the induced emf always act to decrease the magnetic flux through a circuit? (20 Time)
   - ii. Does the induced emf in a circuit depend upon the resistance of the circuit? Does the induced current depend on the resistance of the circuit? (10 Time)
   - iii. What is electromagnet? Mention two practical examples of electromagnet.
   - iv. A sinusoidal current has rms value of 10A. What is the maximum or peak value? (16 Times)
   - v. Differentiate between peak value and peak to peak value. (4 Times)
   - vi. What is the root mean square value of current? Explain. (2 times)
   - vii. Distinguish between crystalline and amorphous or glassy solids. (9 Times)
   - viii. Define unit cell. (3 Times)
   - ix. Define crystal lattice. (4 Times)
   - x. What is net charge on a n-type or p-type substances? (16 Times)
   - xi. Give four applications (or uses) of a photo diode. (2 Times)
   - xii. Define depletion region. (2 times)
4. **Write short answer to any SIX parts.**
   - i. As a solid is heated and begins to glow, why does it first appear red? (8 times)
   - ii. Which has the lower energy quanta, radio waves or X-rays? (8 times)
   - iii. Which has the lower energy quanta, radio waves or x-rays? Explain. (2 times)
   - iv. What do we mean when we say that the atom is excited? (16 times)
   - v. Explain how line spectrum can be used for the identification of elements.
   - vi. What is fluorescence?
   - vii. What do you mean by critical mass and critical volume? (8 times)
   - viii. Define mass defect and binding energy. (10 times)
   - ix. Show that $1\,u = 931\,MeV$ by using the relation $E = (\Delta m)c^2$. (3 times)

SECTION - II

Attempt any THREE questions. Each question carries 08 Marks.

5. (a) Define electric flux. Find electric flux through a surface enclosing charge. (3 times)
   What is electric flux? Explain
   (b) What is wheat stone bridge? Describe its construction and working. How can it be used to find the unknown resistance of a wire? (4 times)
6. (a) Derive expression for force on a moving charge in magnetic field? (3 Times)
   (b) Define motional emf and derive a relation for it. (4 Times)
7. (a) Draw the circuit diagram of (R-L-C) series resonance circuit. Discuss its behavior for A.C and also write down its properties.
   (b) What is meant by strain energy? Derive the relation for strain energy in a deformed material from the area under force extension graph. (4 Times)
8. (a) Define rectification. What are its types? Discuss half wave rectification. (4 times) (8 Times)
   (b) Define photoelectric effect. Give its explanation on the basis of Quantum theory.
9. (a) What are postulates of Bohr's model of the hydrogen atom? Show that radii of hydrogen atom are quantized? (4 Times)
   (b) Explain principle, construction and working of a Nuclear reactor. (3 times)

Full Book Model Paper (Specimen)

(Class 12th)
Objective

Time : 20 Minutes
Marks : 17

Note: You have four choices for each objective type question as A, B, C and D. The choice which you think is correct; fill that circle in front of that question numbr with marker or pen. Cutting of filling two or more circles will result in zero mark in that question.

1. The electric field created by positive charge is:- (2 times)
(a) Radially inward (b) Zero (c) Circular (d) radially outward

2. The unit of Electric intensity other than NC^{-1} is:- (2 times)
(a) V/A (b) V/m (c) V/C (d) N/V

3. IF fourth band is missing on resistance, its tolerance is: (2 Times)
(A) ± 5 % (B) ± 10 % (C) ± 15 % (D) ± 20 %

4. A rheostat can be used as: (2 times)
(A) Potential divider (B) Rectifier (C) Amplifier (D) Oscillator

5. Magnetic flux density is measured in: (2 times)
(A) Weber (B) Weber/m^2 (C) Tesla – m (D) Gauss

6. Work done on charged particle moving in uniform magnetic field is: (2 times)
(A) Maximum (B) Zero (C) Minimum (D) Negative

7. Emf is induced due to change in: (2 times)
(A) Charge (B) Current (C) Magnetic flux (D) Electric field

8. The notation for Henry is: (8 Times)
(A) $V.S^{-1}A$ (B) $N.m.A^{-1}$ (C) $V^{-1}.S.A$ (D) $V.S.A^{-1}$

9. The phase angle at +ve positive peak is: (3 times)
(A) $\frac{\pi}{2}$ (B) π (C) $\frac{3\pi}{2}$ (D) 2π

10. An A.C. Voltmeter reads 220 V, its peak value will be: (2 Times)
(A) 255 V (B) 340 V (C) 311.12V (D)300 V

11. Good conductor have conductivities of the order of: (4 Times)
(A) $10^{-7}(\Omega m)^{-1}$ (B) $10^{7}(\Omega m)^{-1}$ (C) $10^{2}(\Omega m)^{-1}$ (D) $10^{-2}(\Omega m)^{-1}$

12. The potential barrier for silicon is: (3 Times)
(A) 0.3 V (B) 0.5 V (C) 0.7 V (D) 0.8 V

13. A sensor of light is: (3 Times)
(A) Transistor (B) LED (C) Diode (D) Light dependent resistor

14. The central region of a transistor is called. (3 Times)
(A) Base (B) emitter (C) Collector (D) Neutral

15. When Platinum is heater, it becomes orange at: (2 times)
(a) 500^oC (b) 900^oC (c) 1100^oC (d) 1300^oC

16. In an electronic transition, an atom cannot emit: (4 Times)
(A) $\gamma - rays$ (B) Infrared rays (C) UV-rays (D) X-rays

17. Which of the following is similar to electron: (2 times)
(A) α -particle (B) β -particle (C) Neutrino (D) Photon

Full Book Model Paper (Specimen)

(Class 12th)
Subjective

Time : 2:40 Hours
Marks : 68

2. Write short answers to any EIGHT parts.

i. Is E necessary zero inside a charged rubber balloon if balloon is spherical? (7 Times)
ii. Give the statement of Gauss's law. Write down its mathematical form. (5 Times)
iii. Do electrons tends to go to region of high potential or low potential? (20 Times)
iv. Define electric potential and give its SI unit. (2 times)
v. Define temperature co-efficient of resistance and write its formula. (3 times)
vi. Describe a circuit that will give continuously varying potential. (8 times)
vii. Why the terminal potential difference of a battery decreases when the current drawn from it is increased? (5 times)
viii. What is short circuit and open circuit mean to you? (3 times)
ix. State ampere's law. Write down its formula. (3 times)
x. Why does the picture on a TV screen become distorted when a magnet is brought near the screen? (22 Times)
xi. How can you use a magnetic field to separate isotopes of chemical element? (19 Times)
xii. Define Lorentz Force. Write its formula. (12 Times)

3. Write short answer to any EIGHT parts.

i. Define induced emf and induced current. (4 Times)
ii. Define motional emf and write its formula. (2 times)
iii. State Faraday's law of electromagnetic induction. (9 Time)
iv. Define Instantaneous Value and Peak Value of Current. (2 times)
v. How many times per second will an incandescent lamp reach maximum brilliance when connected to a 50 Hz source? Explain. (10 Times)
vi. An AC voltmeter reads 250V. What is its peak value? (2 Time)
vii. Distinguish between Crystalline, Amorphous and Polymeric Solids. (7 Times)
viii. Distinguish between elasticity and plasticity. (3 Times)
ix. Define stress and strain. What are their SI units? (13 Times)
x. What is the effect of forward and reverse biasing of a diode on the width of depletion region? (8 Times)
xi. Differentiate between forward and reverse biasing. (3 Times)
xii. Explain why an ordinary Silicon diode does not emit light. (21 Times)

4. Write short answer to any SIX parts.

i. What are black body radiations and how can you get a black body? (2 times)
ii. Why don't we observe a Compton Effect with visible light? (15 times)
iii. Define ionization potential and excitation potential. (4 times)
iv. Define continuous spectra and line spectra.
v. Write two postulate of Bohr's model of H-atom. (7 Time)
vi. Write four uses of X-rays. (3 times)
vii. Why are heavy nuclei unstable? (18 times)
viii. A particle, which produces more ionization, is less penetrating. Why? (11 times)
ix. Why moderators are used in the core of nuclear reactor? (2 Time)

SECTION - II

Attempt any THREE questions. Each question carries 08 Marks.

5. (a) State Gauss's law. Derive relation for electric intensity at a point near an in infinite sheet of charge. **(4 times)**
(b) What is potentiometer? Give its construction and how can it be used to find unknown emf. **(2 times)**

6. (a) Explain how e/m (charge to mass ratio) for an electron is determined? **(4 Times)**
(b) State and prove the Faraday's law of electromagnetic induction. **(4 Times)**

7. (a) What are electromagnetic waves? Discuss principle of generation, transmission and reception of electromagnetic waves. **(5 Times)**
(b) What is the energy band theory? How behaviors of electrical conductors, Insulators and semi-conductors can be explained on the basis of energy band theory. **(12 Times)**

8. (a) What is a transistor? Describe the use of transistor as a amplifier and calculate its voltage gain. **(12 Times)**
(b) Define and explain Compton Effect.

9. (a) State the postulates of Bohr model of hydrogen atom and explain De-Broglie's interpretation of Bohr's orbit to show that $mvr = \frac{nh}{2\pi}$. **(3 Times)**
(b) What is a nuclear reactor? Describe its four important parts. **(3 times)**