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- Chapter-wise MCQs with solutions from Past Papers of Punjab Board
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- Chapter-wise Long Questions from Past Papers of Punjab Board
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Chapter – 1

BASIC CONCEPTS

SECTION I

Multiple Choice Questions

I) From Exercise:-

(i) Isotopes differ in:

(a) Properties which depend upon mass

(b) arrangement of electrons in orbitals

(c) chemical properties

(d) the extent to which they may be affected in electromagnetic field.

(ii) Which of the following statements is true?

(a) isotopes with odd atomic number are comparatively abundant.

(b) isotopes with odd atomic masses are comparatively abundant.

(c) isotopes with even atomic masses are comparatively abundant.

(d) isotopes with odd atomic masses are comparatively abundant.

(iii) Many elements have fractional atomic masses. This is because:

(a) the mass of the atom is itself fractional.

(b) atomic masses are average masses of isobars.

(c) atomic masses are average masses of isotopes.

(d) Atomic masses are average masses of isotopes proportional to their relative abundance.

(iv) 27g of AI will react completely with how much mass of O_2 to produce AI_2O_3:

(a) 8 g of oxygen (b) 16 g of oxygen

(c) 32 g of oxygen **(d) 24 g of oxygen**

(v) A limiting reactant is the one which:

(a) is taken in lesser quantity in grams as compared to other reactants.

(b) is taken in lesser quantity in volume as compared to the other reactants.

(c) gives maximum amount of the product which is required.

(d) gives the minimum amount of the product under consideration.

II) From Punjab Boards:-

1. Tin has isotopes: (LHR 2011)

(a) 7 (b) 9 **(c) 11** (d) 5

2. How many isotopes are present in palladium? (LHR 2013)

(a) four (b) five

(c) six (d) seven

3. 27 g of Al will react completely with how much mass of O_2 to produce Al_2O_3? (LHR 2013)

(a) 8 g of oxygen (b) 16 g of oxygen

(c) 32 g of oxygen **(d) 24 g of oxygen**

4. The number of carbon atoms in 22.0 g of CO_2 is: (LHR 2015 G-I)

(a) 3.01×10^{23} (b) 6.022×10^{23}

(c) 3.01×10^{22} (d) 6.02×10^{22}

5. The mass of two moles of electrons is: (LHR 2015 G-II)

(a) 1.10 mg (b) 1.008 mg

(c) 0.184 mg (d) 1.673 mg

6. 2.7 g of Al will react completely with how much mass of O_2 to produce Al_2O_3? (LHR 2015 G-II) (DGK G-I-17,18) (MTN-16) (FSD-16) (SGD-16-17)

(a) 0.5 g of oxygen (b) 1.6 g oxygen

(c) 3.2 g of oxygen **(d) 2.4 g of oxygen**

7. The mass of CO_2 containing 8 g of oxygen in grams is: (GRW 2011)

(a) 32 (b) 22 (c) 16 **(d) 11**

8. A limiting reactant is one which : (GRW 2014 G-II)

(a) is taken in lesser quantity in grams

(b) is taken in lesser quantity in volume

(c) gives maximum amount of product

(d) gives minimum amount of product

9. The percentage of nitrogen in ammonia is: (MTN 2013)

(a) 82.35% (b) 46.67%

(c) 92% (d) 78%

10. The number of isotopes of cadium is (MTN 2017)

(a) 6 (b) 7

(c) 5 **(d) 9**

11. Percentage of N_2 in NH_3 is: (FSD 2011)

(a) $\frac{14}{17} \times 100$ (b) $\frac{14}{34} \times 100$

(c) $\frac{3}{17} \times 100$ (d) $\frac{3}{34} \times 100$

12. Isotopes differ in number of: (FSD 2011)

(a) electron **(b) neutron**

(c) proton (d) proton number

13. A limiting reactant is the one which: (FSD 2012)

(a) is taken in .lesser quantity in grams as compared to other reactants

(b) is taken in lesser quantity in volume as compared to other reactant

(c) Gives the maximum amount of the product which is required

(d) Gives the minimum amount of the product under consideration

14. Isotopes differ in: (RWP 2015) (SGD 2015)

(a) Properties which depend upon mass

(b) Arrangement of electron in orbitals

(c) Chemical properties

(d) The extent to which they may be affected in electromagnetic field

15. The number of isotopes of Tin are: (SGD 2016) (SWL 2016)

(a) 6 (b) 9 **(c) 11** (d) 14

16. Cd has isotopes. (SWL 2017) (SGD 18)

(a) 3 (b) 4

(c) 5 **(d) 9**

III) From Entry Test:-

(1) The volume occupied by 5.4 g of N_2O_5 is:

(a) 2.24 dm^3 **(b) 1.12 dm^3**

(c) 22.4 dm^3 (d) 112 cm^3

(2) Vit-A has the formula $C_{20}H_{30}O$. How many molecules are present in 500 mg capsule?

(a) 6.02×10^{23} **(b) 1.05×10^{21}**

(c) 3.01×10^{22} (d) 3.01×10^{23}

(3) What is the mass of same number of atoms of potassium as are present in 11.5 grams of sodium?

(a) 19 grams **(b) 19.5 grams**

(c) 39 grams (d) 78 grams

(4) 16 g of H_2 reacts with 16 g of O_2. The mass of H_2O formed is:

(a) 4.5 g (b) 9 g **(c) 18 g** (d) 36 g

(5) How many sigma electrons are present in 9 grams of ice?

(a) $\frac{NA}{2}$ (b) NA **(c) 2NA** (d) 3NA

(6) Which one of the following is not the mono isotopic element:

(a) Arsenic **(b) Uranium**

(c) Iodine (d) Gold

(7) Percentage of oxygen in calcium carbonate is:

(a) 40% (b) 48% (c) 12% (d) 16%

(8) Which one of the following properties is always in whole number:

(a) Atomic mass (b) Atomic radius

(c) Atomic volume **(d) Atomic number**

(9) Which will weigh more:

(a) 2 mole N_2 (b) 1 mole O_3

(c) 2 mole O_2 **(d) 2 mole CO_2**

(10) The number of electrons in one mole of H_2 is:

(a) 6.02×10^{23} (b) 3.01×10^{23}

(c) 12.04×10^{23} (d) Indefinite

(11) The mass of 0.5 mole of sulphur is:

(a) 13 g **(b) 16 g** (c) 14 g (d) 27 g

(12) Number of neutrons in H_2SO_4.

(a) 50 **(b) 48** (c) 49 (d) 98

SECTION II

SHORT QUESTIONS

I) From Exercise:-

QUESTIONS

1. 23 g of sodium and 238 g of uranium have equal numbers of atoms in them. Justify.

Ans. According to Avogadro's Principle;

Number of atoms of an element

$$= \frac{\text{Mass of an element}}{\text{Molar mass of element}} \times N_A$$

Mass of sodium = 23g

Molar mass of sodium = 23 $g.mol^{-1}$

Number of atoms of Na = $\frac{23g}{23\ g.mol^{-1}} \times 6.02 \times 10^{23} = 6.02 \times 10^{23}$ atoms

Mass of uranium = 238g

Molar mass of uranium = 238 g.mol^{-1}

Number of atoms of U = $\frac{238g}{238\ g.mol^{-}} \times 6.02 \times 10^{23} = 6.02 \times 10^{23}$ atoms

So, proved that 23g of Na and 238g of U have equal number of atoms.

2. Mg atom is twice heavier than that of carbon. Explain.

Ans. 1 Mole of C = 12g

1 Mole of Mg = 24g

According to Avogadro's principle one mole of any element contains 6.02×10^{23} atoms. So we can say that.

C atoms : mass	Mg atoms : mass
6.02×10^{23} atoms of C = 12g	6.02×10^{23} atoms of Mg = 24g
1 atom of C = $\frac{12g}{6.02\times10^{23}}$	1 atom of C = $\frac{24g}{6.02\times10^{23}}$
$= 2 \times 10^{-23}$g	$= 4 \times 10^{-23}$g

Comparing both;

C : Mg

2×10^{-23}g : 4×10^{-23}g

Dividing with smaller value;

$\frac{2 \times 10^{-23}g}{2 \times 10^{-23}g} : \frac{4 \times 10^{-23}g}{2 \times 10^{-23}g}$

1 : 2

Hence one atom of Mg is twice heavier than that of C atom.

3. 180 g of glucose and 342 g of sucrose have the same number of molecules but different number of atoms present in them. Justify.

Ans. According to Avogadro's Principle;

Number of molecules of a substance = $\frac{\text{Mass of a substance}}{\text{Molar mass of the substance}} \times N_A$

Mass of glucose = 180g

Molar mass of glucose = 180 g.mol^{-1}

Number of molecules of glucose = $\frac{180g}{180\ g.mol^{-}} \times 6.02\times10^{23}$

$= 6.02\times10^{23}$ molecules

Mass of sucrose = 342g

Molar mass of sucrose = 342 g.mol^{-1}

Number of molecules of glucose = $\frac{342g}{342\ g.mol^{-}} \times 6.02\times10^{23}$

$= 6.02\times10^{23}$ molecules

So, 180 g of and 342 g of sucrose contain equal number of molecules.

i.e., 6.02×10^{23}

1 molecule of glucose ($C_6H_{12}O_6$) has

= 6 + 12 + 6 = 24 atoms

Hence,1 mole of glucose contain = $24 \times 6.02 \times 10^{23}$ atoms = 1.44×10^{25} atoms

Similarly,

1 molecule of sucrose ($C_{12}H_{22}O_{11}$) has

= 12 + 22 + 11 = 45 atoms

Hence,1 mole of sucrose contain

= $45\times6.02\times10^{23}$ atoms = 2.709×10^{25} atoms

therefore, both have different numbers of atoms.

4. 4.9 g of H_2SO_4 when completely ionized in water have equal number of positive and negative charges but the number of positively charged ions are twice the number of negatively charged ions. Justify.

Ans. Mass of H_2SO_4 = 4.9g

Molar mass of H_2SO_4 = 98 g/mole

No. of molecules of H_2SO_4 = $\frac{4.9g}{98\ g/mole} \times 6.02\times10^{23} = 3.01 \times 10^{22}$ molecules

H_2SO_4 ionizes in water as follows:

$$H_2SO_4 \rightleftharpoons 2H^+ + SO_4^{2-}$$

(i) Total Positive Ions:

H_2SO_4 : H^+

1 : 2

3.01×10^{22} : $2\times3.01\times10^{22} = 6.02\times10^{22}$ ions

(ii) Total Negative Ions:

H_2SO_4 : SO_4^{2-}

1 : 1

3.01×10^{22} : $3.01 \times 10^{22} = 3.01 \times 10^{22}$ ions

➢ So number of positive ions is twice than the negative ions.

(iii) Total Positive Charge:

Total Positive Charge=No. of +ve ions×charge on +ve ion

$$= 6.02 \times 10^{22} \times +1$$
$$= +6.02 \times 10^{22} \text{ units}$$

iv) Total Negative Charge:

Total Negative Charge=No. of −ve ions×charge on −ve ion.

$$= 3.01 \times 10^{22} \times -2$$
$$= -6.02 \times 10^{22} \text{ units}$$

➢ So the number of positive and negative charges are same.

5. One mg of K_2CrO_4 has thrice the number of ions than the number of formula units when ionized in water. Justify.

Ans. Mass of K_2CrO_4 = 1mg = 10^{-3}g

Molar mass of K_2CrO_4 = 194 g/mole

No. of formula units

$$= \frac{10^{-3}\text{g}}{194 \text{ g/mole}} \times 6.02 \times 10^{23}$$

$= 3.10 \times 10^{18}$ formula units

K_2CrO_4 ionizes in water as

$$K_2CrO_4 \rightleftharpoons 2K^+ + CrO_4^{2-}$$

According to Balanced Equation:

K_2CrO_4	:	Ions
1	:	3
3.10×10^{18}	:	$3 \times 3.10 \times 10^{18}$
	:	$\boxed{9.30 \times 10^{18}}$ Ans.

So,

1mg or 3.10×10^{18} formula units of K_2CrO_4 contain thrice (9.30×10^{18}) the number of ions.

6. Two grams of H_2, 16 g of CH_4 and 44 g of CO_2 occupy separately the volumes of 22.414 dm^3, although the sizes and masses of molecules of three gases are very different from each other. Justify.

Ans. 2g of H_2 = 1 mole of H_2 = 6.02×10^{23} molecules

16gof CH_4 = 1 mole of CH_4=6.02×10^{23} molecules

44g of CO_2 = 1 mole of CO_2=6.02×10^{23} molecules

The given amount of each gas is equal to one mole of that gas. *"According to the concept of molar volume, one mole of any gas at STP occupies a volume of 22.414dm^3."*

The volume occupied by a gas does not depend on the size and mass of gas molecules and it only depend on the number of molecules. As 1 mole of all gases have same number of molecules, so they occupy same volume which is 22.414 dm^3.

7. Calculate : Mass in grams of 2.74 moles of $KMnO_4$:

Ans. Mass in grams of 2.74 moles of $KMnO_4$:

Data:

Mass of $KMnO_4$ = ?

No. of moles of $KMnO_4$ = 2.74 moles

Molar mass of $KMnO_4$ = (39) + (55) + (16 × 4)

$= 158\text{g mol}^{-1}$

Using Formula:

$$\text{No. of moles} = \frac{\text{Mass of } KMnO_4}{\text{Molar Mass}}$$

Mass of $KMnO_4$ = No. of moles × Molar mass

$= 2.74 \text{ moles} \times 158\text{g.mol}^{-1}$

$= \boxed{432.92\text{g}}$

8. Calculate: Moles of Oxygen atoms in 9.00g of $Mg(NO_3)_2$:

Ans. Moles of Oxygen atoms in 9.00g of $Mg(NO_3)_2$:

Data:

Mass of $Mg(NO_3)_2$ = 9.00g

Molar mass of $Mg(NO_3)_2$= (24)+(14×2)+(16×6)

$= 148\text{g.mol}^{-1}$

To Find:

No. of moles of O atom= ?

Step I: Calculate no. of moles of $Mg(NO_3)_2$:

$$\text{No. of moles of } Mg(NO_3)_2 = \frac{\text{Mass of } Mg(NO_3)_2}{\text{Molar Mass}}$$
$$= \frac{9.00\text{g}}{148.0\text{g.mol}^{-1}}$$
$$= 0.06 \text{ moles}$$

Step II: Calculate no. of moles of O atoms.

$Mg(NO_3)_2$	:	O atoms
1	:	6
0.06	:	6 × 0.06
		= 0.36 Ans

So, 9.00g of $Mg(NO_3)_2$ contain 0.36 moles of O atoms.

9. Calculate: No. of Oxygen atoms in 10.037g of $CuSO_4.5H_2O$:

Ans. No. of Oxygen atoms in 10.037g of $CuSO_4.5H_2O$:

Data:

Mass of $CuSO_4 . 5H_2O$ = 10.037g

Molar mass of $CuSO_4.5H_2O$ = (63.5)+(32)+(16×4)+(5× 18)

= 249.5g.mol^{-1}

To Find:

No. of O atom = ?

Step I: Calculate the No. of formula units of $CuSO_4.5H_2O$

$$\text{No. of particles} = \frac{\text{Mass of } CuSO_4 . 5H_2O}{\text{Molar Mass}} \times N_A$$

$$= \frac{10.037g}{249.5g.mol^{-1}} \times 6.02 \times 10^{23}$$

$$= 2.42 \times 10^{22} \text{ formula units}$$

Step II: Find out no. of O atoms:

$CuSO_4 . 5H_2O$	:	O atoms
1	:	9
2.42×10^{22}	:	$9 \times 2.42 \times 10^{22}$

= 2.18×10^{23} atoms **Ans.**

So, 10.037g of $CuSO_4.5H_2O$ contain 2.18×10^{23} atoms of oxygen.

10. Calculate: Mass in kilogram of 2.6×10^{20} molecules of SO_2:

Ans. Mass in kilogram of 2.6×10^{20} molecules of SO_2:

Data:

No. of molecules of SO_2 = 2.6×10^{20}

Molar mass of SO_2 = (32)+ (16 × 2)

= 64g.mol^{-1}

To Find:

Mass of SO_2 in kg. = ?

Solution:

$$\text{No. of molecules of } SO_2 = \frac{\text{Mass of } SO_2}{\text{Molar Mass}} \times N_A$$

$$\text{Mass of } SO_2 = \frac{\text{No. of molecules} \times \text{Molar mass}}{N_A}$$

$$= \frac{2.6 \times 10^{20} \times 64g.mol^{-1}}{6.02 \times 10^{23}}$$

$$= 2.764 \times 10^{-2}g$$

To convert it into kilogram.

$$\text{Mass of } SO_2 \text{ in kg.} = \frac{2.764 \times 10^{-2}}{1000}$$

= **2.764×10^{-5} kg.** **Ans.**

11. Calculate : Moles of Cl atoms in 0.822g of $C_2H_4Cl_2$

Ans. Moles of Cl atoms in 0.822g of $C_2H_4Cl_2$:

Data:

Mass of $C_2H_4Cl_2$ = 0.822g

Molar mass of $C_2H_4Cl_2$=(12×2)+(1×4)+(35.5×2)

= 99g mol^{-1}

To Find:

No. of moles of Cl atoms = ?

Step I: Calculate the No. of Moles of $C_2H_4Cl_2$.

No. of moles of $C_2H_4Cl_2$

$$= \frac{\text{Mass of } C_2H_4Cl_2}{\text{Molar Mass}} = \frac{0.822g}{99g.mol^{-1}}$$

= 8.30×10^{-3} moles

Step II:

Calculate the No. of moles of Cl atoms.

$C_2H_4Cl_2$	:	Cl
1	:	2
8.30×10^{-3}	:	$2 \times 8.3 \times 10^{-3}$

= **0.0166 moles of Cl atom** **Ans.**

12. Calculate : Mass in grams of 5.136 moles of Ag_2CO_3

Ans. Mass in grams of 5.136 moles of Ag_2CO_3:

Data:

No. of moles of Ag_2CO_3 = 5.136 moles

Molar mass of Ag_2CO_3 = (107.87×2)+(12)+(16×3)

= 275.74 g.mol^{-1}

To Find:

Mass of Ag_2CO_3 in grams= ?

Solution:

$$\text{No. of moles} = \frac{\text{Mass of } Ag_2CO_3}{\text{Molar Mass}}$$

Mass of Ag_2CO_3 = No. of moles×Molar mass

= 5.136×275.74 g.mol^{-1}

Mass of Ag_2CO_3 = **1416.2g** **Ans.**

13. Calculate: Mass in grams of 2.78×10^{21} molecules of CrO_2Cl_2.

Ans. Mass in grams of 2.78×10^{21} molecules of CrO_2Cl_2:

Data:

No. of molecules of CrO_2Cl_2=2.78×10^{21} molecules

Molar mass of CrO_2Cl_2=(52)+(16×2)+(35.5×2)

= 155 g.mol^{-1}

To Find:

Mass of CrO_2Cl_2 in grams = ?

Solution:

$$\text{No. of molecules} = \frac{\text{Mass of } CrO_2Cl_2}{\text{Molar Mass}} \times N_A$$

$$\text{Mass of } CrO_2Cl_2 = \frac{\text{No. of molecules} \times \text{Molar Mass}}{N_A}$$

$$= \frac{2.78 \times 10^{21} \times 155 \text{ g.mol}^{-}}{6.02 \times 10^{23}}$$

$$= \boxed{0.7158 \text{ g}} \quad \text{Ans.}$$

14. Calculate: No. of moles and formula units in 100g of $KClO_3$:

Ans. No. of moles and formula units in 100g of $KClO_3$:

Data:

Mass of $KClO_3$ = 100g

Molar mass of $KClO_3 = (39) + (35.5) + (16 \times 3)$

$= 122.5 \text{ g.mol}^{-1}$

To Find:

(i) No. of Moles = ?

Solution:

$$\text{No. of moles} = \frac{\text{Mass of } KClO_3}{\text{Molar Mass}}$$

$$= \frac{100\text{g}}{122.5 \text{ g.mol}^{-1}}$$

$$= 0.816 \text{ moles}$$

(ii) No. of formula units = ?

No. of formula units = No. of moles $\times N_A$

$= 0.816 \times 6.02 \times 10^{23}$

$= \boxed{4.91 \times 10^{23} \text{ formula units}}$ **Ans.**

15. Calculate: No. of K^+ ions, ClO_3^{-1} ions, Cl atoms and O atoms in (h):

Ans. No. of K^+ ions, ClO_3^{-1} ions, Cl atoms and O atoms in (h):

(i) No. of K^+ Ions:

$KClO_3$	:	K^+
1	:	1
4.91×10^{23}	:	$1 \times 4.91 \times 10^{23}$

$= \boxed{4.91 \times 10^{23} \text{ } K^+ \text{ ions}}$ **Ans.**

(ii) No. of ClO_3^{-1} Ions:

$KClO_3$	:	ClO_3^{-1}
1	:	1
4.91×10^{23}	:	$1 \times 4.91 \times 10^{23}$

$= \boxed{4.91 \times 10^{23} \text{ } ClO_3^{-1} \text{ ions}}$ **Ans.**

(iii) No. of Cl Atoms:

$KClO_3$	:	Cl
1	:	1
4.91×10^{23}	:	$1 \times 4.91 \times 10^{23}$

$= \boxed{4.91 \times 10^{23} \text{ Cl atoms}}$

Ans.

(iv) No. of O Atoms:

$KClO_3$	:	O
1	:	3
4.91×10^{23}	:	$3 \times 4.91 \times 10^{23}$

$= \boxed{1.47 \times 10^{24} \text{ 0 atoms}}$ **Ans.**

16. Law of conservation of mass has to be obeyed during Stoichiometric calculations.

Ans. According to law of conservation of mass, *"Mass can neither be created nor destroyed during the chemical reaction but it changes from one form to another"*. We can say from the above definition that in a chemical reaction the mass of the reactants is always equal to the mass of the products, e.g.

$$NaOH + HCl \longrightarrow NaCl + H_2O$$

40g 36.5g 58.5g 18g

So while doing stoichiometric calculations law of conservation of mass has to be obeyed.

17. Many chemical reactions taking place in our surrounding involve the limiting reactants.

Ans. The reactant which is consumed earlier and hence produces least amount of the product in a chemical reaction is called limiting reactant. Many reactions taking place in our surrounding involve limiting reactants,

Examples;

(i) Combustion of Natural Gas:

$$CH_{4(g)} + 2O_{2(g)} \longrightarrow CO_{2(g)} + 2H_2O_{(l)}$$

(ii) Combustion of Coke:

$$C_{(s)} + O_{2(g)} \longrightarrow CO_{2(g)}$$

In both examples O_2 gas is present in very large excess while C and CH_4 are consumed earlier and hence they are limiting reactants.

18. No individual neon atom in the sample of the element has a mass of 20.18 amu.

Ans. Neon element has three isotopes $_{10}Ne^{20}$, $_{10}Ne^{21}$, $_{10}Ne^{22}$ and their % age abundances are 90.92%, 0.257% and 8.82% respectively. While 20.18 amu is the average atomic mass of all the isotopes of neon according to their % age abundance.

$$\text{Average atomic mass} = \frac{(\text{Mass of } {}^{20}\text{Ne} \times \%\text{age}) + (\text{Mass of } {}^{21}\text{Ne} \times \%\text{ age}) + (\text{Mass of } {}^{22}\text{Ne} \times \%\text{age})}{100}$$

$$= \frac{(20 \times 90.92) + (21 \times 0.257) + (22 \times 8.82)}{100}$$

= 20.18amu

Hence no individual atom in the sample has a mass of 20.18 amu.

19. One mole of H_2SO_4 should completely react with two moles of NaOH. How does Avogadro's number help to explain it?

Ans. One mole of H_2SO_4 ionizes in water to produce 2 mole of H^+ ion as.

$$H_2SO_{4(aq)} \rightleftharpoons 2H^+_{(aq)} + SO^{2-}_{4(aq)}$$

While, one mole of NaOH ionizes in water and produce only one mole of OH^{-1} ions.

$$NaOH_{(aq)} \rightleftharpoons Na^+_{(aq)} + OH^-_{(aq)}$$

The neutralization reaction can be shown as follows

$$H^+_{(aq)} + OH^-_{(aq)} \longrightarrow H_2O_{(l)}$$

In a neutralization reaction one mole of H^+ ions (i.e. 6.02×10^{23}) from an acid combines with one mole of OH^{-1}(i.e. 6.02×10^{23}) ions from a base to form one mole of water as.

Now in order to neutralize two moles of H^+ ions of H_2SO_4, we need two moles of NaOH which give two moles of OH^- ions.

So,

$$2NaOH_{(aq)} \rightleftharpoons 2Na^+_{(aq)} + 2OH^-_{(aq)}$$

Hence,

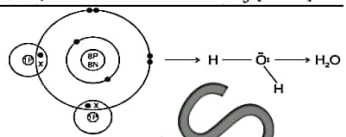
$$2H^+_{(aq)} + 2OH^-_{(aq)} \rightleftharpoons 2H_2O_{(l)}$$

Hence one mole of H_2SO_4 should completely react with two moles of NaOH.

20. One mole of H_2O has two moles of bonds, three moles of atoms, ten moles of electrons and twenty-eight moles of the total fundamental particles present in it.

Ans. Water molecule is formed when two atoms of hydrogen combine with one atom of oxygen as.

$${}_8O^{16} = 8p + 8e + 8n \qquad {}^1_1H = 1p + 1e$$



➢ According to Avogadro,s principle,1 mole of water H_2O contains 6.02×10^{23} molecules.

i) Bonds; 1 molecule of water contain 2 bonds.

H_2O molecules	:	bonds
1	:	2
6.02×10^{23}	:	$2 \times 6.02 \times 10^{23}$
	:	1.204×10^{24} (2 mole) Ans.

ii) Atoms; 1 molecule of water contain 3 atoms.

H_2O molecules	:	atoms
1	:	3
6.02×10^{23}	:	$3 \times 6.02 \times 10^{23}$
		1.806×10^{24} (3 mole) Ans.

iii) Electrons; 1 molecule of water contain 10 electrons. ($8e^-$ of O + $2e^-$ of H)

H_2O molecules	:	electrons
1	:	10
6.02×10^{23}	:	$10 \times 6.02 \times 10^{23}$
		6.02×10^{24} (10 mole) Ans.

iv) Fundamental particles; (1 molecule of water contain 28 electrons. [O $(8p+8e^-+8n)+2H(2p+2e^-)$]

H_2O molecules	:	fundamental particles
1	:	28
6.02×10^{23}	:	$28 \times 6.02 \times 10^{23}$
	:	16.8×10^{24} (28 mole) Ans.

21. N_2 and CO have the same number of electrons protons and neutrons.

Ans.

N_2	CO
Atomic No. of N is 7. $_7N^{14} = 7p + 7n + 7e^-$ One molecule of nitrogen contain two nitrogen atoms, The total number of protons electrons and neutrons be calculated as.	Atomic No. of C is 6 and O is 8. $_6C^{12} = 6p + 6n + 6e^-$ $_8O^{16} = 8p + 8n + 8e^-$ One molecule of carbon monoxide contains one carbon and one oxygen atom.

$^{14}_{7}N = 7p+7n+7e$	$^{12}_{6}C = 6p+6n+6e^-$
$^{14}_{7}N = 7p+7n+7e^-$	$^{16}_{8}O = 8p+8n+8e^-$
$N_2 = 14p+14n+14e^-$	$CO = 14p+14n+14e^-$

So N_2 and CO have same number of electrons, protons and neutrons.

II) From Punjab Boards:-

1. Define limiting reactant. Give an example.
(LHR 2011) (SWL 2013) (AJK 2016)
(BWP 2017) (FSD 2014) (MTN 2016, 18)

Ans. Limiting Reactant:

Definition:

"Limiting reactant is a reactant that controls the amount of the product formed in a chemical reaction due to its smaller amount."

Example:

Consider the reaction between hydrogen and oxygen to form water

$$2H_2 + O_2 \longrightarrow 2H_2O$$

In this above equation, hydrogen is a limiting reactant.

2. Explain mathematical relationship for m/e of an ion in mass spectrometry. (LHR 2011)

Ans. Mathematical relationship for m/e ion in mass spectrometry:

The mathematical relationship for m/e is;

$$\frac{m}{e} = \frac{H^2 r^2}{2E}$$

Where H is the strength of magnetic field, E is the strength of electrical field, r is the radius of circular path. If E is increased, by keeping constant then radius will increase and positive ion of a particular m/e will fall at a different place as compared to first place.

3. Mg atom is twice heavier than that of carbon atom. Comment.
(LHR 2011) (BWP 2016, 18)
(GRW 2011, 14, 17)

Ans. The atomic mass of Mg is 24 g mol^{-1} which is twice in mass as compared to the atomic mass of C i.e. 12g mol^{-1}. So Mg is twice heavier than that of carbon.

4. Why theoretical field is greater than actual yield? (RWP 2012, 17, 18) (BWP 2011, 12)
(LHR 2013, 2015) (FSD 2016) (SGD 2017)

Ans. Theoretical yield is greater than actual yield because it is the amount of product calculated from balanced chemical equation.

5. What is mass spectrum? (LHR, GRW 2013)

Ans. Mass Spectrum:

"The distribution of ions shown by the use of a mass spectrograph or mass spectrometric is called as mass spectrum."

6. No individual neon atom in the sample of the element has a mass of 20.18 amu.
(LHR 2014) (BWP 2012)(FSD 2012)
(DGK GI,II-2016) (GRW 2014)

Ans. Neon has three isotopes of atomic masses 20, 21 and 22 with relative abundances as 90.92%, 0.26% and 8.82%

The relative atomic mass of neon, comes out to be 20.18 a.m.u. So, 20.18 a.m.u is the average atomic mass of all the three isotopes and there is no atom of Ne with this atomic mass.

$$\text{Average atomic mass} = \frac{(20\times 90.92)+(21\times 0.26)+(22\times 8.82)}{100}$$

Average atomic mass = 20.18 a.m.u.

7. Give assumptions of stoichiometry.
(LHR 2014, 18)

Ans. Assumption of Stoichiometry:

When stoichiometeric calculations are performed; we have to assume the following conditions:

1. All the reactants are completely converted into the products.
2. No side reaction occurs.
3. No by – product is formed.
4. No reversibility of the reaction.

8. Calculate the mass in kg of 2.6×10^{20} molecules of SO_2.
(LHR 2014) (RWP 2016 GP-I)

Ans. Given:

No. of SO_2 molecules = 2.6×10^{20}

Molar mass of SO_2 = 64 g mol^{-1}

Mass in kg = ?

Mass of SO_2 molecules

$$= \frac{\text{Molar mass}}{N_A} \times \text{No. of molecules}$$

$$= \frac{64}{6.02 \times 10^{23}} \times 2.6 \times 10^{20}$$

$$= 27.641 \times 10^{-3}\ g$$

$$= \frac{27.641 \times 10^{-3}}{1000}$$

$$= 27.641 \times 10^{-3} \times 10^{-3}$$

$$= 2.7641 \times 10^{-2-3}$$

Mass of SO_2 molecule $= 2.7641 \times 10^{-5}$ kg

9. What is Avogadro's number? Give equations to relate the Avogadro's number and mass of element?
(LHR 2015) (DGK 2016 GP-II) (SWL 2016 GP-I)

Ans. Avogadro's Number:

It is the number of atom, molecules and ions in one gram atom of an element, one gram molecule of a compound and one gram ion of a substance respectively.

quations to relate avogadro's no. and mass of element:

i. No. of atoms of an element
$$= \frac{\text{Mass of element} \times N_A}{\text{atomic mass}}$$

ii. No. of molecules of compound
$$= \frac{\text{Mass of compound} \times N_A}{\text{Molecular mass}}$$

iii. No. of ions of an ionic specie
$$= \frac{\text{Mass of ion} \times N_A}{\text{Ionic mass}}$$

iv. No of formula units of ionic compound
$$= \frac{\text{Mass} \times NA}{\text{Formula mass}}$$

10. N_2 and CO_2 have the same number of electrons protons and neutrons. Justify it.
(LHR 2016 GP-I,II)(GRW 2014) (BWP 2014) (SGD 2016) (AJK 2016)

Ans.

N_2	CO
Atomic No. of N is 7. $_7N^{14} = 7p + 7n + 7e^-$ One molecule of nitrogen contain two nitrogen atoms. The total number of protons electrons and neutrons be calculated as.	Atomic No. of C is 6 and O is 8. $_6C^{12} = 6p + 6n + 6e^-$ $_8O^{16} = 8p + 8n + 8e^-$ One molecule of carbon monoxide contains one carbon and one oxygen atom.
$^{14}_{7}N = 7p+7n+7e$	$^{12}_{6}C = 6p + 6n + 6e^-$
$^{14}_{7}N = 7p+7n+7e^-$	$^{16}_{8}O = 8p + 8n + 8e^-$
$N_2 = 14p+14n+14e^-$	$CO = 14p + 14n + 14e^-$

11. Calculate the number of moles of O atoms in 9.00 gram of $Mg(NO_3)_2$.
(LHR 2016 GP-I)

Ans. Moles of Oxygen atoms in 9.00g of $Mg(NO_3)_2$:

Data:

Mass of $Mg(NO_3)_2$ $= 9.00g$

Molar mass of $Mg(NO_3)_2$

$= (24) + (14 \times 2) + (16 \times 6)$

$= 148 g.mol^{-1}$

To Find:

No. of moles of O atom = ?

Step I: Calculate no. of moles of $Mg(NO_3)_2$:

No. of moles of $Mg(NO_3)_2$ = $\frac{\text{Mass of } Mg(NO_3)_2}{\text{Molar Mass}} = \frac{9.00g}{148.0 g.mol^{-1}}$

$= 0.06$ moles

Step II: Calculate no. of moles of O atoms.

$Mg(NO_3)_2$	:	O atoms
1	:	6
0.06	:	6×0.06
		$= 0.36$ Ans

So, 9.00g of $Mg(NO_3)_2$ contain 0.36 moles of O atoms.

12. N_2 and CO have the same number of electrons, protons and neutrons. Give reason. (GRW 2012)

Ans.

N_2	7 + 7 = 14	7 + 7 = 14	7+7=14
CO	6 + 8 = 14	6 + 8 = 14	6+8=14

13. Why law of conservation of mass has to be obeyed during stoichiometric calculations? (GRW 2016)

Ans. According to law of conservation of mass, *"Mass can neither be created nor destroyed during the chemical reaction but it changes from one form to another"*. We can say from the above definition that in a chemical reaction the mass of the reactants is always equal to the mass of the products, e.g.

$$\underset{40g}{NaOH} + \underset{36.5g}{HCl} \longrightarrow \underset{58.5g}{NaCl} + \underset{18g}{H_2O}$$

So while doing stoichiometric calculations law of conservation of mass has to be obeyed.

14. Why many chemical reactions taking place in our surroundings involve the limiting reactant? (GRW 2016)

Ans. The reactant which is consumed earlier and hence produces least amount of the product in a chemical reaction is called limiting reactant.

Many reactions taking place in our surrounding involve limiting reactants,

Examples;

(i) Combustion of CH_4:

$$CH_{4(g)} + 2O_{2(g)} \longrightarrow CO_{2(g)} + 2H_2O_{(l)}$$

(ii) Combustion of Coke:

$$C_{(s)} + O_{2(g)} \longrightarrow CO_{2(g)}$$

In both examples O_2 gas is present in very large excess while C and CH_4 are consumed earlier and hence they are limiting reactants.

15. Calculate: Mass in grams of 2.74 moles of $KMnO_4$: (GRW 2017) (SWL 2016)

Ans. Mass in grams of 2.74 moles of $KMnO_4$:

Data;

Mass of $KMnO_4$ = ?

No. of moles of $KMnO_4$ = 2.74 moles

Molar mass of $KMnO_4 = (39)+(55)+(16\times4)$

$= 158 g\ mol^{-1}$

Using Formula:

$$\text{No. of moles} = \frac{\text{Mass of } KMnO_4}{\text{Molar Mass}}$$

$$\text{Mass of } KMnO_4 = \text{No. of moles} \times \text{Molar mass}$$

$$= 2.74 \text{ moles} \times 158 g.mol^{-1}$$

$$= \boxed{432.92 g}$$

16. Define relative abundance of isotopes, How it is determined? (MTN 2013,14,17)

Ans. (i) The relative abundance of the isotopes of elements can be determined by mass spectrometry. In this technique, an elements is first volatized and then ionized with the help of high energy beam of electrons. The gaseous positive ions are separated on the basis of their mass to charge (m/e) & then recorded in the form of peaks. These peaks gives the relative abundance of isotopes.

(ii) The percentage occurrence of on isotope of an element as compared to all other its isotopes are known as relative abundance.

17. By using a balanced chemical equation, what type of relationship can be studied? (MTN2018)

Ans. By using a balance chemical equation, the following type of relationship can be studied.

(a) Mass-mass relationship

(b) Mass-mole relationship or mole-mass relationship.

(c) Mass-volume relationship

(d) Mole-mole calculation

18. Define gram formula. Give two example. (MTN 2017)

Ans. Gram Formula:

The formula unit mass of an ionic compound expressed in grams is called gram formula of the substance. e.g.

1 gram formula of NaCl = 58.5g

1 gram formula of $AgNO_3$ = 170g

19. What is Stoichiometry? Give its two assumptions. (MTN 2017)

Ans. Stoichiometry:

Stoichiometry is a branch of chemistry which tells us the quantitative relationship between reactants and products in a balanced chemical equation.

Two Assumptions:

There are following two assumptions of stoicheometry:

(a) All the reactants are completely converted into products.

(b) No side reaction occurs.

20. Calculate no. of gram atoms of Na when it mass is 0.1kg. At mass of Na = 23g mol^{-1}. (BWP 2016, 17)

Ans. Mass of sodium = 0.1 kg = 100g.

Atomic mass of sodium = 23 g/mol

$$\text{Gram atoms of Na} = \frac{m}{M} = \frac{100}{23} = 4.347$$

21. How many molecules of H_2O is present when its amount is 0.25 moles? (BWP 2011)

Ans. $0.25 \times 6.02 \times 10^{23} = 1.5 \times 10^{23}$ molecules.

22. 11 gm of carbon is reacted with 32 gm of O_2 to give CO_2, which one is the limiting reactant? (FSD 2013)

Ans. Carbon is limiting reactant.

Ans.

One atom of N has	One atoms of C has
Protons = 7	Protons = 6
Neutrons = 7	Neutrons = 6
Electrons = 7	Electrons = 6
One mole of N_2 has	One atoms of O has
Proton = 14	Protons = 8
Neutrons = 14	Neutrons = 8
Electrons = 14	Electrons = 8

One molecule of CO has protons, Neutrons and Electrons = 14 each.

23. Differentiate between actual and theoretical yields. (FSD 2016 GP-II)

Ans. Actual yield: The amount of product obtained practically during chemical reaction called actual yield.

Theoretical yield: The amount of products calculated from balanced chemical equation is called theoretical yield.

24. Define mole and molar volume. (FSD 2016 GP-II)

Ans. Atomic mass of an element expressed in grams is called mole e.g one mole of carbon is 12g.

Molar volume: One mole of any gas at standard temperature and pressure (STP) occupies a volume of 22.414 dm^3. e.g., 2.016g of H_2 = 1 mole of H_2 = 6.02×10^{23} molecules of H_2 = 22.414 dm^3 of H_2.

25. Calculate the number of CO_2 molecules in 20.0 grams of it. (RWP 2012, 14)

Ans. mole of CO_2 $= \frac{20}{44}$

mole of CO_2 $= 0.45$

No. of molecule of $CO_2 = 0.45 \times 6.022 \times 10^{23}$

2.73×10^{23} molecules ans.

26. What are monoisotoipic elements? Give examples. (RWP 2013)(DGK 2019)

Ans. Some elements have only a single isotope they are called monoisotopic elements, e.g Arsenic, fluorine, Gold and iodine etc.

27. Write down two stoichiometric assumptions? (RWP 2013)

Ans. Stochiometric assumptions are:

(i) Reactions completely change into products

(ii) No side reaction occur

28. Why in an experimental work one or more reactant is/are deliberally used in excess quantity? (RWP 2011, 12)

Ans. We use one or more reactants deliberally because

(i) They decrease loss of expansive material

(ii) They make the reaction faster and faster

(iii)They make the reaction 100% complete.

29. Define stoichiometry. Give two stoichiometric assumptions. (SGD 2016, 18)

Ans. Stoichiometry:

Stoichiometry is a branch of chemistry which tells us the quantitative relationship between reactants and products in a balanced chemical equation.

The basic assumptions of stachiometery are.

→ All reactants are converted into products.

→ No side reaction takes place.

→ No by product is formed

→ No reversibility of reaction

30. How many molecules of water are there in 10g of ice. (SGD 2016)

Ans. Mass of ice = 9g

No of mole of water $= \frac{\text{mass of } H_2O}{\text{molar mass}}$

No of mole of H_2O $= \frac{10}{18}$

No of mole of H_2O = 0.55 mole

No of molecules of $H_2O = 0.55 \times 6.02 \times 10^{23}$

$= 3.31 \times 10^{23}$ molecules

31. Calculate the mole of chlorine atoms in 0.822 grams of $C_2H_4Cl_2$. (DGK 2012)

Ans. Molecular mass of $C_2H_4Cl_2$

$\equiv 24 + 4 + 71 \equiv 99$g of $C_2H_4Cl_2$ contain.

Moles of Cl = 2

1 moles of Cl $= \frac{2}{99}$

0.822 moles of Cl = $\frac{2}{99} \times 0.82 = 0.017$ moles

32. N_2 and CO have same number of electrons, protons neutrons. (DGK 2012)

Ans.

	ELECTRON	PROTONS	NEUTRONS
C	6	6	6
N	7	7	7
O	8	8	8
N_2	14	14	14
CO	14	14	14

33. Define molecule with examples. (DGK 2014 G-II)

Ans. A molecule is a smallest particle of a pure substance which can exist independently.
For example Cl_2 He, O_2

34. Define molar volume with example. (DGK 2014 G-II)

Ans. One mole of any gas at standard temperature and pressure (STP) occupies a volume of 22.414dm³. This volume is called molar volume. This is true only for ideal gases. For example volume of 2.016g of H_2 is 22.414 dm³. Similarly 1g of CH_4 (1mole) has the volume of 22.414 dm³.

35. Give the reasons to explain that actual yield is less than theoretical yield. (DGK 2014 G-II)

Ans. Actual yield is less than theoretical yield because

i. Many processes like filtration, separation by distillation, washing, drying and crystallization decrease the theoretical yield because it is not carried out properly.
ii. Some reactants take part in competing side reactions.
iii. Sometimes reaction is reversible.

36. How can the efficiency of a chemical reaction be expressed? (SWL 2013)

Ans. 1.The efficiency of a reaction is expressed by comparing the actual and theoretical yield in the form of percentage (%) yield.

$$\% \text{ yield} = \frac{\text{Actual yield}}{\text{theoretical yield}} \times 100$$

37. Define stoichiometry and Molar volume. (SWL 2013)

Ans. Stoichiometry:

Stoichiometry is a branch of chemistry which tells us the quantitative relationship between reactants and products in a balanced chemical equation.

Molar Volume:

One mole of any gas at standard temperature and pressure (STP) occupies a volume of 22.414 dm^3. The volume of 22.414 dm^3 is called molar volume and it is true only when the gas is ideal.

38. Differentiate between gram atom and gram molecule. (AJK 2016, 18)

Ans.

	Atom	Molecule
i)	An atom is the smallest particle of an element which can take part in a chemical reaction. e.g., Hydrogen (H), Carbon (C).	Molecule is the smallest particle of an element or compound which can exist as an independent unit, e.g., hydrogen gas (H_2), methane (CH_4).
ii)	It may or may not exist independently.	It always exists in nature independently.
iii)	An atom always contains only one nucleus in its center.	A molecule contains one or more than one nuclei in their center.

SECTION III

LONG QUESTIONS

1. Calculate the number of grams of K_2SO_4 and water produced when 14g of KOH are reacted with excess of H_2SO_4. Also calculate the number of molecules of water produced:

(LHR 2011) (RWP 2016) (DGK 2011)

$$2KOH\ (aq) + H_2SO_4(aq) \rightarrow K_2SO_4(aq) + 2H_2O\ (l)$$

(At. mass K = 39 g mol^{-1}, S = 32, O = 16)

2. What is difference between actual yield and the theoretical yield? Why actual yield is less than theoretical yield?

(LHR 2012) (FSD 2014)

3. Calculate the number of grams of Al_2S_3 which can be prepared by the reaction of 20g of Al and 30g of sulphur. How much the non-limiting reactant is in excess?

(LHR 2013) (GRW 2013)

4. A mixture of N_2H_4 and N_2O_4 are used in rockets. They produce N_2 and water vapours. How many grams of N_2 gas will be formed by reacting 100g of N_2H_4 and 200g of N_2O_4.

(DGK 2018)(LHR 2015) (GRW 2011) (MTN 2013, 16)

$$2N_2H_4+N_2O_4 \rightarrow 4H_2O + 3N_2$$

5. NH_3 gas can be prepared by heating together two solids $NH_4C\lambda$ and $Ca(OH)_2$. If a mixture of 100 gm of each solid is heated then calculate the number of grams of NH_3 produced:

(LHR 2016) (SGD 2011) (MTN 2013, 16)

$$2NH_4C\lambda_{(s)}+Ca(OH)_{2(s)} \rightarrow CaCl_{2(s)}+2NH_{3(g)}+2H_2O_{(\lambda)}$$

Atomic mass of H = 1.008 g mol^{-1}, N = 14, C = 35.5 g mol^{-1}, O = 16 g mol^{-1}, Ca = 40

6. Ethylene glycol is used as automobile antifreeze. It has 38.7% carbon, 9.7% hydrogen and 51.6% oxygen. Its molar mass is 62.1 grams mol^{-1}. Determine its empirical and molecular formula.

(LHR 2017, 18) (SGD 2018)

7. A well known ideal gas is enclosed in a container having volume 500 cm^3 at S.T.P. Its mass comes out to be 0.72g. What is the molar mass of this gas. (GRW 2013)

8. Define and explain the concept of Mole and Avogadro's number with examples.

(FSD 2012)

9. Mg metal reacts with HCλ to give hydrogen gas. What is the minimum volume of HCλ solution (27% by weight) required to produce 12.1g of H_2? The density of HCλ solution is 1.14g cm^{-3}.

$$Mg_{(s)} = 2HC\lambda_{(aq)} \Rightarrow MgC\lambda_{2(g)} + H_{2(g)}$$

(Mg = 24 g mol^{-1}, Cλ = 35.5 g mol^{-1} & H = 1.008 g mol^{-1})

(FSD 2016) (RWP 2014) (DGK 2017)

10. Define stoichiometry. Give assumptions, Mention any two important laws which help to perform stoichimetric calculation.

(RWP 2011, 14)

11. Explain Isotopes with their relative abundance.

(DGK 2014)

12. Define the following and give one example of each. (DGK 2014)

(i) mole (ii) isotopes

(iii) Avogadro's number.

13. A well known ideal gas is enclosed in a container having volume 500cm^3 at S.T.P. Its mass comes out to be 0.72 g. What is the molar mass of this gas? (SWL 2016, 2018)

14. Serotenin is a compound that conducts nerve impulses in brain and muscles. It contains 68.2% C, 6.86% H, 15.09% N and 9.08% O. What is its molecular formula? (Molar mass of Serotenin = 1.76 g mol^{-1})

(SWL 2017) (BWP 2017) (LHR 2016)

❋❋❋❋

Chapter — 2

EXPERIMENTAL TECHNIQUES

SECTION I

Multiple Choice Questions

I) From Exercise:-

(i) Solvent extraction is an equilibrium process and it is controlled by:

(a) Law of mass action
(b) The amount of solvent used
(c) Distribution law
(d) The amount of solute

(ii) Solvent extraction method is a particularly useful technique for separation when the product to be separated is:
(LHR, SGD 2019)

(a) Non-volatile or thermally unstable
(b) Volatile or thermally stable
(c) Non-volatile or thermally stable
(d) Volatile or thermally unstable

(iii) The comparative rates at which the solutes move in paper chromatography; depend on:

(a) The size of paper used
(b) R_f values of solutes
(c) Temperature of the experiment
(d) Size of the chromatographic tank used

II) From Punjab Boards:-

1. I_2 dissolves in water in the presence of KI due to the function of: (LHR 2013)

(a) I_2 (b) I^- **(c) I_3^-** (d) I_4

2. The comparative rates at which the solute move in paper chromatography depend upon: (FSD 2018) (SGD 2017,18, 19) (LHR 2014, 17 G-I) (GRW 2017, 14, 18) (FSD 2014,16,17) (AJK 2016) (RWP 2018)

(a) size of paper **(b) Rf values of solutes**
(c) temperature of experiment
(d) Size of chromatographic tank used

3. Solvent extraction method is particularly useful technique for separation when the product to be separated is: (LHR 2014,16 G-II) (MTN 2016) (FSD 2015) (DGK 2016)

(a) non-volatile or thermally unstable
(b) volatile or thermally stable
(c) Non-volatile or thermally stable
(d) Volatile or thermally unstable

4. In solvent extraction, the law applied is: (LHR 2015 G-I) (DGK 2016) (GRW 2015) (BWP 2016)

(a) Law of mass action
(b) Distribution law
(c) Coulomb's law (d) Boyle's law

5. Substance that does not show the process of sublimation is: (GRW 2011)

(a) $K_2Cr_2O_7$ (b) Iodine
(c) Naphthalene (d) NH_4Cl

6. Chromatography in which the stationary phase is a solid is called: (MTN 2014,2017) (SGD 2014)

(a) Partition chromatography
(b) Thin layer chromatography
(c) Adsorption chromatography
(d) Paper chromatography

7. The most common solvent used in solvent extraction is : (FSD 2011)

(a) Acetone (b) Ethanol
(c) Rectified spirit **(d) Diethyl ether**

8. During chromatography strip should be dipped into solvent mixture to a depth of: (DGK 2014,2015)

(a) 3-4mm (b) 4-5mm
(c) 5-6mm (d) 6-7 mm

9. Compound which undergo sublimation is

(a) $KMnO_4$ (b) $CaCO_3$
(c) NH_4Cl (d) Na_2CO_3

III) From Entry Test:-

(1) The component with large K_D value, most likely have Rf value:

(a) Large (b) Small
(c) Zero (d) Unpredictable

(2) The vapours of iodine have colour:

(a) Brown (b) Greyish black
(c) Violet (d) Pale yellow

(3) Such solids will sublime on heating have:
(a) Weak type of intermolecular forces
(b) Low vapour pressure at boiling point
(c) High vapour pressure even at temperature below their boiling points
(d) Both (a) and (c)

(4) Which of the following is not locating agent?
(a) H_2S **(b) CS_2**
(c) Rubeanic acid (d) Ninhydron

(5) A process controlled by distribution law:
(a) Crystallization (b) Sublimation
(c) Solvent extraction (d) Filtration

(6) Mixture of NaCl and NH_4Cl can be separated by:
(a) Filtration (b) Crystallization
(c) Sublimation (d) Solvent extraction

(7) Cold finger is used for effective:
(a) Filtration (b) Crystallization
(c) Sublimation (d) Chromatography

(8) Pb^{2+} in paper chromatography are located by using:
(a) Rubeanic acid (b) Carbon disulphide
(c) Ninhydrin
(d) Hydrogen sulphide

(9) Crystallization does not involve:
(a) Heating **(b) Sublimation**
(c) Cooling (d) Vaporization

SECTION II
SHORT QUESTIONS

From Exercise:-

1. What is sublimation process?

Ans. Sublimation;

"It is a process in which a solid substance, when heated directly changes into vapours without passing through the liquid phase and these vapours when cooled again condensed to solid state is called as sublimation."

Solid $\rightleftharpoons$ Vapours

Examples of such solids are,
Ammonium chloride, naphthalene, iodine and benzoic acid, etc.

2. What is distribution law? And Distribution co-efficient?

Ans. The solvent extraction technique is based on distribution law or partition law.

Distribution Law; This law states that,

"A solute distributes itself between two immiscible liquids in a constant ratio of concentration, irrespective of the amount of solute added."

The ratio of the concentrations of the solute in the organic and aqueous layer is called as the distribution co- efficient.

Mathematically,

$$K_D = \frac{\text{Conc. of solute in the organic layer}}{\text{Conc. of solute in the aqueous layer}}$$

3. In solvent extraction technique, why repeated extractions using small portion of solvent are more efficient than using a single extraction but large volume of solvent?

Ans. Solvent extraction technique is based on distribution law. According to this law a solute distributes itself in two immiscible solvents in a constant ratio of concentration. In a single extraction with organic solvent, we obtain only a small amount of the solute. So, in order to get the maximum amount of the solute from the solution, the process should be repeated for several times using small portion of fresh solvent.

4. What is the basic principle of chromatography?

Ans. The word chromatography originates from a Greek word ***"Khromatos"*** meaning ***colour writing.***

In chromatography substances are separated from each other on the basis of their relative affinities for the stationary and mobile phase. The distribution of the components of a mixture between the two phases is governed by distribution co-efficient K.

$$K = \frac{\text{Conc. of component in the moving phase}}{\text{Conc. of component in the stationary phase}}$$

5. Differentiate between stationary and mobile phase.

Ans

Stationary Phase	Mobile Phase
(i) The stationary phase may be a solid or a liquid supported as a thin film on the surface of an inert solid.	(i) The mobile phase may be a gas or liquid flowing over the surface of the stationary phase.

(ii)The component of the mixture with small value of K mostly remains in the stationary phase as the moving phase flows over it.	(ii) The component with a greater value of K remains largely dissolved in the mobile phase as passes over the stationary phase.

6. What is R_f value? Why it has no units?

Ans. R_f value:

"It is the ratio of the distance traveled by the component from the original spot to the distance traveled by the solvent from the original spot."

It is called as retardation factor or retention factor.

Mathematically,

$$R_f = \frac{\text{Distance travelled by the component from original spot}}{\text{Distance travelled by the solvent from original spot}}$$

Units:

Since it is the ratio of two distances having same units therefore, it has no units.

7. Differentiate between adsorption and partition chromatography.

Ans.

Adsorption chromatography	Partition chromatography
(i) Chromatography in which the stationary phase is a solid, is classified as adsorption chromatography.	(i) Chromatography in which the stationary phase is a liquid is called as partition chromatography.
(ii) In this type a substance leaves the mobile phase to become adsorbed on the surface of the solid phase.	(ii) In this type, the substances being separated are distributed throughout both the stationary and mobile phase.
(iii) e.g. column chromatography, Thin layer chromatography.	(iii) e.g. paper chromatography.

II) From Punjab Boards:-

1. Differentiate b/w adsorption and partition chromatography.

(LHR 2011) (DGK 2017) (GRW 2018) (SWL 2016) (RWP 2016)

Ans.

Adsorption Chromatography	Partition Chromatography
Definition: It is a type of chromatographhy in which physical focus are involved in retentive ability of stationary phase. In adsorption chromatographym, a solid is used as stationary phase. **Examples:** (i) Column chromatography. (ii) Thin layer chromatography.	**Definition:** It is a type of chromatography in which separation involved distribution of components. In partition chromatography, liquid or liquid supported on solid is used as stationary phase. **Example:** Paper chromatography.

2. What is solvent extraction.

(LHR 2013, 17) (SGD 2012) (GRW 2013)

Ans. Solvent Extraction:

It is an experimental technique in which solute can be separated from the aqueous solution by shaking the solution with a solvent in which the solute is more soluble and the added solvent does not mix the solution. Usually it is by shaking the solution and the solvent into a separating funnel.

3. What is sublimation? Give example.

(GRW 2013, 17) (BWP 2011) (LHR 2014, 15) (DGK 2012, 18)

Ans. Sublimation:

"It is a process in which a solid, when heated, vapourizes directly without passing through the liquid phase and these vapours can be condensed to form the solid again."

Sublimation is frequently used to purify a solid.

Examples:

1. Ammonium chloride 2. Iodine
3. Naphthalene 4. Benzoic acid

4. Define chromatography and give formula of distribution coefficient.

(FSD 2016) (GRW 2011)

Ans. It is the ratio of the amounts of solute dissolved in the immiscible liquids at equilibrium.

Distribution coefficient

$$(K_D) = \frac{\text{concentration of solute in organic phase}}{\text{concentration of solute aqueous phase}}$$

This technique is used in the solvent extraction of certain soluble compounds.

5. What is partition law?

(MTN 2012) (GRW 2012)

Ans. This law states, that a solute distributes itself between two immiscible liquids in a constant ratio of concentrations irrespective of the amount of solute added.

6. Give statement of Distribution law?

(GRW 2014, 17) (SWL 2016) (DGK 2014)

Ans. Distribution Law

Statement:

A solute distributes itself between two immicible liquids in a constant ratio of concentrations irrespective of the amount of solute added.

Mathematically:

$$K(D) = \frac{\text{concentration of solute in organic phase}}{\text{concentration of solute in aqua phase}}$$

7. Differentiate b/w stationary and mobile phase. (GRW 2014) (FSD 2013)

Ans.

Stationary Phase	Mobile Phase
"The phase over which mobile phase flows in chromatography."	"The phase which flows on the stationary phase in chromatography."
It may be solid or liquid.	It may be liquid or gases.
It is packed in column.	It is called "eluent".
Example: Sillica gel, filter paper	**Example:** Water, ethanol, etc.

8. What is R_f value? Why has it no unit?

(GRW 2017)(FSD 2011)(MTN 2016, 17)(SGD 2018)

Ans. R_f value;

"It is the ratio of the distance traveled by the component from the original spot to the distance traveled by the solvent from the original spot."

It is called as retardation factor or retention factor.

Mathematically,

$$R_f = \frac{\text{Distance travelled by the component from original spot}}{\text{Distance travelled by the solvent from original spot}}$$

Units;

Since it is the ratio of two distances having same units therefore, it has no units.

9. Give two applications of paper chromatography.

(BWP 2011) (DGK 2016)

Ans.

i) It is used in organic synthesis for separation, isolation and purification of the products.

ii) It is equally important in qualitative and quantitative and for determination of purity of a substance.

11. How purification is carried out by sublimation? (BWP 2017)

Ans. Sublimation is a process in which a solid vapourizes directly without passing through a liquid phase on heating. These vapours can be condensed to form the solid again. For example ammonium chloride, Iodine, Naphtalene.

12. Give two uses of chromatography?

(SGD 2017, 2018) (BWP 2017)

Ans. Uses of chromatography are:

- For the separation and purification of coloured organic compounds.
- For checking the purity of compound analysis.

13. What is chromatogram?

(RWP 2011)

Ans. Chromatogram: It is the piece of filter paper which is used for chromatography.

14. Mention important uses of chromatography.

(SGD 2018) (RWP 2013)

Ans. Sometimes crystal become coloured due to impurities. To prevent it the substance is boiled wit animal charcoal. Animal charcoal absorbs the coloured impurities. The pure colourless crystal are formed by cooling the filtrate.

❋❋❋❋

Chapter — 3

GASES

SECTION I

Multiple Choice Questions

I) From Exercise:-

(i) Pressure remaining constant, at which temperature the volume of a gas will become twice of what it is at 0°C. **(SGD 2019)**

(a) 546°C (b) 200°C
(c) 546 K (d) 273 K

(ii) Number of molecules in one dm^3 of water is close to: **(SGD 2019)**

(a) $\frac{6.02}{22.4} \times 10^{23}$ (b) $\frac{12.04}{22.04} \times 10^{23}$
(c) $\frac{18}{22.4} \times 10^{23}$ **(d) $55.6 \times 6.02 \times 10^{23}$**

(iii) Which of the following will have the same number of molecules at STP?
(a) 280 cm^3 of CO_2 and 280 cm^3 of N_2O
(b) 11.2 dm^3 of O_2 and 32 g of O_2
(c) 44 g of CO_2 and 11.2 dm^3 of CO
(d) 28 g of N_2 and 5.6 dm^3 of oxygen

(iv) If absolute temperature of a gas is doubled and the pressure is reduced to one half, the volume of the gas will:
(a) Remain unchanged
(b) Increase four times
(c) Reduce to 1/4 (d) Be doubled

(v) How should the conditions be changed to prevent the volume of a given gas from expanding when its mass is increased?
(a) Temperature is lowered and pressure is increased.
(b) Temperature is increased and pressure is lowered.
(c) Temperature and pressure both are lowered.
(d) Temperature and pressure both are increased.

(vi) The molar volume of CO_2 is maximum at: **(MTN 2019)**

(a) STP **(b) 127°C and 1 atm.**
(c) 0°C and 2 atm. (d) 273°C and 2 atm.

(vii) The order of the rate of diffusion of gases NH_3, SO_2, Cl_2 and CO_2 is: **(LHR, MTN 2019)**

(a) $NH_3 > SO_2 > Cl_2 > CO_2$
(b) $NH_3 > CO_2 > SO_2 > Cl_2$
(c) $Cl_2 > SO_2 > CO_2 > NH_3$
(d) $NH_3 > CO_2 > Cl_2 > SO_2$

(viii) Equal masses of methane and oxygen are mixed in an empty container at 25°C. The fraction of total pressure exerted by oxygen is:

(a) $\frac{1}{3}$ (b) $\frac{8}{9}$ (c) $\frac{1}{9}$ (d) $\frac{16}{17}$

II) From Punjab Boards:-

1. Normal human body temperature is: **(LHR 2011)**

(a) 37°C (b) 986°C (c) 37°F (d) 273 k

2. Pressure remaining constant of which temperature, the volume of a gas will become twice of what it is at 0°C: **(LHR 2012, 13, 14 G-I, 15 G-I, 15 G-II) (GRW 2012) (SGD 2017) (MTN- 2017) (FSD 2014) (BWP 2016) (SGD 2019)**

(a) 546°C (b) 200°C **(c) 546 k** (d) 273 k

3. The partial pressure of oxygen in the lungs is: **(LHR 2012) (GRW 2012) (DGK 2016)**

(a) 760 torr (b) 670 torr
(c) 159 torr **(d) 116 torr**

4. S.I. unit of pressure is: **(LHR 2014 G-II) (RWP 2013) (MTN 2015)**

(a) Torr (b) mm of Hg
(c) Nm^{-2} (d) Pound / Inch

5. The volume of CO_2 is maximum at: **(LHR 2015 G-I)(RWP 2017) (GRW 2014,15)(DGK 14,16) (MTN 15,17) (SGD 2017,18) (SWL 2016,19)**

(a) S.T.P. **(b) 127°C and 1 atm**
(c) 0°C and 2 atm (d) 273°C and 2 atm

6. Equal masses of methane and oxygen are mixed in an empty container at 25°C. The fraction of total pressure exerted by oxygen is:

(LHR 2015 G-II) (AJK 2016) (FSD 2014) (RWP 2012) (DGK 2018) (GRW 18)

(a) $\frac{1}{3}$ (b) $\frac{8}{9}$ (c) $\frac{1}{9}$ (d) $\frac{16}{17}$

7. Which of the following will have the same number of molecules at STP:
(LHR 2016) (DGK 2016) (RWP 2013,15,18)
(a) 280 cm^3 of CO_2 and 280 cm^3 of N_2O
(b) 11.2 dm^3 of O_2 and 32 g of O_2
(c) 44 g of CO_2 and 11.2 dm^3 of CO
(d) 28 g of N_2 and 5.6 dm^3 of oxygen

8. The order of the rate of diffusion of gases NH_3, SO_2, $C\lambda_2$ and CO_2 is:
(LHR 2016)(DGK 2016) (SGD 2017.18) (RWP 2018) (BWP 17) (LHR, MTN 2019)
(a) $NH_3 > SO_2 > C\lambda_2 > CO_2$
(b) $NH_3 > CO_2 > SO_2 > C\lambda_2$
(c) $C\lambda_2 > SO_2 > CO_2 > NH_3$
(d) $NH_3 > CO_2 > C\lambda_2 > SO_2$

9. If absolute temperature of a gas is doubled and the pressure is reduced to one half, the volume of the gas will: (LHR 2017)
(FSD 2012)(MTN 2016)(GRW 2016)(DGK 2018)
(a) Remain unchanged
(b) Increase four times
(c) Reduce to ¼ (d) Be doubled

11. Number of molecules in one dm^3 of water is close to: (MTN 2016) (RWP 17) (AJK 16) (SWL 2016)
(a) $\frac{6.02}{22.4} \times 10^{23}$ (b) $\frac{12.04}{22.4} \times 10^{23}$
(c) $\frac{18}{22.4} \times 10^{23}$ **(d) $55.6 \times 6.02 \times 10^{23}$**

12. Density of an ideal gas can be calculated by the formula: (FSD 2011)
(a) $d = nRT$ **(b) $d = \frac{PM}{RT}$**
(c) $d = \frac{m}{M} RT$ (d) $d = \frac{PV}{M}$

13. The pair of gases which do not obey Dalton's law of partial pressure under normal condition is: (FSD 2016)
(a) H_2 and O_2 (b) H_2 and He
(c) NH_3 and HCλ (d) He and Ne

14. The sum of mole fraction of gases in a mixture of gases is: (FSD 2016)
(a) Always more than 1
(b) Always less than 1
(c) May be less or more than 1
(d) Always 1

15. The spreading of fragrance of scent in air is due to: (RWP 2011)
(a) Effusion **(b) Diffusion**
(c) Osmosis (d) Density

16. Formula used for the conversion of °F into °C is: (RWP 2014)
(a) $°F = \frac{9}{5}$ (°C) + 32 **(b) $°C = \frac{5}{9}$ (°F − 32)**
(c) $°F = \frac{5}{9}$ (°C) + 32 (d) $°C = \frac{9}{5}$ [°F - 32]

17. An ideal gas has volume 1dm^3 at 303 k. keeping pressure constant at which kelvin temperature its volume will become 2 dm^3. (SGD 2011)
(a) 240 (b) 303 (c) 330 **(d) 606**

18. The temperature of a natural plasma is about. (DGK 2017)
(a) 20000 °C (b) 10000 °C
(c) 5000 °C (d) 1000 °C

III) From Entry Test:-

(1) Kinetic energy of 3 moles of a gas is:
(a) 3RT **(b) $\frac{RT}{2}$** (c) 2RT (d) $\frac{3}{2}$ RT

(2) The value of gas constant (R) depends upon:
(a) Temperature (b) Volume
(c) No. of moles
(d) Units of volume and pressure

(3) At what temperature, the hydrogen molecules will have same kinetic energy as nitrogen molecules at 280 K?
(a) 280 K (b) 400 K (c) 40 K (d) 50 K

(4) The root mean square velocity of an ideal gas at constant pressure varies with density as:
(a) d^2 (b) d (c) $\sqrt{d}$ **(d) $\frac{1}{\sqrt{d}}$**

(5) Oxygen gas contained in a flask at STP was replaced by SO_2 under same conditions. The weight of SO_2 will be:
(a) Equal to O_2 (b) Half of O_2
(c) Twice that of O_2 (d) Thrice that of O_2

(6) Which of the following molecules have maximum root mean square velocity at 25°C?
(a) CO_2 (b) H_2S **(c) NH_3** (d) SO_2

(7) Equal volumes of H_2 and He are present in the same vessel. The pressure exerted by H_2 and He are in the ratio of:
(a) 1 : 1 (b) 2 : 1 (c) 1 : 2 (d) 4 : 1

(8) What will be the pressure of 1 mole of an ideal gas maintained at 300 K and 250 cm^3 volume:

(a) 98.5 atm (b) 96.7 atm
(c) 95.8 atm (d) 97.1 atm

(9) Hydrogen diffuses four times more rapidly than volume of an unknown gas, molar mass of unknown gas should be:

(a) 16 $g\text{-}mol^{-1}$ **(b) 32 $g\text{-}mol^{-1}$**
(c) 48 $g\text{-}mol^{-1}$ (d) 64 $g\text{-}mol^{-1}$

(10) The expression for root mean square velocity is:

(a) $C_{rms} = \left(\frac{3RT}{M}\right)^{1/2}$ (b) $C_{rms} = \left(\frac{3PV}{M}\right)^{1/2}$

(c) $C_{rms} \approx \left(\frac{3P}{d}\right)^{1/2}$ **(d) All are correct**

(11) According to Graham's law, the rate of diffusion of H_2 and O_2 gases has the ratio:

(a) 1 : 4 (b) $1 : \sqrt{4}$ **(c) 4 : 1** (d) 3 : 32

(12) Which one of the following gases is more ideal at STP:

(a) SO_2 (b) NH_3 **(c) H_2** (d) H_2S

(13) Eight grams each of O_2 and H_2 at 27°C will have total K.E in the ratio:

(a) 1 : 1 (b) 16 : 1 (c) 8 : 1 **(d) 1 : 16**

SECTION II

SHORT QUESTIONS

From Exercise:-

QUESTIONS

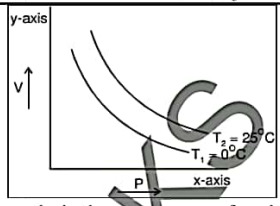
1. What is isotherm. What happens to the position of the isotherm, when it is plotted at high temperature.

Ans. **Isotherm:**

When a graph is plotted between pressure of the gas on the x-axis (abscissa) and volume on the y-axis (ordinate), by keeping the temperature constant at 0°C a curve line is obtained. This curve is called as "isotherm".

- "iso" mean same.
- "therm" mean heat.

If we increase the temperature of the gas to 25°C, the curve line goes away from both the axes. The reason is that at higher temperature the volume of gas is increased and



Hence the isotherm moves away from both the axes.

2. Justify that the Charles's Law is only obeyed when the temperature in taken in Kelvin scale.

Ans. Consider a gas having a volume of 566cm^3 at 10°C if its temperature is increased to 100°C, the volume of the gas will be 746cm^3.

Now applying, Charles's Law.

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

$$\frac{566}{10} \neq \frac{746}{100}$$

The two sides of the equation are not equal. So Charles's Law is not obeyed when temperature is measured on Celsius Scale.

Now if the temperature is converted into Kelvin scale.

$T_1 = 10°C = 10 + 273 = 283K$

$T_2 = 100°C = 100 + 273 = 373K$

Again applying Charles's Law

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

$$\frac{566}{283} = \frac{746}{373}$$

$$2 = 2$$

Both the sides of the equation are equal. So Charles's Law is obeyed when temperature is taken in Kelvin Scale.

3. Calculate the value of "R" in general units of pressure and volume.

Ans. Consider 1 mole of an ideal gas at STP. According to Avogadro's principle;

T = 0°C = 273K
P = 1 atm
n = 1 mole
V = 22.414 dm^3

According to the General gas equation;

$$PV = nRT$$

$$R = \frac{PV}{nT}$$

Putting Values in above equation,

$$R = \frac{1 \text{ atm} \times 22.414 \text{ dm}^3}{1 \text{ mole} \times 273K}$$

$$= 0.0821 \text{ atm . dm}^3 \text{ . mole}^{-1} \text{. K}^{-1}$$

If pressure is in mm of Hg units.

$P = 1 \text{ atm} = 760\text{mm of Hg}$

$R = 62.4\text{mm of Hg. dm}^3 \text{ . mole}^{-1} \text{. K}^{-1}$

$\therefore$ 1mm of Hg = 1 torr

$R = 62.4 \text{ torr. dm}^3 \text{ . mole}^{-1} \text{. K}^{-1}$

If volume of the gas is in cm^3

$R = 62400 \text{ torr . cm}^3 \text{ . mole}^{-1} \text{. K}^{-1}$

$\therefore$ $1dm^3 = 1000cm^3$

4. Calculate the value of "R" is S.I. units.

Ans. Consider one mole of an ideal gas at STP. If the units of the pressure and volume are expressed in S.I. units, the data is given as.

$n = 1$ mole

$P = 1 \text{ atm} = 101325 \text{ N.m}^{-2}$

$V = 22.414dm^3 = 0.022414m^3$

$\therefore$ $(m^3 = 1000dm^3)$

$T = 273.16K$

According to general gas equation;

$PV = nRT$

$$R = \frac{PV}{nT}$$

$$R = \frac{101325 \text{ N.m}^{-2} \times 0.022414 \text{ m}^3}{1 \text{ mole} \times 273.16K}$$

$= 8.314 \text{ N.m. mole}^{-1} \text{ K}^{-1}$ $\because 1 \text{ N.m} = 1J$

$R = 8.3143 \text{ J K}^{-1} \text{ mol}^{-1}$

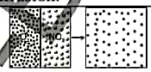
$R = 1.987 \text{ cals K}^{-1} \text{ mol}^{-1}$ $(1 \text{ cal} = 4.184J)$

5. How Dalton's Law helps the deep sea divers?

Ans. Deep sea drivers take oxygen mixed with an inert gas say He and adjust the pressure of oxygen according to the requirement. Actually, in sea after every 100 feet depth, the diver experiences approximately 3 atm pressure, so normal air cannot be breathed in depth of sea. Moreover the pressure of N_2 increases in depth of sea and it diffuses in the blood.

6. What is the difference between diffusion and effusion?

Ans.

DIFFUSION	EFFUSION
(i) The spontaneous intermixing of molecules of different gases by random motion and collision to form a homogeneous mixture is called "diffusion".	(i) The escape of gas molecules one by one without collision through an extremely small opening into a region of low pressure is called as effusion.
(ii) In diffusion the molecules of both gases move into each other until a homogenous mixture is obtained.	(ii) In effusion the molecules of a gas enclosed in a container escape slowly through a hole one by one.
(iii) The spreading of fragrance of a rose or a scent is due to diffusion.	(iii) The reduction in the size of a balloon is an example of effusion.
	

7. Why lighter gases diffuse more rapidly than heavier gases?

Ans. According to Graham's Law:

"The rate of diffusion or effusion of a gas is inversely proportional to the square root of it's density at constant temperature and pressure."

$$\text{Rate} \propto \frac{1}{\sqrt{d}}$$

We know that at constant temperature and pressure.

$$d \propto M$$

So, Graham's Law can be written as.

$$\text{Rate} \propto \frac{1}{\sqrt{M}}$$

According to this lighter gases (having less molecular mass) will diffuse more rapidly than heavier.

8. Dalton's Law of partial pressures is only obeyed by those gases which don't have attractive forces among their molecules. Explain it?

Ans. The pressure exacted by a gas is due to the collision of the gas molecules per unit area. So the pressure is directly proportional to the number of moles of the gas.

$$P_i \propto n_i$$

In order to obey the Dalton's Law, it is necessary that the gas molecules behave individually within the mixture of gases. So that, they can exert their individual partial pressures. If gases react together, or they develop forces of attraction between themselves, they cannot exert their individual pressures on the walls of the container and hence Dalton's Law is not obeyed.

9. How can we calculate the pressure of a gas collected over water.

Ans. Some gases are collected over water in the laboratory. The gas during collection gathers water vapours and becomes moist. The pressure exacted by this moist gas is, therefore, the sum of the partial pressures of the dry gas and that of water vapours.

$$P_{moist} = P_{dry} + P_{water\ vapours}$$
$$\text{gas} \quad \text{gas}$$

The partial pressure exerted by the water vapours is called aqueous tension.

$P_{moist} = P_{dry} + P_{water\ vapours}$ (aqueous tension)

So pressure of dry gas can be calculated by moist gas.

$$P_{dry} = P_{moist} - \text{aqueous tension}$$
$$\text{gas} \quad \text{gas}$$

10. Explain that the process of respiration obeys the Dalton's Law of partial pressure?

Ans. Dalton's Law finds its applications during the process of respiration. The process of respiration depends upon the difference in partial pressures. When animals inhale air then oxygen moves into lungs as the partial pressure of oxygen in the air is 159 torr, while the partial pressure of oxygen in the lungs is 116 torr.

CO_2 produced during respiration moves out in the opposite direction as its partial pressure is more in the lungs than that in air.

11. Why Pilots use pressurized cabins?

Ans. At higher altitudes, the pilots feel uncomfortable breathing because the partial pressure of oxygen in the un-pressurized cabin is low as compared to 159 torr, where one feels comfortable breathing. Therefore the pilots cabins are pressurized to maintain the partial pressure of oxygen to 159 torr inside the cabin.

12. Do you think that 1 mole of H_2 and 1 mole of NH_3 at 0°C and 1 atm pressure will have Avogadro's number of particles?

Ans. According to Avogadro's law:

"Equal volumes of all the ideal gases at the same temperature and pressure contain equal number of molecules".

1 mole of H_2 and 1 mole of NH_3 occupy 22.414 dm^3 at 0°C and 1 atm pressure separately.

Since both gases occupy same volume. So according to Avogadro's law they have same number of particles i.e., Avogadro's number of molecules.

1 mole H_2 = 22.414 dm^3 = 6.02×10^{23} molecules

1 mole NH_3 = 22.414 dm^3 = 6.02×10^{23} molecules

13. Justify that 1 cm^3 of H_2 and 1 cm^3 of CH_4 at STP will have same number of molecules when one molecule of CH_4 is 8 times heavier than that of H_2?

Ans. According to Avogadro's law:

"Equal volumes of all the ideal gases at the same temperature and pressure contain equal number of molecules".

Since both gases have same volume i.e., 1cm^3 (0.001 dm^3) at STP so both contain equal number of molecules.

We can justify it mathematically.

Data:

Volume of H_2 gas = 1cm^3 = 0.001 dm^3

Molar volume of H_2 gas = 22.414 dm^3 at STP

Using formula:

$$\text{No. of particles} = \frac{N_A \times \text{Vol. of gas}}{\text{mol volume}}$$

$$\text{No. of } H_2 \text{ molecules} = \frac{6.02 \times 10^{23} \times 0.001\ dm^3}{22.414\ dm^3}$$

$$= \boxed{2.68 \times 10^{19} \text{ molecules}} \text{ Ans.}$$

Data:

Volume of CH_4 gas = 1cm^3 = 0.001 dm^3

Molar volume of CH_4 gas = 22.414 dm^3 at STP

$$\text{No. of } CH_4 \text{ molecules} = \frac{6.02 \times 10^{23} \times 0.001\ dm^3}{22.414\ dm^3}$$

$$= \boxed{2.68 \times 10^{19} \text{ molecules}} \text{ Ans.}$$

Although CH_4 is eight times heavier than H_2 yet masses and sizes do not effect volume and number of molecules at same temperature and pressure.

II) From Punjab Boards:-

1. Define plasma state. Give its an application. (LHR 2011) (BWP 2014)

Ans. Gaseous mixture which is considered of ions, electrons and neutral atoms is called plasma.

2. Some of the postulates of kinetic molecular theory of gases are faulty. Justify. (LHR 2012)

Ans. These postulates are:

- There are no forces of attraction or repulsions among the molecules of a gas.
- The actual volume of a gas is negligible as compared to the volume of the vessel.

3. Calculate the value of R in S.I units. (LHR 2013) (GRW 2011) (MTN 2017) (BWP 2014) (DGK 2013)

Ans. Using SI units of pressure, volume and temperature in the general gas equation, the value of R is calculated as follows:

$n = 1$ mole

$T = 273.15$ k

$P = 1$ atm $= 760$ torr $= 101325$ N n^{-2}

$V = 22.44$ dm^3 $= 0.022414$ m^3 (1m$^3 = (000$ dm^3)

Using general gas equation, we get

$$R = \frac{PV}{nT}$$

$$R = \frac{101325 \times 0.022414}{1 \times 273.15}$$

$$= 8.3143 \text{ Nm K}^{-1} \text{ mol}^{-1}$$

$$= 8.3143 \text{ J K}^{-1} \text{ mol}^{-1}$$

4. Derive Graham's law of diffusion in the light of kinetic molecular theory of gases. (LHR 2013) (DRW 2013) (DGK 2011)

Ans. Rate of diffusion $\alpha \frac{1}{\sqrt{d}}$ (at constant temperature and pressure)

Applying the kinetic equation:

$$PV = \frac{1}{3} mNc^2$$

If we take one mole of an ideal gas, it will have Avogadro's number of molecules, then $n = N_A$

So, $$PV = \frac{1}{3} mN_Ac^2$$

But $mN_A = M$, then

$$PV = \frac{1}{3} Mc^2$$

$$C^2 = \frac{2PV}{M}$$

$$\sqrt{C^2} = \sqrt{\frac{3PV}{M}}$$

$$\sqrt{C^2} = \sqrt{\frac{3P}{\frac{M}{V}}}$$

$$\sqrt{C^2} = \sqrt{\frac{3P}{d}} \quad \left(\frac{M}{V} = d\right)$$

Since the root mean square velocity of the gas is proportional to the rate of diffusion of gas.

$$\sqrt{C^2} \alpha r$$

$$r \alpha \sqrt{\frac{3P}{d}}$$

At constant pressure,

$$r \alpha \frac{1}{\sqrt{d}}$$

"Thus Graham's law is proved"

5. Explain Boyle's law according to kinetic molecular theory of gases. (LHR 2014) (GRW 2013) (BWP 2013) (RWP 2017)

Ans. $PV = k$

According to kinetic theory of gases:

$$\frac{1}{2} mNc^2 \text{ a } T$$

$$\frac{1}{2} mNc^2 = kT \ldots\ldots\ldots \text{(i)}$$

According to kinetic equation of gases:

$$PV = \frac{1}{3} mNc^2$$

Multiply and divide by 2

$$PV = \frac{2}{3} \left(\frac{1}{2} mNc^2\right) \ldots\ldots\ldots \text{(ii)}$$

By comparing equation 1 and 2, we get

$$PV = \frac{2}{3} kT$$

If temperature is kept constant then the right hand side of the quation is constant.

$$\frac{2}{3} kT = k'$$

So,

$PV = k'$

"Thus Boyle's law is proved"

6. What are isotherms? (LHR 2014)

Ans. If a graph is plotted between pressure on the x-axis (ordinate) and the volume on y-axis (abscissa), then a parabolic curve is obtained. The curve is called isotherm. Iso means "same" and therm means "heat".

7. Define Avogadro's law of gases.
(LHR 2014), 16) (GRW 2017) (DGK 2013)

Ans. At constant temperature and pressure, equal volumes of all gases contain equal number of molecules.

8. What do you mean by absolute zero temperature of gases?
(DGK 2013) (FSD 2013)
(MTN 2016) (LHR 2016)

Ans. Absolute zero:

"The hypothetical temperature (–273.16°C) at which the volume of a gas theoretically becomes equal to zero is called as absolute zero."

It is taken as zero (0K) on the Kelvin scale of temperature.

At this temperature, the molecular motion ceases and kinetic energy of gas molecules is equal to zero. So no gas can exist at this temperature.

9. Why lighter gases diffuse more than heavier gases? (LHR 2016) (RWP 2017)

Ans. According to Graham's Law:

"The rate of diffusion or effusion of a gas is inversely proportional to the square root of it's density at constant temperature and pressure."

$$\text{Rate} \propto \frac{1}{\sqrt{d}}$$

We know that at constant temperature and pressure.

$$d \propto M$$

So, Graham's Law can be written as.

$$\text{Rate} \propto \frac{1}{\sqrt{M}}$$

According to this lighter gases (having less molecular mass) will diffuse more rapidly than heavier.

10. Derive charles law by kinetic equation of gasses. (LHR 2017) (BWP 2017)

Ans. We know that

$$PV = \frac{2}{3} KT$$

Or $$V = \frac{2}{3}\frac{KT}{P}$$

$$= \left(\frac{2K}{3P}\right) T$$

At constant pressure $\frac{2K}{3P} = K''$ (a new constant)

$$V = K'' T$$

$$\frac{V}{T} = K'' \text{ (which is charle's law)}$$

11. Derive molecular mass of a gas by general gas equation. (LHR 2017)

Ans. We know that

$$PV = n RT$$

$$n = \frac{m}{M}$$

$$PV = \frac{m}{M} RT$$

$$PVM = m RT$$

$$M = \frac{m RT}{PV}$$

12. State Dalton's Law of partial pressure. Write its two applications. (BWP 2012) (GRW 2011)(MTN 2012, 16)(DGK 2018)

Ans. The total pressure exderted by the mixture of gases is equal to the sum of individual partial pressures at a given temperature. Let there be a mixture of three gases.

$$P = pH_2 + pO_2 + pCH_4$$

$$P = n_t \frac{RT}{V} \text{ where } n_t = nH_2 + nO_2 + nCH_4$$

13. Define thermometry. Name the scales and devices. (MTN 2012) (BWP 2012)

Ans. There are three scales of thermometry, i.e. Centrigrade, Fahrenheit and Absolute or Kelvin scale.

$$K = (°C + 273),\ °C = \frac{5}{9}(F° - 32), °F = \frac{9}{5}(°C) + 32$$

14. Discuss the factors affecting the critical temperature. (MTN 2014)

Ans. (i) Size of the molecules.
(ii) Shape of the molecules.
(iii) Intermolecular forces

15. What is the difference between diffusion & effusion? (MTN 2017) (FSD 2013) (BWP 2012) (SGD 2017) (SWL 2017)

Ans.

Diffusion	Effusion
1. The spontaneous intermixing of the molecules of different gases by random motion and collision to form a homogenous mixture.	1. Escape of gas molecules one by one without collision through a hole of molecular dimensions.

2. Collision is necessary.	2. Collisions are not necessary
3. It takes place through open surface.	3. If takes place through tiny hole.
Ex. spreading of fragrance of perfumes	Ex. Escape of air through the tiny holes of balloons or tyres.

16. Rate of diffusion of NH_3 Ias is more than HCl Ias why? (BWP 2011)

Ans. At a given temperature the average K.E. of different gas molecules are same. Since their masses are different, so their velocities will also be different. The lighter molecules will have greater velocities and so they will diffuse rapidly.

17. Give two characteristics of Plasma.
(BWP 2017) (SGD 2017) (SWL 2017)
(RWP 2014) (DGK 2017)

Ans. 1. Plasma includes electrons and ions and conducts electricity but it is macroscopically neutral. In measurable quantities the number of electrons and ions are equal.

2. Plasma must have sufficient number of charged particles. It exhibits a collective response to electric and magnetic fields. The motion of the particles in the plasma generates fields and electric currents within plasma density.

17. Convert –40°C of F°.
(FSD 2012) (RWP 2016) (DGK 2011)

Ans. $F^\circ = \frac{9}{5}(-40) + 32$

$F^\circ = -72 + 32$

$F^\circ = 40°F$

18. Prove that $d = \frac{PM}{RT}$.
(FSD 2014)(DGK 2017)

Ans. We know the atom for general gas equation

$PV = nRT$

If n is mole of a gas and m is mass and M is molar mass of a gas then $n = \frac{m}{M}$

$PV = \frac{m}{M} RT$

Substitudy the value $PM = \frac{m}{V}RT$; $d = \frac{m}{v}$

$PM = dRT$

$d = \frac{PM}{RT}$

19. Explain procedure of sea divers breath.
(RWP 2011) (DGK 2011)

Ans. Deep sea divers use adjusted mixture of oxygen and inert gas e.g. He for breathing. The reason is that at every after 100 feet depth, the partial pressure of oxygen is three times than normal. i.e. approximately 3 atm pressure More over due to increased pressure N_2, if used, diffuses into blood. Due to above reason divers can not use normal air for breathing.

20. Lighter gases diffuse more rapidly than heavier gases. (SGD 2017)

Ans. According to Graham's Law:

"The rate of diffusion or effusion of a gas is inversely proportional to the square root of it's density at constant temperature and pressure."

$$\text{Rate} \propto \frac{1}{\sqrt{d}}$$

We know that at constant temperature and pressure. $d \propto M$

So, Graham's Law can be written as.

$$\text{Rate} \propto \frac{1}{\sqrt{M}}$$

According to this lighter gases (having less molecular mass) will diffuse more rapidly than heavier.

21. Calculate density of CH_4 gas at O°C and 160mm Hg pressure. (DGK 2011)

Ans. Hg Pressure. Molecular mass of $CH_4 = 16$

Pressure = 760 mm Hg = 101325 Nm^{-2}

T = 0°C

T = 0°C + 273 = 273

Molecular mass = 16 g mol^{-1}

$$d = \frac{PM}{RT} = \frac{101325 \times 16}{8.31 \times 273} = 0.714 \text{ g dm}^{-3}$$

SECTION III

LONG QUESTIONS

1. State and explain Graham's law of diffusion of gases. (LHR 2011, 16, 17)
(DGK 2011, 13, 16, 17, 18)
(GRW 2018) (RWP 2013, 16) (FSD 2016)

2. Explain Avogadro's law and Graham's law of diffusion on the basis of kinetic molecular theory of gases. (MTN 2011)
3. Write eight postulates of Kinetic Molecular Theory of Gases. (MTN 2017) (SWL 2018)
4. A sample of nitrogen gas is enclosed in a vessel of volume $380cm^3$ at 120°C and pressure of $101325Nm^{-2}$. This gas in transferred to a $10dm^3$ flask and cooled to 27°C. Calculate the pressure in Nm^{-2} exerted by the gas at 27°C. (FSD 2012)
5. What is kinetic molecular theory of gases? Derive Boyle's law from kinetic equation. (FSD 2013)
6. Derive Charles law and Graham's law from kinetic theory of gases. (RWP 2016)
7. Explain Boyle's law and Avogadro's law from kinetic molecular theory of gases. (SGD 2016)
8. Derive General gas equation also calculate the value of "R" in S.I units. (SGD 2017)
9. Calculate the mass of $1dm^3$ of NH_3 gas at 30°C and 1000 mmHg pressure. Considering that NH_3 is behaving ideally. (SWL 2014) (MTN 2014) (DGK 2012)
10. What is Joule Thomson Effect? How Linde's method is used for liquefaction of gases? (SWL 2016)
11. State and explain Dalton's Law of Partial pressures. Derive an expression for calculating Partial pressure of a gas. (SWL 2017, 13) (GRW 2013) (LHR 2016) (RWP 2012, 16, 18) (FSD 2011)
12. Write down application of Dalton law of partial pressure. (DGK 2018) (SGD 2018)
13. Define plasma state. How is it formed? Describe its four application. (FSD 2018)

Chapter — 4

LIQUIDS AND SOLIDS

SECTION I

Multiple Choice Questions

I) From Exercise:-

1. **London dispersion forces are the only forces present among the:**
   (a) Molecules of water in liquid state
   (b) Atoms of helium in gaseous state at high temperature
   (c) Molecules of solid iodine.
   (d) Molecules of hydrogen chloride gas.
2. **Acetone and chloroform are soluble in each other due to:**
   (a) Intermolecular hydrogen bonding
   (b) Dipole-dipole interaction
   (c) Instantaneous dipoles
   (d) All of the above
3. **NH_3 shows a maximum boiling point among the hydrides of vth group elements due to:**
   (a) Very small size of nitrogen
   (b) Lone pair of electrons present on nitrogen.
   (c) Enhanced electronegative character of nitrogen
   (d) Pyramidal structure of NH_3
4. **When water freezes at 0°C, its density increase due to:**
   (a) cubic structure of ice
   (b) empty spaces present in the structure of ice
   (c) change of bond angles
   (d) Change of bond lengths
5. **Amorphous solids:**
   (a) Have sharp melting points
   (b) Undergo clean cleavage when cut with knife
   (c) Have perfect arrangement of atoms
   (d) Can possesses small regions of orderly arrangement of atoms
6. **The molecules of CO_2 in dry ice form the:**
   (a) Ionic crystals (b) Covalent crystals
   (c) Molecular crystals
   (d) Any type of crystals
7. **Which of the following is a pseudo solid:**
   (a) CaF_2 **(b) Glass** (c) NaCl (d) All

II) From Punjab Boards:-

1. **The example of hexagonal system is:** **(LHR 2011)**
   (a) sulphur (b) NaCl
   (c) Graphite (d) Diamond
2. **Liquid hydrocarbon is:** **(LHR 2011)**
   (a) Methane (b) Propane
   (c) Ethane **(d) Hexane**
3. **The existence of an element in more than are crystalline form is called:** **(LHR 2012)**
   (a) Allotropy (b) Isotopy
   (c) Isomorphism (d) Polymorphism
4. **Acetone & chloroform are soluble in each other due to:** **(LHR 2012,13)**
   (a) Intermolecular hydrogen bonding
   (b) Ion-dipole interaction
   (b) Instantaneous dipole
   (d) Covalent bonding
5. **Which of the following is a pseudo solid?** **(LHR 2014 G-I) (BWP 2016,17) (FSD 2014) (LHR 2015,16) (DGK 2016,17)(GRW 2015) (MTN 2017)**
   (a) CaF_2 **(b) Glass** (c) NaCl (d) All
6. **In dry ice, CO_2 molecules form:** **(LHR 2015 G-I) (RWP 2016) (SGD 2014) (DGK 2017) (MTN 2019)**
   (a) Ionic crystals (b) Covalent crystals
   (c) Molecular crystals
   (d) Any type of crystals
7. **Allotropy is the property of : (GRW 2011)**
   (a) Element (b) compound
   (c) mixture (d) ions
8. **When water freezes at 0°C, its density decreases due to:** **(GRW 2012, 2013) (AJK 2016) (DGK 2012)**
   (a) cubic structure of ice
   (b) change of bond length
   (c) empty spaces present in the structuring of ice
   (d) change of band angles
9. **London dispersion forces are the only forces present among the :** **(GRW 2014 G-I, 2015)(DGK 2016)**
   (a) molecules of water in liquid state
   (b) atoms of helium in gaseous state at high temperature
   (c) molecules of solid iodine
   (d) molecules of hydrogen chloride gas

10. Acetone and chloroform are soluble in each other due to: (GRW 2014 G-II) (FSD 2015) (RWP 2015) (SGD 2014) (BWP 2016) (FSD 2016)
(a) inter molecular hydrogen boding
(b) Ion dipole interaction
(c) instantaneous dipole
(d) all of these

11. Down the VII-A group, polarizability generally: (GRW 2016)
(a) decreases **(b) increases**
(c) remains the same (d) unpredictable

12. Dipole-induced dipole forces are called: (MTN 2011, 15) (DGK 2018)
(a) London dispersion **(b) Debye forces**
(c) Huckel forces (d) Electrostatic forces

13. Acetone and chloroform are soluble in each other due to: (MTN 2012, 2013) (SGD 2018)
(a) Intermolecular hydrogen bonds
(b) Ion-dipole interaction
(c) Instantaneous dipole
(d) All of these

14. When water freezes at 0°C its density decreases due to: (MTN 2016,17) (SGD 2013)
(a) Cubic structure of ice
(b) Empty spaces present in the structure of ice
(c) Change of bond length
(d) Change of bond angles

15. Transition temperature of Tin (Sn) is: (FSD 2011)
(a) 128°C (b) 95.5°C **(c) 13.2°C** (d) 32.8°C

16. Water has maximum density at : (FSD 2011)
(a) 4 °C (b) 0°C (c) 100°C (d) 10°C

17. Acetone and chloroform are soluble in each other due to: (FSD 2016)(DGK 2019)
(a) Intermolecular hydrogen bonding
(b) Ion dipole interaction
(c) Instantaneous dipole
(d) London dispersion forces

18. Which of the following liquid has highest boiling point? (RWP 2011)
(a) HCl (b) HBr **(c) H_2O** (d) Br_2

19. Ice occupies more space than liquid water upto: (RWP 2011)
(a) 9% (b) 10% (c) 11% (d) 12%

20. NH_3 shows a maximum boiling point among hydrides of 5th group elements due to: (RWP 2012) (FSD 2013)
(a) Enhanced electronegative character of nitrogen
(b) Pyramidal structure of NH_3
(c) Lone pair of electrons present on nitrogen
(d) Very small size of nitrogen atom

21. The unit cell length for Cu is: (RWP 2014)
(a) $a \neq b = c$ (b) $a \neq b \neq c$
(c) $a = b \neq c$ **(d) $a = b = c$**

22. NH_3 shows a maximum boiling point among: (RWP 2017)
(a) very small size of nitrogen
(b) love pair of electron present on nitrogen
(c) enhanced electronegative character present
(d) pyramidal structure of NH_3

23. Dipole forces are present among: (SGD 2016)
(a) molecules of iodine
(b) atoms of I_2 invapour phase
(c) atoms of Neon in gases is state
(d) molecules of chloroform

24. Vapour pressure of liquid depends upon: (SGD 2016)
(a) amount of liquid (b) surface area
(c) temperature (d) size of container

25. When $a \neq b \neq c$ and $\alpha = \gamma = 90°$, $\beta \neq 90°$ then the crystal system is: (DGK 2013, 2014, 2015)
(a) Hexagonal **(b) Monoclinic**
(c) Cubic (d) Tetragonal

26. Dipole-dipole forces are present among. (SWL 2016)
(a) molecules of Iodine
(b) atoms of Iodine in vapour phase
(c) atoms of Neon in gaseous state
(d) molecules of chloroform

27. Vapour pressure of liquid depends upon. (SWL 2016, 17)
(a) amount of liquid (b) surface area
(c) temperature (d) size of container

28. Transition temperature of KNO_3. (SWL 2017)
(a) 13.2 °C (b) 95.5 °C **(c) 128 °C** (d) 32.2 °C

III) From Entry Test:-

(1) In the graphite lattice, what is the number of nearest neighbours for each carbon atom?
(a) 3 (b) 4 (c) 5 (d) 6

(2) In hexagonal closest packing, the number of nearest neighbours for a given lattice point:
(a) 6 (b) 8 (c) 10 **(d) 12**

(3) Hydrocarbons having high molecular mass exist as:
(a) Solid (b) Liquid
(c) Gas (d) Vapours

(4) The solid particles possess only:
(a) Translational K.E. (b) Rotational K.E.
(c) Vibrational K.E. (d) All of these

(5) Glass is:
(a) Amorphous solid (b) Vitreous solid
(c) Pseudo solid **(d) All**

(6) Water is wetting liquid. It is due to:
(a) Adhesive forces exceed cohesive forces
(b) Cohesive forces exceed adhesive forces
(c) Adhesive forces become equal to the cohesive forces
(d) None is true

(7) Select the mismatch:
(a) NaCl → Cubic **(b) Borax → Trigonal**
(c) Ice → Hexagonal (d) $K_2Cr_2O_7$ → Triclinic

(8) Which pair of molecules have Debye forces in them:
(a) Ar and Ar **(b) Argon and water**
(c) Na^+ ion and water (d) Water and water

(9) Which pair of compounds are isomorphic in nature:
(a) NaCl and KNO_3 (b) KNO_3 and MgO
(c) MgO and NaF (d) NaF and $CaCO_3$

SECTION II

SHORT QUESTIONS

From Exercise:-

QUESTIONS

1. Cleavage of the crystals is itself anisotropic behaviour.

Ans. Some of the crystals show variation in physical properties depending upon the directions, such properties are called anis tropic properties. Cleavage is an anis tropic property because many crystals have a specific cleavage plane and they can be cleaved only in that plane.

Example:

Mica sheets can be cleaved only parallel to length of sheet and not easily in the other direction.

2. The crystals showing isomorphism mostly have the same atomic ratios.

Ans. Isomorphism;

Two different substances which have same crystalline form are called as isomorphs and this phenomenon is called as isomorphism.

Examples:

Isomorphs	Crystalline Form	Atomic Ratio
$NaNO_3$, KNO_3	Rhombohederal	1 : 1 : 3
$ZnSO_4$, $NiSO_4$	Orthorhombic	1 : 1 : 4

Mostly the ratio of atoms in various compounds is such that, they can form same crystal lattices and show isomorphism. This phenomenon is commonly shown by ionic compounds having same atomic ratios.

3. The transition temperature is shown by elements having allotropic forms and by compounds showing polymorphism.

Ans. Transition temperature;

The temperature at which the crystalline forms of a substance (an element or compound) can co-exist at equilibrium is called as transition temperature.

Examples:

(Element) Grey Tin (cubic) $\overset{13.2^{\circ}C}{\rightleftharpoons}$ White thin (tetragonal)

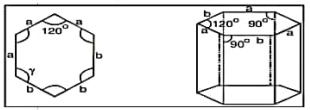
(Compound) KNO_3 (Orthorhombic) $\overset{128^{\circ}C}{\rightleftharpoons}$ KNO_3 (rhombohedral)

It is obvious from the examples that, the transition temperature is shown by both elements as well as compounds which have more than one crystalline forms.

4. One of the unit cell angles of hexagonal crystal is 120°.

Ans. For a hexagonal crystalline shape.

$a = b \neq C$, $\alpha = \beta = 90°$, $\gamma = 120°$



The interior angles of a regular figure of "n" sides are always equal and can be calculated by using formula that.

$$\text{Angle} = 180\left[\frac{n-2}{n}\right]$$

∴ Where "n" is the number of sides of a regular shape. A regular hexagonal shape have six equal sides (a = b) and have six equal angles (γ). So the angle γ of a regular hexagon can be calculated as.

$$\text{Angle } \gamma = 180\left[\frac{6-2}{6}\right]$$

$$= 180 \times \frac{4}{6} = 120°$$

(II) From Punjab Boards:-

1. Define isomorphism and polymorphism.

(LHR 2013) (MTN 2017, 18)

Ans.	Isomorphism	Polymorphism
(i)	ISO means same "morph" means structure.	Poly means "many" morph means structure.
(ii)	The phenomenon in which two different substances are found in same crystalline form is called Isomorphism.	The phenomenon in which substance is present in more than one crystalline form is called polymorphism.
(iii)	**Example:** $CaCO_3$, $NaNO_3$ (Rhmbohederal)	**Example:** limestone ($CaCO_3$) is found in nature as calicite which in trigonal and as aragonite which is orthorhombic.

2. Define transition temperature with an example. (FSD 2016) (SGD 2017) (LHR 2014) (AJK 2016) (SWL 2016)

Ans. Transition temperature:

The temperature at which two crystalline forms of a substance can co-exist at equilibrium is called transition temperature.

Example: Grey tin $\underset{}{\overset{13.2°C}{\rightleftharpoons}}$ White Tin

(Cubic) (Tetragonal)

3. What is the relationship between polymorphism and allotropy?(LHR 2015)

Ans. Polymorphism: When a compound exists in more than one crystal shape, then the phenomenon is called polymorphism. Lunar caustic ($AgNO_3$) exist as trigonal and orthorhombic.

Allotropy: When an element exists in more than one crystalline form, called allotropy. Carbon has allotropic form diamond, graphite.

4. Why ice floats over the surface of water? (LHR 2016, 17) (DGK 2016) (BWP 2017) (DGK 2018)

Ans. Ice is solid water. Water expands when it is solidified. This expansion is due to empty spaces which are left behind due to the hydrogen bonding the density of ice is close to 0.91 g cm^{-3} as compared to that of liquid water which is 1.00 g cm^{-3} at 4°C.

5. Water is liquid at room temperature while H_2S is a gas, comment. (LHR 2011) (RWP 2011)

Ans. This is due to high electro negativity of oxygen as compared to sulphur. Water has hydrogen bonding, but H_2S does not have. Due to absence of hydrogen bonding in H_2S at room temperature, it is a gas.

6. Cleavage of the crystals is itself anisotropic behaviour? (GRW 2012) (MTN 2016) (DGK 2016, 18)

Ans. Anisotropy is a property of being directionally dependent. The cleavage of a crystal is also a directional so cleavage of the crystal is called its anisotropic behaviour.

7. What are crystallographic elements? (GRW 2014) (RWP 2017) (DGK 2014)

Ans. Crystallographic Elements:

The complete description of the unit cell is given by six parameters. These are three edge lengths (a, b, c) and interfacial angle (α, β,γ). These are called crystallographic elements or unit cell dimensions.

8. The electrical conductivity of the metals decreases with the increase in temperature. (FSD 2017) (DGK 2018)

Ans. As the temperature is increased, the positive ions start oscillating and hinder the movement of free electrons.

9. Why HF has less acidic strength than HI? (GRW 2016) (MTN 2017)

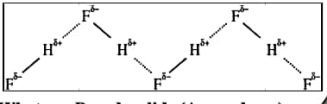
Ans. HF has stronger Hydrogen bonding in HF, the partial positively charged hydrogen is trapped between two strongly electronegative Fluorine atoms.

Moreover, Bond energy of HF > HI

HF = 567 KJ mol^{-1}

HI = 299 KJ mol^{-1}

So HF has less acidic strength than HI.



10. What are Pseudosolids (Amorphous). (BWP 2016)

Ans. Amorphous Solids:

Those solids in which the atoms, ions, or molecules are arranged in a random manner are called amorphous solids or pseudo solids.

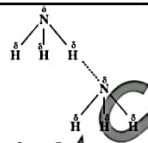
For example: Glass

11. Define crystalline solids and crystallites. (RWP 2014)

Ans. Those solid in which atoms, ions or molecules are arranged in a definite three dimensional pattern are called crystalline solids. This repairing regular geometrical pattern of structure extend three dimensionally. A long rang regularity does not exist in amorphous solids but they can possess small regions of orderly arrangements. These crystalline parts of amorphous solids are known as crystallites.

12. Define Hydrogen bonding. Show hydrogen bonding in ammonia molecule. (RWP 2016, 17)

Ans. The electrostatic force of attraction between a highly electronegative atom and partial positively charged hydrogen atoms.



13. Intermolecular forces are weaker than intra molecular force why? (SGD 2012)

Ans. Because inter molecular forces are exist between the molecules while intermolecular forces are exist between the atoms within a molecule that is why interamolecular forces are stronger.

14. Define Amorphous solids and Crystalline solids. (SGD 2017)

Ans. Amorphous Solids:

Those solids in which the atoms, ions, or molecules are arranged in a random manner are called amorphous solids or pseudo solids.

For example: Glass

Crystalline Solids:

Those solid substances in which the atoms, molecules or ions are arrange in regular, repeating, three-dimensional well-ordered pattern.

For example: NaCl

15. Define allotropy with an example. (DGK 2-14, 16)

Ans. The existence of an element in more than one crystalline forms is known as allotropy and these forms are called allotropes.

For example sulphur has two allotropes (rhombic monoclinic) and carbon also contain two allotropes diamond (cubic) and graphite (hexagonal).

16. Define unit cell with example.(SWL 2014)

Ans. The smallest part of a crystal which show all of its characteristics features is called unit cell.

SECTION III

LONG QUESTIONS

1. Explain hydrogen bonding in NH_3, H_2O and HF. How it is helpful in explaining the structure of ice? (LHR 2011)
2. What are intermolecular forces? Write the names of different types of their forces and explain instantaneous dipole-induced dipole forces. (FSD 2012)
3. Differentiate between isomorphism and polymorphism with suitable example. (FSD 2016)
4. What is meant by the term hydrogen bonding? How does hydrogen bonding explain the properties of Proteins. (SGD 2017) (GRW 2012)
5. Explain seven crystal system with angles and edges. (DGK 2014)
6. Write a note on three factors affecting the London Forces. (BWP 2017) (DGK 2014)
7. Define hydrogen bonding. How it is helpful in explaining the structure of ice? (SWL 2013) (SGD 2011)
8. Explain the terms dipole-dipole and dipole induced dipole forces. (SWL 2014)
9. Define the followings with examples. (SWL 2016)
   (i) Amorphous solids
   (ii) Habit of a crystal
   (iii) Allotropy
   (iv) Transition temperature

❋❋❋❋

Chapter – 5

ATOMIC STRUCTURE

SECTION I

Multiple Choice Questions

I) From Exercise:-

(i) The nature of the positive rays depend on:
(a) The nature of the electrode
(b) The nature of the discharge tube
(c) The nature of the residual gas
(d) All of the above

(ii) The velocity of the photon is: (MTN 2019)
(a) Independent of its wavelength
(b) Depend on its wavelength
(c) Equal to square of its amplitude
(d) Depends on its source

(iii) The wave number of the light emitted by a source is 2×10^6 m^{-1}. The wavelength of this light will be:
(a) 500 nm (b) 500 m
(c) 200 nm (d) 5×10^7 m

(iv) Rutherford's model of atom failed because:
(a) The atom did not have a nucleus and electrons
(b) It did not account for the attraction between protons and neutrons
(c) It did not account for the stability of the atom
(d) There is actually no space between the nucleus and the electrons

(v) Bohr model of atom in contradicted by: (DGK 2019)
(a) Planck's quantum theory
(b) Dual nature of matter
(c) Heisenberg's uncertainty principle
(d) All of the above

(vi) Splitting of spectral lines when atoms are subjected to strong electric field is called: (MTN 2019)
(a) Zeeman effect **(b) Stark effect**
(c) Photoelectric effect
(d) Compton effect

(vii) In the ground state of an atom, the electron is present: (MTN 2019)
(a) In the nucleus
(b) In the second shell
(c) Nearest to the nucleus
(d) Farthest from the nucleus

(viii) Quantum number values for 2p orbitals are: (LHR, MTN 2019)
(a) n = 2, l = 1 (b) n = 1, l = 2
(c) n = 1, l = 0 (c) n = 2, l = 0

(ix) Orbitals having same energy are called: (DGK 2019)
(a) Hybrid orbitals (b) Valence orbitals
(c) Degenerate orbitals
(d) d-orbitals

(x) When 6d orbital is complete, the entering electron goes into: (SGD 2019)
(a) 7f (b) 7s **(c) 7p** (d) 7d

II) From Punjab Boards:-

1. Neutron was discarded by: (LHR 2011)
(a) Chadwick (b) C.D. Anderson
(c) Rutherford (d) Goldstein

2. Mass of electron is: (LHR 2011)
(a) 9.1095×10^{31} kg **(b) 9.1095×10^{-31} kg**
(c) 9.1095×10^{-27} (d) 9.1095×10^{-31} g

3. The nature of the positive rays depends on: (LHR 2012) (GRW 2014) (MTN 2016) (RWP 2017)
(a) The nature of the cathode
(b) The nature of the anode
(c) The nature of the residual gas
(d) The nature of the discharge tube

4. The e/m value for the positive rays is maximum for: (LHR 2013)
(a) Hydrogen (b) Helium
(c) Oxygen (d) Nitrogen

5. The velocity of photon is: (LHR 2013) (DGK 2012)
(a) Independent of the wavelength
(b) Depends on its wavelength
(c) Equal to square of its amplitude
(d) Depends on its source

6. In ground state of an atom the electron is present: (LHR 2014 G-I) (GRW 2014) (LHR 2016) (BWP 2017)
(a) In the nucleus (b) In the second shell
(c) Nearest to the nucleus
(d) Farthest from the nucleus

7. When 6d orbital is complete, the next electron goes into:
(LHR 2014 G-I) (AJK 2016) (DGK 2016,17) (MTN 2015,17) (RWP 2015,17) (SGD 2019)
(a) 7 f (b) 7s **(c) 7p** (d) 7 d

8. When 4s orbital is complete, the entering electron goes into : (LHR 2014 G-II)
(a) 4p orbital **(b) 3d orbital**
(c) 4f orbital (d) 4d orbital

9. Orbitals having same energy are called:
(LHR 2015 G-I) (DGK 2013,17) (RWP 2017)
(a) Hybrid orbitals (b) Valence orbitals
(c) Degenerate orbitals
(d) d-orbitals

10. The wave number of light emitted by a certain is 2×10^{6} m^{-1}. The wavelength of this light will be:
(LHR 2015 G-II) (AJK 2016) (FSD 2014) (SGD 2015) (GRW 2016) (MTN 2014,17)
(a) 500 nm (b) 500 m
(c) 200 nm (d) 5×10^{7} m

11. For which system does equilibrium constant, K, has units of $(concentration)^{-1}$.
(LHR 2016) (GRW 2016)
(a) $Na + 3H_2 \rightleftharpoons 2NH_3$
(b) $H_2 + I_2 \rightleftharpoons 2HI$
(c) $2NO_2 \rightleftharpoons N_2O_4$
(d) $2HF \rightleftharpoons H_2 + F_2$

12. Which of the hydrogen halides has the highest percentage of ionic character:
(LHR 2016)
(a) HCλ (b) HBr **(c) HF** (d) HI

13. Quantum number value for 2p orbitals are:
(LHR 2016)(DGK 2019)
(a) n = 2, λ = 1 (b) n = 1, λ = 2
(c) n = 1, λ = 0 (d) n = 2, λ = 2

14. Orbitals having same energy are called:
(LHR 2017) (FSD 2016) (SGD 2016) (BWP 2017) (DGK 2017) (LHR 2015)
(a) Hybrid oribtals (b) Valence orbitals
(c) Degenerate orbitals
(d) d-orbitals

15. Bombardment of α-particles on Beryllium (Be) atoms emits neutron and this process is called: (GRW 2011)
(a) natural radioactivity
(b) Artificial radioactivity
(c) Pauli exclusion principle
(d) Hund's rule

16. Blamer series in hydrogen spectrum lies in the region: (GRW 2011)
(a) ultraviolet **(b) visible**
(c) infrared (d) microwave

17. Cathode rays strike aluminina and produce a _____ color: (GRW 2015)
(a) Red (b) Blue (c) Yellow (d) Green

18. Rutherford's model of atom failed because:
(a) The atoms did not have nucleus and electrons
(b) It did not occur for the attraction between proton and neutron
(c) It did not account for the stability of atom
(d) There is actually no space between nucleus and electrons

19. Lyman series occur in:
(FSD 2015) (DGK 2019)
(a) visible region **(b) uv region**
(c) I.R region (d) non of these

20. When fast neutron carry nuclear reaction with nitrogen, it ejects particles.
(RWP 2014)
(a) α (b) β (c) r (d) s

21. The limiting line of Balmer series lies in the region: (SGD 2011)
(a) Visible **(b) U.V**
(c) Near 10R (d) Far I.R

22. When ∝-particles strike on the nucleus of $^{9}_{4}$ Be then the emitted particles is:
(DGK 2013, 2015)
(a) Proton **(b) Neutron**
(c) Neutrino (d) r-radiations

23. de-Broglie equation is represented by:
(DGK 2015)
(a) $h = \frac{\lambda}{mv}$ (b) $m = \frac{h}{\lambda v}$
(c) $m = \frac{h}{hm}$ (d) $\lambda = \frac{h}{mv}$

24. Ruther ford's model failed because.
(DGK 2016)
(a) The atom did not have a nucleus and electrons
(b) It did not account for the attraction between protons and neutrons
(c) It did not account for the stability of the atom
(d) There is no space between nucleus and the electrons

25. Bohr model of atom was contradicted by (DGK 2016)
(a) Planck's quantum theory
(b) dual nature of the matter
(c) Heisenberg's uncertainty principle
(d) Aufbau principle

26. When 5d orbital is completed then entering electron goes into. (SWL 2017)
(a) 6 s **(b) 6 p** (c) 6 d (d) 6 f

III) From Entry Test:-

(1) Which colour have minimum energy?
(a) Violet (b) Blue **(c) Red** (d) Green

(2) The shape of dz^2 orbital is:
(a) Spherical (b) Dumb-bell
(c) Dumb-bell with collar
(d) Sausage

(3) How many times mass of electron is lighter than mass of hydrogen?
(a) 2×10^{-4} (b) 3×10^{-4}
(c) 4×10^{-4} **(d) 5×10^{-4}**

(4) Which of the following elements have highest ionization energy?
(a) $1s^2\ 2s^2\ 2p^3$ (b) $1s^2\ 2s^2\ 2p^4$
(c) $1s^2\ 2s^2\ 2p^4\ 3s^1$ (d) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^3$

(5) Mass of 1 mol of electron is:
(a) 1.008 mg (b) 0.184 mg
(c) 1.673 mg **(d) 0.54 mg**

(6) Which of the following determines the position of an element in the periodic table?
(a) Chemical reactivity
(b) First ionization energy
(c) No. of electrons in the outer orbital
(d) No. of protons in the nucleus

(7) What is the proton (atomic) number of an element which has four unpaired electrons in the ground state?
(a) 6 (b) 16 (c) 18 **(d) 26**

(8) Which particle has longest wavelength if they have same speed?
(a) Proton **(b) Electron**
(c) Neutron (d) α-particle

(9) Television picture tube is a type of:
(a) X-ray tube **(b) Discharge tube**
(c) Positive rays tube (d) Millikan tube

(10) The maximum number of electrons in a sub-shell with $l = 3$ is:
(a) 6 (b) 10 **(c) 14** (d) 18

(11) Radius of the third shell of H-atom is:
(a) 5.716°A **(b) 4.761°A**
(c) 6.671°A (d) 3.716°A

SECTION II
SHORT QUESTIONS

From Exercise:-

QUESTIONS

1. Why is it necessary to decrease the pressure in the discharge tube to get the cathode rays?

Ans. It is observed that current does not flow through the gas at ordinary pressure even at high voltage of 5000 volts due to crowdedness of gas molecules. When pressure is reduced to 0.01 torr, the number of molecules decreases and empty spaces are produced. Therefore electrons (cathode rays) can easily pass through these empty spaces and move towards the anode.

2. Why e/m value of the cathode rays is just equal to that of electrons?

Ans. J.J Thomson in 1897 concluded from his experiments that cathode rays consist of streams of negatively charged particles. Stony named these particles as electrons. Thomson also determined that the e/m value of cathode rays for different gases i.e., 1.7588×10^{11} C/kg. J.J Thomson said that cathode rays are simply electrons. Therefore, the e/m value of cathode rays is just equal to that of electrons.

3. Whichever gas is used in the discharge tube, the nature of the cathode rays remains the same. Why?

Ans. Cathode rays are consist of negatively charged particles moving from anode towards cathode. J.J. Thomson calculate the e/m value of these particles, which is 1.7588×10^{11}C. kg^{-1}. In his experiment, he used different gases but the e/m value for all the gases remain same. Stoney named these particles as electrons.

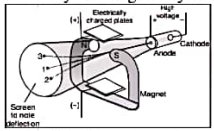
Thomson concluded that electrons (cathode rays) are the fundamental particles of all the atoms hence which ever gas is used in the discharge tube, the nature of the cathode rays remains the same.

4. How the bending of cathode rays in the electric and magnetic fields shows that they are negatively charged?

Ans. In 1895 J.Perrin observed that cathode rays are deflected in a magnetic field, perpendicular to the line joining the north and

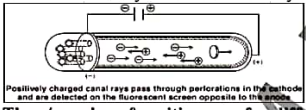
south pole. This shows that cathode rays are charged particles.

In 1897, J.J Thomson passed the cathode rays through an electric field. The cathode rays deflected towards the positive end indicating that cathode rays are negatively charged.



5. Why the positive rays are also called canal rays?

Ans. E. Goldstein took a discharge tube provided with a cathode having fine holes. When a large potential different is applied between electrodes, it was observed that while cathode rays traveling away from the cathode there are some other rays which after passing through the holes of cathode opposite to the anode. When these rays pass through the holes of the cathode, they appear as canals. Therefore these rays are called canal rays.



6. The e/m value of positive rays for different gases are different but those for cathode rays, the e/m values are the same. Justify it.

Ans. Hydrogen atom s consist of a proton and an electron. The positive particles obtained from hydrogen gas are protons, while Cathode rays are simply electrons. The mass of proton is 1836 times greater than that of the electrons; therefore e/m value of positive rays obtained from hydrogen gas is 1836 times less than that of cathode rays.

7. The e/m value for positive rays obtained from hydrogen gas is 1836 times less than that of cathode rays. Justify it.

Ans. The positive rays are produced when the high speed cathode rays (electrons) knock out electrons from the molecules of a gas. Hence, the e/m value for these positive rays depend upon the gas used inside the discharge tube and is different for different gases. The heavier the gas, the smaller is the e/m value. But cathode rays are simply electrons and electrons are the fundamental particles of atoms and their nature remains the same for every gas. So, e/m value of cathode rays remains the same.

8. How did Rutherford's model of an atom first of all proved the existence of nucleus of an atom?

Ans. In 1911 Lord Rutherford performed an experiment and studied the scattering of high speed α-particles. A photographic plate or screen coated with ZnS was used as a detector. It was observed that most of the particles went through the foil undeflected. Some were deflected at fairly large angles and a few were deflected backwards. Rutherford proved that the rebounding particles must have collided with the central heavy portion of the atom which he called as nucleus.

9. What are the defects in the Rutherford atomic model?

Ans. The main defects in Rutherford atomic model are as following.

(i) Rutherford model was based on law of gravity, but the laws of motion can be applied to the neutral particles like planets and are not applicable on charged particles like electrons and protons.

(ii) According to Rutherford the electron should continuously revolve around the nucleus to overcome the nuclear force. So due to continuous loss of energy, the electron is attracted more towards the nucleus. Therefore the radius of the moving electrons should become smaller and smaller, ultimately it should fall in the nucleus. Thus an atomic structure as proposed by Rutherford would collapse.

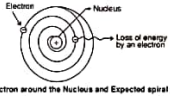


Fig. Rotation of Electron around the Nucleus and Expected spiral path

(iii) Since the electron is moving continuously around the nucleus, so it should radiate energy continuously. Hence we should get a continuous spectrum but actually atoms give line spectrum.

10. Differentiate between frequency and wavelength.

Ans.

Frequency	Wavelength
"Frequency is the number of waves passing through a point per second." ➢ It is denoted by "ν". Mathematically, $E \propto \nu$ $E = h\nu$ Where "h" is called as Planck's constant (6.625×10^{-34} joule sec)	"Wavelength is defined as the distance between the two adjacent crests or troughs of a wave and is expressed in A° or nm. ➢ It is denoted by λ (lambda)". Mathematically, $V \propto \frac{1}{\lambda}$ $V = f(c,\lambda)$

11. How can we calculate the mass of an electron?

Ans. The value of charge on electron is 1.602×10^{-19} coulombs, while e/m of electrons is 1.7588×10^{11} coulombs kg^{-1}.

$e/m = 1.7588 \times 10^{11}\ C.kg^{-1}$

$e = 1.602 \times 10^{-19}\ C$

$m = ?$

We know,

$$\frac{e}{m} = 1.7588 \times 10^{11}\ C.kg^{-1}$$

Putting value of "e", in above equation.

$$\frac{1.602 \times 10^{-19} C}{m} = 1.7588 \times 10^{11} C.kg^{-1}$$

So,

$$m = \frac{1.602 \times 10^{-19} C}{1.7588 \times 10^{11} C.kg^{-1}}$$

$$m = \boxed{9.1095 \times 10^{-31}\ kg}$$

Hence mass of electron is 9.1095×10^{-31}kg

12. Write the equations, when neutron hits nitrogen and copper metal.

Ans. When neutrons are used as projectiles, they can carry out the nuclear reactions.

(i) Nitrogen:

A fast neutron ejects an α-particle from the nucleus of nitrogen atom and boron is produced.

$$^{14}_{7}N + {}^{1}_{0}n \longrightarrow {}^{11}_{5}B + {}^{4}_{2}He$$

(ii) Copper Metal:

When a slow neutron hit the Cu metal, the γ-radiations are emitted.

$$^{65}_{29}Cu + {}^{1}_{0}n \longrightarrow {}^{66}_{29}Cu + h\nu\ (\gamma\text{-radiations})$$

The radio active $^{66}_{29}Cu$ is converted into $^{66}_{30}Zn$ by emitting electron.

$$^{65}_{29}Cu \longrightarrow {}^{66}_{30}Zn + {}^{0}_{-1}e$$

13. Justify that the distance gapes between different orbits go on increasing from lower to higher orbitals?

Ans. The radius of any orbit "n" can be calculated by following relation.

$$\boxed{r_n = 0.529\ A^\circ (n)^2}$$

By putting the value of n as 1, 2, 3, 4, 5, ... we can calculate the radii of orbits of hydrogen atom as,

If $n = 1, r_1 = 0.529\ A^\circ \times (1)^2 = \boxed{0.529\ A^\circ}$

If $n = 2, r_2 = 0.529\ A^\circ \times (2)^2 = \boxed{2.116\ A^\circ}$

Gap between successive orbits of H atom:

The comparison of radii shows that the distance between orbits of H-atom goes on increasing as we move from 1st orbit to higher orbits.

$r_2 - r_1 = 2.116\ A^\circ - 0.529\ A^\circ = \boxed{1.587\ A^\circ}$

$r_3 - r_2 = 4.716\ A^\circ - 2.116\ A^\circ = \boxed{2.645\ A^\circ}$

$r_4 - r_3 = 8.464\ A^\circ - 4.761\ A^\circ = \boxed{3.703\ A^\circ}$

$r_5 - r_4 = 13.225\ A^\circ - 8.464\ A^\circ = \boxed{4.761\ A^\circ}$

So, $r_2 - r_1 < r_3 - r_2 < r_4 - r_3 < r_5 - r_4 < \ldots\ldots$

14. How Bohr's model of atom explain the ionization energy of an atom?

Ans. Ionization energy:

The energy required to remove an electron from the valence shell of an isolated gaseous atom in its ground state is called ionization energy.

The energy difference between first and infinite energy level in the hydrogen atom can be calculated from the Bohr's equation as.

$E_\infty - E_1 = 0 - (-1313.31)$

$= 1313.31$ KJ/mole

This energy is the ionization energy of the hydrogen atom and it represent the energy required for moving electron from the first orbit of H atom to a position where it is free from the attraction of nucleus.

15. Differentiate between atomic emission and atomic absorption spectrum?

Ans.

Atomic Emission Spectrum	Atomic Absorption Spectrum
(i) Spectrum of emitted radiation of a heated element.	(i) Spectrum of a radiation after being absorbed by an element in the ground state.
(ii) It is characteristic of an element in the exited state.	(ii) It is characteristics of an element in the ground state.
(iii) It appears as bright lines against dark background.	(iii) It appears as dark lines against bright background.
(iv) **Example:** Spectrum of excited hydrogen	(iv) **Example:** Spectrum of O_2 in the ground state

16. What is the function of principal quantum number?

Ans. The quantum number which represent the main energy level or main shell in which an electron revolves around the nucleus is called principal quantum number.

- It is denoted by 'n'.

Its values are non zero positive integers upto infinity.

e.g., n = {1, 2, 3, ... ∞}.

Significance:

- It determine the location of electron is an atom.
- It gives a quantitative measure of the size an electronic shell.
- It also provides us the energy of electron in a shell.

The value of "n" also gives the maximum number of electrons, which can be accommodated in a shell by the formula "$2n^2$"

17. Differentiate between orbit and orbital?

Ans.

Orbit	Orbital
(i) It is a definite circular path at a fixed distance from the nucleus on which the electron is revolving around the nucleus.	(i) It is a three dimensional region or space around the nucleus in which the probability of finding an electron is maximum (95%)
(ii) Orbits are supposed to have a circular shape.	(ii) Orbitals have different shapes e.g., s-orbital is spherically symmetrical while p-orbitals are dumb-bell shaped.
(iii) Orbits represent the planar motion of the electron.	(iii) Orbitals represent three dimensional motion of the electron.
(iv) The maximum number of electrons in an orbit is equal to $2n^2$, where n is equal to the number of the orbit.	(iv) The maximum number of electrons in an orbital is equal to 2.

II) From Punjab Boards:-

1. Why is it necessary to decrease the pressure in the discharge tube to get the cathode rays? (LHR-2011, 2012)

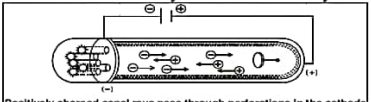
Ans. It is observed that current does not flow through the gas at ordinary pressure even at high voltage of 5000 volts due to ***crowdedness*** of gas molecules. When pressure is reduced to 0.01 torr, the number of molecules decreases and empty spaces are produced. Therefore electrons (cathode rays) can easily pass through these empty spaces and move towards the anode.

2. Why e/m ratio of the cathode rays is just equal to that of electron? (MTN 2014)

Ans. J.J Thomson in 1897 concluded from his experiments that cathode rays consist of streams of negatively charged particles. ***Stony named these particles as electrons.*** Thomson also determined that the e/m value of cathode rays for different gases i.e., 1.7588×10^{11} c/kg. J.J Thomson said that cathode rays are simply electrons. Therefore, the e/m value of cathode rays is just equal to that of electrons.

3. Why the positive rays are also called canal rays? (GRW 2014,16)(BWP2013)(SWL 2014)

Ans. ***E. Goldstein*** took a discharge tube provided with a cathode having fine holes. When a large potential difference is applied between electrodes, it was observed that while cathode rays traveling away from the cathode there are some other rays which after passing through the holes of cathode opposite to the anode. When these rays pass through the holes of the cathode, they appear as canals. Therefore these rays are called canal rays.



Positively charged canal rays pass through perforations in the cathode and are detected on the fluorescent screen opposite to the anode

4. The e/m value of positive rays obtained from the hydrogen gas is 1836 times less than that of cathode rays. Justify. (FSD-2018) (SWL-2012) (AJK-2018)

Ans. Hydrogen atom is consisting of a proton and an electron. The positive particles obtained from hydrogen gas are protons, while Cathode rays are simply electrons. The mass of proton is 1836 times greater than that of the electrons; therefore e/m value of positive rays obtained from hydrogen gas is 1836 times less than that of cathode rays.

5. e/m value for positive rays is maximum for hydrogen gas. Why? (SGD-2018)

Ans. The e/m value for positive rays depends upon the mass of the gas used in the discharge tube. The heavier the gas, the smaller will be the e/m value and vice versa.

When hydrogen gas is used in the discharge tube, the e/m value is found to be maximum in comparison to any other gas because the value of 'm' is the lowest for the positive particles obtained from the hydrogen gas.

6. What is the origin of positive rays in the discharge tube? (BWP 2012)

Ans. **Origin of positive rays;**

The positive rays were produced when high-speed cathode rays struck the molecules of gas present in the discharge tube. They knocked out the electron from the gas molecules and positive ions were produced which starts moving towards cathode.

$$e^- + M \longrightarrow M^+ + 2e^-$$

7. What are the defects in the Rutherford atomic model? (GRW 2016), (FSD 2016) (DGK 2014, 16) (MTN 2016)

Ans. The main defects in Rutherford atomic model are as following.

(i) Rutherford model was based on law of gravity, but the laws of motion can be applied to the neutral particles like planets and are not applicable on charged particles like electrons and protons.

(ii) According to Rutherford the electron should continuously revolve around the nucleus to overcome the nuclear force. So due to continuous loss of energy, the electron is attracted more towards the nucleus. Therefore the radius of the moving electrons should become smaller and smaller, ultimately it should fall in the nucleus. Thus an atomic structure as proposed by Rutherford would collapse.

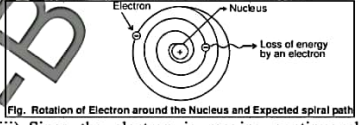


Fig. Rotation of Electron around the Nucleus and Expected spiral path

(iii) Since the electron is moving continuously around the nucleus, so it should radiate energy continuously. Hence we should get a continuous spectrum but actually atoms give line spectrum.

8. How will you relate energy of the emitted light with its frequency and wavelength? (RWP-2017)

Ans. According to Planck's quantum theory, the amount of energy associated with a quantum of radiation is proportional to the frequency of radiation.

$$E \propto \nu$$

$$E = h\nu \quad \ldots\ldots\ldots (i)$$

The frequency 'ν' is related to the wavelength of the photon as.

$$\nu \propto 1/\lambda$$

$$\nu = c/\lambda \quad \ldots\ldots\ldots (2)$$

where, c = velocity of light

Putting this in equation (2) in (1).

$$E = h\,c/\lambda \qquad \therefore\ hc \cong \text{Constant}$$

$$E \propto \frac{1}{\lambda}$$

According to this relation greater the wavelength associated photon, smaller is its energy.

9. Differentiate between frequency and wavelength?
(GRW 2011,03,16), (FSD 2012,13,14, 18)

Ans.

Frequency	Wavelength
"Frequency is the number of waves passing through a point per second." ➢ It is denoted by "ν". Mathematically, $E \propto \nu$ $E = h\nu$ Where **"h"** is called as Planck's constant (6.625×10^{-34} joule sec)	"Wavelength is defined as the distance between the two adjacent crests or troughs of a wave and is expressed in A° or nm. ➢ It is denoted by λ (lambda)". Mathematically, $\nu \propto \frac{1}{\lambda}$ $\nu = \frac{c}{\lambda}$

10. How can we calculate the mass of an electron? (GRW 2012, 13) (MTN 2016)

Ans. Mass of Electron:

The value of charge on electron is 1.602×10^{-19} coulombs, while e/m of electrons is 1.7588×10^{11} coulombs kg^{-1}.

$e/m = 1.7588 \times 10^{11}\ C.kg^{-1}$

$e = 1.602 \times 10^{-19}\ C$

$m = ?$

We know,

$$\frac{e}{m} = 1.7588 \times 10^{11}\ C.kg^{-1}$$

Putting value of "e", in above equation.

$$\frac{1.602 \times 10^{-19} C}{m} = 1.7588 \times 10^{11} C.kg^{-1}$$

So,
$$m = \frac{1.602 \times 10^{-19} C}{1.7588 \times 10^{11} C.kg^{-1}}$$

$$m = \boxed{9.1095 \times 10^{-31}\ kg}$$

Hence mass of electron is 9.1095×10^{-31} kg

11. Write the equations, when neutron hits nitrogen and copper metal.
(DGK-2011, 12) (FSD-2016)

Ans. When neutrons are used as projectiles, they can carry out the nuclear reactions.

(i) Nitrogen:

A fast neutron ejects an α-particle from the nucleus of nitrogen atom and boron is produced.

$$^{14}_{7}N + {}^{1}_{0}n \longrightarrow {}^{11}_{5}B + {}^{4}_{2}He$$

(ii) Copper Metal:

When a slow neutron hit the Cu metal, the γ-radiations are emitted.

$$^{65}_{29}Cu + {}^{1}_{0}n \longrightarrow {}^{66}_{29}Cu + h\nu\ (\gamma\text{-radiations})$$

The radio active $^{66}_{29}Cu$ is converted into $^{66}_{30}Zn$ by emitting electron.

$$^{66}_{29}Cu \longrightarrow {}^{66}_{30}Zn + {}^{0}_{-1}e$$

12. justify that the distance gapes between different orbits go on increasing from lower to higher orbits?
(RWP 2012, 14) (DGK 2018)

Ans. The radius of any orbit "n" can be calculated by following relation.

$$\boxed{r_n = 0.529\ A° (n)^2}$$

By putting the value of n as 1, 2, 3, 4, 5, ..., we can calculate the radii of orbits of hydrogen atom as.

If $n = 1$, $r_1 = 0.529\ A° \times (1)^2 =$ $\boxed{0.529\ A°}$

If $n = 2$, $r_2 = 0.529\ A° \times (2)^2 =$ $\boxed{2.116\ A°}$

Gap between successive orbits of H atom;

The comparison of radii shows that the distance between orbits of H – atom goes on increasing as we move from 1st orbit to higher orbits.

$r_2 - r_1 = 2.116\ A° - 0.529A° =$ $\boxed{1.587\ A°}$

$r_3 - r_2 = 4.716\ A° - 2.116A° =$ $\boxed{2.645\ A°}$

$r_4 - r_3 = 8.464\ A° - 4.761\ A° =$ $\boxed{3.703\ A°}$

$r_5 - r_4 = 13.225\ A° - 8.464\ A° =$ $\boxed{4.761\ A°}$

So, $r_2 - r_1 < r_3 - r_2 < r_4 - r_3 < r_5 - r_4 < .....$

13. Justify that the potential energy of the bonded electron is negative.
(BWP 2012) (AJK 2016)

Ans. It is assumed that when as electron is at infinite distance from nucleus, then its potential energy is equal to zero, because electron is not being attracted by anything. But as the electron moves closer to nucleus

due to the nuclear attraction, work is done itself by the electron. Energy is evolved in this process.

Hence the potential energy of an electron is always less than zero, and energy less than zero has negative value.

So,

$$P.E = -\frac{Ze^2}{4\pi\epsilon_o r}$$

14. Justify that total energy of an electron is negative.

Ans. According to Bohr's Model of atom, the total energy of an electron is equal to the sum of its kinetic energy and potential energy.

i.e.

Total $E = K.E + P.E$

Now,

$$P.E = -\frac{Ze^2}{4\pi\epsilon_o r}$$

$$K.E = +\frac{Ze^2}{8\pi\epsilon_o r}$$

Putting the values in the above equation,

$$E = +\frac{Ze^2}{8\pi\epsilon_o r} - \frac{Ze^2}{4\pi\epsilon_o r}$$

Taking L.C.M

$$E = \frac{-Ze^2}{8\pi\epsilon_o r}$$

(Putting value of r, we get)

$$E_n = -\frac{Z^2e^4m}{8\epsilon_0^2h^2n^2}$$

Hence it is proved that the total energy of an electron has negative value.

15. How Bohr's model of atom explains the ionization energy of an atom?

(DGK 2018) (SGD 2018)

Ans. Ionization energy:

The energy required to remove an electron from the valence shell of an isolated gaseous atom in its ground state is called ionization energy.

The energy difference between first and infinite energy level in the hydrogen atom can be calculated from the Bohr's equation as.

$$E_\infty - E_1 = 0 - (-1313.31)$$
$$= 1313.31 \text{ KJ/mole}$$

This energy is the ionization energy of the hydrogen atom and it represent the energy required for moving electron from the first orbit of H atom to a position where it is free from the attraction of nucleus.

16. Differentiate between atomic emission and atomic absorption spectrum?

(GRW 2014)

Ans.

Atomic Emission Spectrum	Atomic Absorption Spectrum
(1)When solids are volatilized or elements in their gaseous states are heated to high temperature or subjected to an electrical discharge, radiation of certain wavelengths are emitted. The spectrum of such radiations is called atomic emission spectrum.	(1)When a beam of white light is passed through a gaseous sample of an element, the element absorbs certain wavelengths, while the rest of wavelengths pass through it. The spectrum of such radiations is called as an atomic absorption spectrum.
(2)The atomic emission spectrum contain bright lines against a dark background.	(2)The atomic absorption spectrum contain dark lines and the background is bright.
(3)It is produced, due to de-excitation of electrons.	(3)It is produced due to the excitation of electrons.
(4) 	(4) 

17. Write the names and wavelengths of the various spectral series in hydrogen spectrum? (LHR 2011)

Ans. These spectral lines can be classified into five groups called as spectral series.

- ***(i) Lyman series. (U.V region)***
- ***(ii) Balmer series. (Visible region)***
- ***(iii) Paschen series. (I.R (N) region)***
- ***(iv) Brackett series. (I.R (M) region)***
- ***(v) P-fund series. (I.R (F) region)***

These series are named after their discoverers. The wavelengths of these spectral lines lie in the ultra-violet, visible and infra-red regions.

18. State Heisenberg's uncertainty principle?

(LHR 2016), (MTN 2014), (SWL 2014,15)

(BWP 2011), (RWP 2016)

Ans. On the basis of wave particle nature of matter, ***Heisenberg in 1927*** suggests that.

"It is not possible to measure simultaneously the exact position and velocity of a moving microscopic particle like electron".

According to him;

$$\Delta x \cdot \Delta p \geq \frac{h}{4\pi}$$

Δx = Uncertainty in position

Δp = Uncertainty in momentum

h = Plank's constant

The above equation is called as uncertainty principle.

19. What is the function of principal quantum number?

(GRW 2008,14), (FSD 2009), (LHR-2017)

Ans. The quantum number which represent the main energy level or main shell in which an electron revolves around the nucleus is called principal quantum number.

➢ It is denoted by 'n'.

Its values are non zero positive integers upto infinity.

e.g., n = {1, 2, 3, 4, ... ∞}

Significance:

- It determines the location of electron is an atom.
- It gives a quantitative measure of the size an electronic shell.
- It also provides us the energy of electron in a shell.
- The value of "n" also gives the maximum number of electrons, which can be accommodated in a shell by the formula ***"$2n^2$"***

20. Differentiate between orbit and orbital?

(LHR 2016), (MTN 2012)

Ans.

ORBIT	ORBITAL
(1) It is a definite circular path at a fixed distance from the nucleus on which the electron is revolving around the nucleus.	(1) It is a three dimensional region or space around the nucleus in which the probability of finding an electron is maximum (95%)
(2) Orbits are supposed to have a circular shape.	(2) Orbitals have different shapes e.g., s-orbital is spherically symmetrical while p-orbitals are dumb-bell shaped.
(3) Orbits represent the planar motion of the electron.	(3) Orbitals represent three dimensional motion of the electron.
(4) The maximum number of electrons in an orbit is equal to $2n^2$, where n is equal to the number of the orbit.	(4) The maximum number of electrons in an orbital is equal to 2.

21. Draw the shapes of p-orbitals?

(LHR 2016), (RWP 2012)

Ans. Shape of p-orbitals:

p-subshell of any energy level has three possible orientations in space i.e., along x, y and z axes.

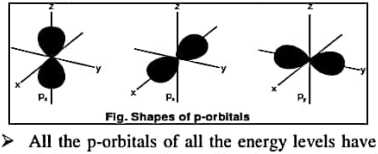


Fig. Shapes of p-orbitals

➢ All the p-orbitals of all the energy levels have similar shapes but with the increase of principal quantum number of the shell, their sizes are increased.

SECTION III

LONG QUESTIONS

1. Discuss magnetic and spin quantum numbers. (SWL 2015)
2. Describe Millikan's oil drop method for determination of charge of electron.
   (GRW 2012) (LHR 2013, 16) (DGK 2014) (SWL 2018) (RWP 2018)
3. Define quantum numbers. Discuss briefly Azimuthal quantum number.
   (GRW 2016) (SWL 2013) (LHR 2016) (SGD 2017) (MTN 2012)
4. Derive the formula for calculating the energy of an electron in nth orbit using Bohr's model. (LHR 2011) (GRW 2018)
5. Discuss properties of cathode rays.
   (LHR 2012) (MTN 2014)
6. Write down the main postulates of Bohr's theory. (FSD 2016) (LHR 2017) (DGK 2011) SWL 2016) (GRW 2013, 14) (RWP 2016) (BWP 2017)
7. How neutrons were discovered?
   (RWP 2011) (GRW 2011)
8. Ruther-fords atomic model is based on the scattering of α-particles from a thin gold foil. Describe it and explain the conclusion.
   (RWP 2014)
9. Derive the equation for the radius of nth orbit of Hydrogen atom using Bohr's model.
   (RWP 2017)
10. Define the equation for radius of nth orbit of hydrogen atom using Bohr's model.
    (SGD 2012, 18) (FSD 2018)
11. Write four properties of Positive rays.
    (SGD 2016)
12. How the charge on an electron was determined? (DGK 2013)
13. What is spectrum? Explain Atomic Emission and atomic absorption spectrum.(DGK 2016)
14. How e/m ratio of electron was determined experimentally.
    (DGK 2017) (DGK 2012) (MTN 2017)
15. What is Atomic spectrum? Explain its types.
    (SWL 2017)
16. Write down four properties of neutron.
    (LHR 2018)

❋❋❋❋

Chapter — 6

CHEMICAL BONDING

SECTION I

Multiple Choice Questions

I) From Exercise:-

(i) An ionic compound A^+B^- is most likely to be formed when

(a) the ionization energy of A is high and electron affinity of B is low.

(b) the ionization energy of A is low and electron affinity of B is high.

(c) both the ionization energy of A and electron affinity of B are high.

(d) both the ionization energy of A and electron affinity of B are low.

(ii) The number of bonds in nitrogen molecule is

(a) one σ and one π **(b) one σ and two π**

(c) three sigma only (d) two σ and one π

(iii) Which of the following statements is not correct regarding bonding molecular orbitals?

(a) Bonding molecular orbitals possess less energy than atomic orbitals from which they are formed.

(b) Bonding molecular orbitals have low electron density between the two nuclei.

(c) Every electron in the bonding molecular orbitals contributes to the attraction between atoms.

(d) Bonding molecular orbitals are formed when the electron waves undergo constructive interference,

(iv) Which of the hydrogen halides has the highest percentage of ionic character?

(a) HCl (b) HBr **(c) HF** (d) HI

(v) Which of the following species has unpaired electrons in antibonding molecular orbitals? (DGK, SAR 2019)

(a) O_2^{2+} **(b) N_2^{2-}** (c) B_2 (d) F_2

II) From Punjab Boards:-

1. Total number of bonds in C_2H_4 molecule are: (LHR 2011)

(a) six (b) four (c) five (d) eight

2. The geometry of ethane is: (LHR 2013) (RWP 2011)

(a) Trigonal planar (b) linear

(c) V-shaped **(d) tetrahedral**

3. Which of the hydrogen halides has the highest percentage of ionic character? (LHR 2013, 2014 G-I, 2015 G-II)(MTN 2016) (RWP 2017) (SWL 2016) (FSD 2016) (DGK 2015)(AJK 2016) (GRW 2018)

(a) HF (b) HBr (c) HCl (d) HI

4. Octet rule is not followed in the formation of: (LHR 2014 G-II) (AJK 2016)

(a) NF_3 (b) CF_4 **(c) PCl_5** (d) BF_3

5. Which of the following species has unpaired electrons in anti-bonding molecular orbitals: (2015 G-II)(DGK 2016, 19)(RWP 2016, 17)

(a) O_2^{-2} (b) B_2 (c) F_2 **(d) N_2^{-2}**

6. The number of bonds in oxygen molecule is: (2015 G-II) (DGK 2017) (BWP 2016) (DGK 2018) (RWP 2018)(MTN 2019)

(a) one sigma and one pi

(b) one sigma and two pi

(c) three sigma only

(d) two sigma only

7. The number of bonds in nitrogen molecule is: (LHR 2016) (GRW 2016) (FSD 2013, 14, 15) (RWP 2012, 15) (DGK 2012, 14) (SWL 2018)

(a) One σ and one Π **(b) One σ and two Π**

(c) Three sigma only (d) Two σ and One Π

8. Which of the following species has unpaired electrons in antibonding molecular orbitals: (LHR 2016) (SWL 2017) (BWP 2016)

(a) O_2^{2+} **(b) N_2^{2-}** (c) B_2 (d) F_2

9. Which one of the following molecule is paramagnetic? (GRW 2016)

(a) H_2 (b) He (c) N_2 **(d) O_2**

10. According to VSEPR theory, the shape of PH_3 molecule is: (MTN 2011)

(a) Trigonal pyramidal (b) Tetragonal

(c) Linear (d) Trigonal planar

11. Which of the following has the highest bond order? (MTN 2013)
(a) O_2^{+1} (b) O_2^{+2} (c) O_2^{-1} (d) O_2^{-2}

12. The bond order of O_2^{-2} is: (MTN 2014) (RWP 2013)
(a) 1 (b) 2 (c) zero (d) 3

13. The most electronegative element is: (FSD 2011)
(a) N_2 (b) F_2 (c) O_2 (d) H_2

14. Carbon atom in CH_4 is hybridized: (FSD 2015, 16)
(a) sp^3 (b) sp^2 (c) sp (d) dsp^2

15. In methanol, bond between carbon and oxygen is: (RWP 2014)
(a) Ionic (b) Non polar
(c) Polar (d) Co-ordinate

16. The molecule which cannot form co-ordinate covalent bond with H^+ ion is: (SGD 2011)
(a) NH_3 (b) H_2O (c) PH_3 **(d) CH_4**

17. VSEPR theory was proposed by: (SGD 2014)
(a) Kossel (b) Lewis
(c) Nylholm & Gillespie
(d) Sigwick

18. The value of third ionization energy of Mg is: (SGD 2015)
(a) 1450 KJ/mole **(b) 7730 KJ/mole**
(c) 7850 KJ/mole (d) 1890 KJ/mole

19. Molecular orbital theory was proposed by: (DGL 2011)
(a) Moseley (b) Werner
(c) Kossel **(d) Mullikan**

20. The experimentally determined bond angle in NH_3 is: (DGK 2016)
(a) 109.5° **(b) 107.5°** (c) 104.5° (d) 102.5°

21. Percentage ionic character of HF is. (DGK 2017)
(a) 100 % (b) 80 % **(c) 43 %** (d) 57 %

22. The carbon atom in C_2H_4 is: (SWL 2016)
(a) sp^3 – hybridized **(b) sp^2 – hybridized**
(c) sp - hybridized (d) dsp^2 – hybridized

23. Which of the following has coordinate covalent bond? (SWL 2017)
(a) NH_4Cl (b) NaCl (c) HCl (d) $AlCl_3$

III) From Entry Test:-

(1) The shape of SF_6 molecule is:
(a) Linear (b) Tetrahedral
(c) Octahedral (d) Pyramidal

(2) The bond order of H_2^+ is:
(a) 1 (b) 2 **(c) 1/2** (d) 3

(3) Which of the following is not planar?
(a) Benzene (b) BF_3
(c) Formaldehyde **(d) Propane**

(4) Which bond is present in NH_4Cl?
(a) Ionic (b) Covalent
(c) Coordinate covalent
(d) All of these

(5) Which of the following solids consist of atoms or molecules held together only by Vander Waal's forces?
(a) CO_2 (b) Cu (c) H_2O (d) SiO_2

(6) The shape of SO_4^{2-} ion is:
(a) Hexagonal
(b) Trigonal bipyramidal
(c) Square planar **(d) Tetrahedral**

(7) Which of the following is most polarizing?
(a) Al^{3+} (b) Ba^{2+} (c) Mg^{2+} (d) Na^+

(8) Which of the following bond is most polar?
(a) Cl – Cl **(b) C – F**
(c) N – F (d) O – F

(9)Which of the following has lowest energy?
(a) Atomic orbital
(b) Bonding molecular orbital
(c) Anti-bonding molecular orbital
(d) None of these

(10) Which of the following has highest bond order?
(a) O_2 **(b) O_2^+** (c) O_2^- (d) O_2^{2-}

(11) In which molecule, the central atom is sp hybridized:
(a) C_2H_4 **(b) $BeCl_2$**
(c) BF_3 (d) None of these

(12) Which of the following has smaller size?
(a) Fe (b) Fe^{+1} (c) Fe^{+2} **(d) Fe^{+3}**

(13) How many sigma electrons are present in ethene?
(a) 2 (b) 4 (c) 5 **(d) 10**

(14) Which molecule is 100% ionic?
(a) NaCl (b) HCl (c) HF **(d) None**

(15) Total number of valence electrons in phosphonium ion (PH_4^+) is:
(a) 8 (b) 9 (c) 10 (d) 12

(16) Which of the following contains 6 bonding electrons?
(a) CH_4 (b) CO_2 **(c) BF_3** (d) H_2S

(17) In which set, both the molecules are paramagnetic in nature?
(a) O_2 and B_2 (b) N_2 and O_2
(c) N_2 and F_2 (d) H_2 and N_2

(18) According to MOT, which molecular orbital has highest energy:
(a) σ 1s (b) $\overset{x}{\sigma}$ 2s
(c) π 2py **(d) $\overset{*}{\sigma}$ 2px**

SECTION II

SHORT QUESTIONS

From Exercise:-

QUESTIONS

1. What is octet rule?

Ans. **Octet rule;**

"The tendency of atoms to attain a maximum of eight electrons in the valence shell is known as the octet rule".

All the elements have inherent tendency to stabilize themselves. They got their stabilization by losing, gaining or sharing electrons to attain the nearest noble gas configuration.

Examples;

$$_{11}Na\ (2, 8, 1) \xrightarrow{\text{lose } e^-} Na^{+1}(2, 8) + 1e^-$$

$$_{17}Cl\ (2, 8, 7) + 1e^- \xrightarrow{\text{Gain } e^-} Cl^{-1}(2, 8, 8)$$

2. Why the radius of an atom cannot be determined precisely?

Ans. The radius of an atom cannot be determined precisely due to the following reasons.

(i) There is no sharp boundary of an atom. The probability of finding an electron never becomes exactly zero even at large distances from the nucleus.

(ii) The electronic probability distribution is affected by neighbouring atoms. For this reason, the size of an atom may change from one compound to another.

3. The size of a cation is always smaller than its parent atom. Why?

Ans. The ionic radius of a cation is smaller than the atomic radius of the element from which it is derived.

Reason:

This is due to the reason that with the successive loss of electrons, the nuclear charge attracts the remaining electrons with a greater force. So the electronic cloud come close to nucleus and size decreases.

Example: The radius of Na atom reduces from 186pm to 95pm after conversion into Na^+ ion.

$$Na \longrightarrow Na^{+1} + 1e^-$$
(186pm) (95pm)

4. The size of an anion is always greater than its parent atom. Explain.

Ans. The ionic radius of an anion is greater than the atomic radius of the corresponding atom.

Reason: The increase in the size of the anion is due to the increase in the electron-electron repulsion because of the increase in the valence shell electrons. This repulsion causes the expansion of electronic cloud and the size increases.

Example: The ionic radius of Cl^- ion increases from 99pm to 181pm.

$$Cl + 1e^- \longrightarrow Cl^{-1}$$
(99pm) (181pm)

5. Define ionization energy. Name the factors which affect the ionization energy of an element.

Ans. **Ionization Energy:**

"The minimum amount of energy, which is required to remove an electron from an isolated gaseous atom to form positive ion is called as ionization energy".

Example;

$$Na(g) \rightarrow Na^{+1}_{(g)} + 1e^- \quad \Delta H = +496\ kJ/mole$$

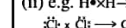
Factors affecting ionization energy:

The ionization energies of atoms depends upon the following factors.

(i) Atomic radius of atom.
(ii) Nuclear charge or proton number of the atom.
(iii) Shielding effect of inner electrons.
(iv) Nature of orbital.

6. Differentiate between covalent and coordinate covalent bond.

Ans.

Covalent Bond	Coordinate Covalent Bond
(i) The bond which is formed by the mutual sharing of electrons between two atoms is called as covalent bond.	(i) A coordinate covalent bond is formed between two atoms when the shared pair of electrons is donated by one of the bonded atoms.
(ii) e.g. $H\bullet\times H \rightarrow H-H$ 	(ii) e.g. 
(iii) Single covalent bond is represented by a single line, double covalent bond by two lines and tripe covalent bond by tree lines.	(iii) Coordinate covalent bond is represented by an arrow pointing from the donor atom to the acceptor atom.

7. Why lone pair of electrons occupy more space than the bond pairs?

Ans. A non bonding electron pair occupy more spare than the lone pair on the central atom.

Reason:

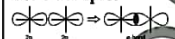
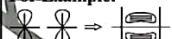
A bonding electron pair is attracted by both the nuclei, while non-bonding by only one nucleus. So a lone pair experiences less nuclear attraction, due to which its electronic cloud is spread out more in space than that for the bonding pair. As a result, the non-bonding electron pairs exert greater repulsive forces on bonding electron pairs and thus tend to compress the bond pairs.

The magnitude of repulsions between the electron pairs in a given molecule decreases in the following order.

Lone pair – lone pair > Lone pair – bond pair > bond pair – bond pair

8. Differentiate between sigma and pi bond.

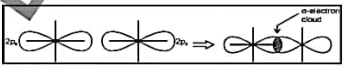
Ans.

Sigma Bond	Pi Bond
(i) The bond which is formed by the linear overlapping of partially filled atomic orbitals is called as a sigma covalent bond.	(i) The bond which is formed by the parallel overlapping of partially filled atomic orbitals is called as pi covalent bond.
(ii) The area of maximum electron density lies between the internuclear axis.	(ii) The area of maximum electron density is present around the internuclear axis.
(iii) Sigma electrons are localized and their position is well defined. **For Example:** 	(iii) π-electrons are delocalized and they are much diffused. **For Example:** 

9. Why pi bond is more diffused than a sigma bond?

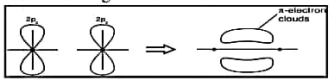
Ans. **Sigma bond:**

A sigma bond is formed by the linear overlapping of partially filled atomic orbitals, and its electron density is present between the inter-nuclear axis. The sigma electrons are strongly attracted by both the nuclei and hence their position is well-defined between both the nuclei.



pi bond:

While a pi bond is formed by the parallel overlap of partially filled atomic orbitals. The π-electrons are present around the inter-nuclear axis. There is a weak nuclear attraction on these electrons, therefore a pi bond become more diffused than a sigma bond.



10. Explain the term bond order.

Ans. **Bond order:**

"The number of bonds formed between two atoms after the atomic orbitals overlap, is called the bond order and is taken as half of the difference between the number of bonding electrons and anti-bonding electrons."

$$\text{Bond order} = \frac{nb - na}{2}$$

Where,

nb = number of electrons in bonding molecular orbitals

na = number of electrons in anti-bonding molecular orbitals

Example;

Bond order of H_2 molecule can be calculated as

nb = 2

na = 0

$$\text{Bond order} = \frac{2-0}{2} = 1$$

11. Differentiate between bonding molecular orbitals and anti-bonding molecular orbitals.

Ans.

Bonding Molecular Orbital	Anti-Bonding Molecular Orbital
(i) In MOT, the molecular orbitals which are lower in energy than the atomic orbitals are called as bonding molecular orbitals.	(i) In MOT, the molecular orbitals which are higher in energy than the atomic orbitals are called as anti-bonding molecular orbitals.
(ii) A molecular orbital is formed due to constructive interference of electronic waves.	(ii) An anti-bonding orbital is formed due to destructive interference of electronic waves.
(iii) In bonding molecular orbital, the area of maximum electron density is present between the bond axis.	(iii) In anti-bonding molecular orbital, the area of maximum electron density is away from the bond axis.
(iv) Bonding molecular orbital is denoted by σ or π.	(iv) Anti-bonding molecular orbital is denoted by σ* or π*.
(v) It is more stable than the atomic orbitals.	(v) It is un-stable than the atomic orbitals.

12. How does ionization energy varies down the group? Give reason.

Ans. Moving top to bottom in a group, the ionization energy decreases inspite of increase in atomic number.

Reason: This decrease in the ionization energy is due to the following two reasons.

(i) In a group, there is a successive addition of electronic shells. Due to which the valence electrons are placed at a larger distance from the nucleus.

(ii) From top to bottom in a group, the shielding effect of the intervening electrons increases.

As a result the force of attraction between the nucleus and the outer electrons decreases, and less amount of energy is required to remove the electron. Therefore ionization energy of elements decreases down the group.

Example;

$$Li_{(g)} \longrightarrow Li^{+1}_{(g)} + 1e^- \quad I.E = 520 \text{ kJ/mole}$$

$$Na_{(g)} \longrightarrow Na^{+1}_{(g)} + 1e^- \quad I.E = 496 \text{ kJ/mole}$$

13. Why second ionization energy of an element is greater than its 1st ionization energy.

Ans. 1st ionization energy;

"The amount of energy required to remove an electron from the isolated neutral atom is called first ionization energy."

Example;

$$Mg_{(g)} \longrightarrow Mg^{+1}_{(g)} + 1e^- \quad I.E_1 = 738 \text{ kJ/mole}$$

2nd ionization energy;

"The amount of energy required to remove a second electron from a uni-positive ion is called second ionization energy."

Example;

$$Mg^{+1}_{(g)} \longrightarrow Mg^{+2}_{(g)} + 1e^- \quad I.E_2 = 1450 \text{ kJ/mole}$$

The second ionization energy of an element is greater than first ionization energy because after removal of first electron from a neutral atom, the attraction of nucleus on the remaining electrons increases. Therefore more energy is required to remove the second electron from a uni-positive ion.

14. Define atomic radius. How does it vary in groups and periods.

Ans. Atomic Radius:

"The average distance between the nucleus of an atom to its outermost electronic shell is called atomic radius."

Variation in Groups:

The atomic radius of elements increases from top to bottom in a group. It is due to the following reasons.

(i) There is a successive addition of electronic shells with increase in atomic number, due to which the valence electrons are placed at a larger distance from the nucleus.

(ii) The nuclear force of attraction decreases due to the increasing shielding effect of the intervening electrons.

Variation in Periods:

The atomic radius of elements decreases from left to right in a period. The decreasing trend in a period is due to the increase in the nuclear charge. As the nuclear charge increases, the pull on the electrons is increased and size of an atom decreases.

15. Bond distance is the compromise distance between two atoms.

Ans. When two atoms approach each other to form a bond, they attract each other and the energy of the system is lowered. When they reach at a certain distance, their forces of attractions are maximum. On further coming close they start repelling each other and thus the energy of the system increases. Now the two atoms try to remain at a compromising distance whereas the energy of the system is minimum. This is called bond distance or compromise distance between the two atoms.

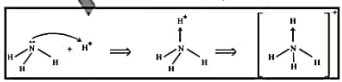
Example:

Bond length of H – H is 75.4 pm.

16. The distinction between a co-ordinate covalent bond and a covalent bond vanishes after bond formation in NH_4^+, H_3O^+ and $CH_3NH_3^+$.

Ans.(a) NH_4^+ ion;

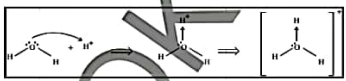
NH_3 have three covalent bonds. It donates its lone pair to H^+ ion to form NH_4^+ ion.



All the four bonds in NH_4^+ ion behave alike and each bond have 25% co-ordinate and 75% covalent character.

(b) H_3O^+ ion;

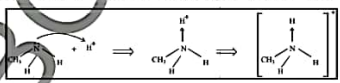
H_2O molecule have two covalent bonds. It forms one co-ordinate covalent bond with one H^+ ion.



In H_3O^+ ion, each bond has 33% co-ordinate covalent and 66.6% covalent character.

(c) $CH_3NH_3^+$ ion

Methylamines have three covalent bonds. It forms a co-ordinate covalent bond with H^+ ion.



All the bonds between N and H are alike.

17. The bond angles of H_2O and NH_3 are not 109.5° like that of CH_4. Although O – and N – atoms are sp^3 hybridized.

Ans.. The geometry of a molecule depends upon the hybridization state of the central atom. In CH_4, NH_3 and H_2O, the central atoms (C,N,O) are sp^3 hybridized. Therefore, it is expected that the bond angles in CH_4, NH_3 and H_2O are 109.5°.

In CH_4 all the electron pairs are bonding, so the geometry of the molecule is perfect tetrahedron with a bond angle of 109.5°. But in NH_3 there is one lone pair, and in H_2O there are two lone pairs. There lone pairs cause greater repulsion and hence the bond angles reduced from 109.5° to 107.5° and 104.5° respectively.

II) From Punjab Boards:-

1. What is octet rule? (LHR 2007L) (LHR 2012) (MTN 2011) (RWP 2016) (SGD 2017) (BWP 2016)(SWL 2013,14) (AJK 2016)

Ans. Octet rule;

"The tendency of atoms to attain a maximum of eight electrons in the valence shell is known as the octet rule".

All the elements have inherent tendency to stabilize themselves. They got their stabilization by losing, gaining or sharing electrons to attain the nearest noble gas configuration.

Examples;

$$_{11}Na\ (2, 8, 1) \xrightarrow{\text{lose } e^-} Na^{+1}(2, 8) + 1e^-$$

$$_{17}Cl\ (2, 8, 7) + 1e^- \xrightarrow{\text{Gain } e^-} Cl^{-1}(2, 8, 8)$$

2. Why the radius of an atom cannot be determined precisely? (2010G)
(GRW 2014), (BWP 2016), (SWL 2013)
(GRW 2017), (BWP 2016)

Ans. The radius of an atom cannot be determined precisely due to the following reasons.

(i) There is no sharp boundary of an atom. The probability of finding an electron never becomes exactly zero even at large distances from the nucleus.

(ii) The electronic probability distribution is affected by neighbouring atoms. For this reason, the size of an atom may change from one compound to another.

3. The size of a cation is always smaller than its parent atom. Why?
(LHR 2008, 9, 10, 14), (MTN 2016)
(BWP 2012)

Ans. The ionic radius of a cation is smaller than the atomic radius of the element from which it is derived.

Reason:

This is due to the reason that with the successive loss of electrons, the nuclear charge attracts the remaining electrons with a greater. So the electronic cloud come close to nucleus and size decreases.

Example:

The radius of Na atom reduces from 186pm to 95pm after conversion into Na+ ion.

$$Na \longrightarrow Na^{+1} + 1e^-$$
(186pm) (95pm)

4. The size of an anion is always greater than its parent atom. (LHR 2010), (MTN 2014)
(SGD 2011), (DGK 2012,14)

Ans. The ionic radius of an anion is greater than the atomic radius of the corresponding atom.

Reason:

The increase in the size of the anion is due to the increase in the electron-electron repulsion because of the increase in the valence shell electrons. This repulsion causes the expansion of electronic cloud and the size increases.

Example:

The ionic radius of Cl^- ion increases from 99pm to 181pm.

$$Cl + 1e^- \longrightarrow Cl^{-1}$$
(99pm) (181pm)

5. Define ionization energy. Name the factors which affect the ionization energy of an element.
(2006G, 2010L), (LHR 2011), (BWP 2012,14,16), (FSD 2014,16), (RWP 2016)

Ans. Ionization Energy:

"The minimum amount of energy, which is required to remove an electron from an isolated gaseous atom to form positive ion is called as ionization energy".

Example;

$$Na(g) \longrightarrow Na^{+1}_{(g)} + 1e^-$$

$\Delta H = +496$ kJ/mole

Factors affecting ionization energy:

The ionization energies of atoms depends upon the following factors.

(i) Atomic radius of atom.
(ii) Nuclear charge or proton number of the atom.
(iii) Shielding effect of inner electrons.
(iv) Nature of orbital.

6. Ionization energy is an index to the metallic character of elements. Justify:
(MTN 2013), (AJK 2016) (LHR 2018)

Ans. Metallic Character:

"The tendency of an atom to lose electron and form positive ion is called as metallic character."

Lower the ionization energy, greater will be the tendency to lose electron or metallic character and vice versa.

(1) The elements having low ionization energies are metals.
(2) Elements having high ionization energies are non-metals.
(3) Elements with intermediate values are mostly metalloids.

7. Why the electron affinity of fluorine is less than chlorine. (MTN 2014), (FSD 2014)

Ans. The electron affinity of the elements increases left to right in a period and decreases down the group. But exceptionally fluorine has electron affinity less than that of chlorine.

Reason:

Fluorine has very small size and seven electrons in 2s and 2p subshells have thick electronic cloud. This thick cloud repels the incoming electron. So initially energy is absorbed to add the electron and then energy is released, therefore the E.A of fluorine is less than that of Chlorine.

Example:

$Cl_{(g)} + 1e^- \longrightarrow Cl^{-1}_{(g)}$

E.A = –349 kJ/mole

$F_{(g)} + 1e^- \longrightarrow F^{-1}_{(g)}$

E.A = –322 kJ/mole

8. Define electronegativity? How the electronegativity difference decides the nature of chemical bond?

(2007L) (LHR 2016) (BWP 2012) (MTN 2011), (FSD 2013), (DGK 2018)

Ans. Electronegativity:

"The tendency of an atom to attract a shared electron pair towards itself is called its electronegativity."

Nature of Chemical Bond:

The difference in the electronegativity value of the bonded atoms determines the nature of the bond.

(1) If the difference is zero, the bond between the two atoms is non-polar.
e.g., H_2, Cl_2, Br_2 etc.

(2) If the difference is less than 1.7 but greater than zero, the bond between the atoms is polar covalent e.g., HCl, HBr etc.

(3) A difference of 1.7 units shows equal contribution of ionic and covalent bond e.g., $AlCl_3$.

(4) If the difference is greater than 1.7 which, the bond will be ionic in nature e.g., NaCl KBr etc.

9. How ionization energy value helps to find the valency of an atom? (BWP 2011)

Ans. *"The energy required to remove the electron from the valence shell is called ionization energy."*

The gaps in the first, second, third and higher ionization energies help us to guess the valency of an element.

If there is sufficient gap between first ionization energy and second one, then the element show valency of one.

Example:

Sodium always exist as Na^{+1}.

$Na \longrightarrow Na^{+1} + 1e^-$

Similarly if a large gap is observed between 2nd I.E and third one, then two valency is shown by the element.

Example:

Magnesium show an oxidation state (+2).

$Mg \longrightarrow Mg^{+2} + 2e^-$

10. No bond in chemistry is 100% ionic in nature. Why? (LHR 2015, 18), (BWP 2013)

Ans. A bond is said 100% covalent, when the electronegativity difference between the bonded atoms is zero.

Example:

H_2, Cl_2, Br_2 etc.

A bond is supposed to be 100% ionic if the electronegativity difference between the bonded atoms is 4.0 units (Maximum).

$\overset{0}{A} — \overset{4.0}{B}$ $\quad \Delta E.N = 4$

It is only possible when A atom show E.N value O were B atom show E.N 4.0. The maximum electronegativity is shown by fluorine i.e. 4; but no atom in the periodic table have E.N value equal to zero. So no bond in chemistry is 100% ionic in nature.

The maximum difference of electro-negativity is shown by Cesium chloride.

$\overset{0.7}{Cs}\ \overset{4.0}{F}$ $\Delta E.N = 3.3$ units (Max)

Therefore, the maximum ionic character in a compound is 92% as in CsF.

According to Hanry = Smith Formula

% ionic character

$= (4)^2 \times (E.N.\ Diff) + 3.5 \times (E.N.\ Diff.)^2$

In case of CST $= (4)^2 \times 3.3 + 3.5 \times (3.3)^2$

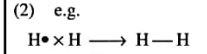
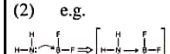
$= 91\%$ approx.

11. Differentiate between covalent and coordinate covalent bond. (RWP 2012)

(2009G), (SWL 2016), (MTN 2012,16)

(DGK 2013) (LHR 2013), (GRW 2013)

Ans.

Covalent Bond	Coordinate Covalent Bond
(1) The bond which is formed by the mutual sharing of electrons between two atoms is called as covalent bond.	(1) A coordinate covalent bond is formed between two atoms when the shared pair of electrons is donated by one of the bonded atoms.
(2) e.g. 	(2) e.g. 
(3) Single covalent bond is represented by a single line, double covalent bond by two lines and triple covalent bond by three lines.	(3) Coordinate covalent bond is represented by an arrow pointing from the donor atom to the acceptor atom.

12. Why lone pair of electrons occupy more space than the bond pairs?

(2009L), (MTN 2012)(RWP 2018)

Ans. A non bonding electron pair occupy more space than the lone pair on the central atom.

Reason:

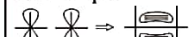
A bonding electron pair is attracted by both the nuclei, while non-bonding by only one nucleus. So a lone pair experiences less nuclear attraction, due to which its electronic cloud is spread out more in space than that for the bonding pair. As a result, the non-bonding electron pairs exert greater repulsive forces on bonding electron pairs and thus tend to compress the bond pairs.

The magnitude of repulsions between the electron pairs in a given molecule decreases in the following order.

Lone pair – lone pair > Lone pair – bond pair > bond pair – bond pair

13. Differentiate between sigma and pi bond.

(LHR 2012), (FSD 2016)

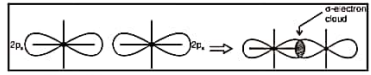
Sigma Bond	Pi Bond
(1) The bond which is formed by the linear overlapping of partially filled atomic orbitals is called as a sigma covalent bond.	(1) The bond which is formed by the parallel overlapping of partially filled atomic orbitals is called as pi covalent bond.
(2) The area of maximum electron density lies between the internuclear axis.	(2) The area of maximum electron density is present around the internuclear axis.
(3) Sigma electrons are localized and their position is well defined. **For Example:** 	(3) π-electrons are delocalized and they are much diffused. **For Example:** 

14. Why pi bond is more diffused than a sigma bond?

(2006L, 2008L, 2010G), (GRW 2011,12,14,16), (MTN 2011,16), (BWP 2014), (RWP 2014, 16), (SGD 2014, 18), (SWL 2014, 18)

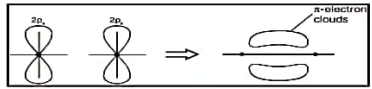
Ans. **Sigma bond;**

A sigma bond is formed by the linear overlapping of partially filled atomic orbitals, and its electron density is present between the inter-nuclear axis. The sigma electrons are strongly attracted by both the nuclei and hence their position is well-defined between both the nuclei.



pi bond;

While a pi bond is formed by the parallel overlap of partially filled atomic orbitals. The π-electrons are present around the inter-nuclear axis. There is a weak nuclear attraction on these electrons, therefore a pi bond become more diffused than a sigma bond.



Q.15 Explain the term bond order.
(2005G, 2007L), (LHR 2014,15, 18)
(GRW 2016), (FSD 2016), (AJK 2016)

Ans. Bond order;

"The number of bonds formed between two atoms after the atomic orbitals overlap, is called the bond order and is taken as half of the difference between the number of bonding electrons and anti-bonding electrons."

$$\text{Bond order} = \frac{nb - na}{2}$$

Where,

nb = number of electrons in bonding molecular orbitals

na = number of electrons in anti-bonding molecular orbitals

Example;

Bond order of H_2 molecule can be calculated as

nb = 2
na = 0

$$\text{Bond order} = \frac{2-0}{2} = 1$$

16. Why second ionization energy of an element is greater than its 1st ionization energy. (2008L), (DGK 2014)

Ans. 1st ionization energy;

"The amount of energy required to remove an electron from the isolated neutral atom is called first ionization energy."

Example;

$$Mg_{(g)} \longrightarrow Mg^{+1}_{(g)} + 1e^- \quad I.E_1 = 738 \text{ kJ/mole}$$

2nd ionization energy;

"The amount of energy required to remove a second electron from a uni-positive ion is called second ionization energy."

Example;

$$Mg^{+1}_{(g)} \longrightarrow Mg^{+2}_{(g)} + 1e^- \quad I.E_2 = 1450 \text{ kJ/mole}$$

The second ionization energy of an element is greater than first ionization energy because after removal of first electron from a neutral atom, the attraction of nucleus on the remaining electrons increases. Therefore more energy is required to remove the second electron from a uni-positive ion.

17. Differentiate between bonding molecular orbitals and anti-bonding molecular orbitals. (2008L), (LHR 2011)
(FSD 2014, 16) (SGD 2018)

Ans.

Bonding Molecular Orbital	Anti-Bonding Molecular Orbital
(i) In MOT, the molecular orbitals which are lower in energy than the atomic orbitals are called as bonding molecular orbitals.	(i) In MOT, the molecular orbitals which are higher in energy than the atomic orbitals are called as anti-bonding molecular orbitals.
(ii) A molecular orbital is formed due to constructive interference of electronic waves.	(ii) An anti-bonding orbital is formed due to destructive interference of electronic waves.
(iii) In bonding molecular orbital, the area of maximum electron density is present between the bond axis.	(iii) In anti-bonding molecular orbital, the area of maximum electron density is away from the bond axis.
(iv) Bonding molecular orbital is denoted by σ or π.	(iv) Anti-bonding molecular orbital is denoted by σ^* or π^*.
(v) It is more stable than the atomic orbitals.	(v) It is un-stable than the atomic orbitals.

18. How does ionization energy varies down the group? Give reason. (2008G)
(LHR 2016), (GRW 2013)

Ans. Moving top to bottom in a group, the ionization energy decreases inspite of increase in atomic number.

Reason: This decrease in the ionization energy is due to the following two reasons.

(i) In a group, there is a successive addition of electronic shells. Due to which the valence electrons are placed at a larger distance from the nucleus.

(ii) From top to bottom in a group, the shielding effect of the intervening electrons increases.

As a result the force of attraction between the nucleus and the outer electrons decreases, and less amount of energy is required to remove the electron. Therefore ionization energy of elements decreases down the group.

Example:

$Li_{(g)} \longrightarrow Li^{+1}_{(g)} + 1e^- \quad I.E = 520\ kJ/mole$

$Na_{(g)} \longrightarrow Na^{+1}_{(g)} + 1e^- \quad I.E = 496\ kJ/mole$

19. Define atomic radius. How does it vary in groups and periods. (2009L) (LHR 2016), (SWL 2016), (DGK 2011,12)

Ans. Atomic Radius:

"The average distance between the nucleus of an atom to its outermost electronic shell is called atomic radius."

Variation in Groups:

The atomic radius of elements increases from top to bottom in a group. It is due to the following reasons.

(i) There is a successive addition of electronic shells with increase in atomic number, due to which the valence electrons are placed at a larger distance from the nucleus.

(ii) The nuclear force of attraction decreases due to the increasing shielding effect of the intervening electrons.

Variation in Periods:

The atomic radius of elements decreases from left to right in a period. The decreasing trend in a period is due to the increase in the nuclear charge. As the nuclear charge increases, the pull on the electrons is increased and size of an atom decreases.

20. Why electron affinity value of IIA group are less than those of I-A? (2007G) (FSD 2012,13)

Ans. Generally electron affinity of elements increases from left to right in a period. But the E.A of group IIA is less than group IA.

Reason:

The general electronic configuration of group IA is ns^1, so the incoming electron is added to the lower energy s-orbital. Whereas the general electronic configuration of group IIA is ns^2. As s-subshell is complete, so the incoming electron will be added to high energy p-orbital. Since p-orbital is higher in energy than s-orbital, therefore less energy is released in case of group IIA elements.

Examples:

$Na_{(g)} + 1e^- \longrightarrow Na^{-1}_{(g)} \quad E.A = -53\ kJ/mole$

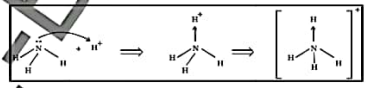
$Mg_{(g)} + 1e^- \longrightarrow Mg^{-1}_{(g)} \quad E.A = -230\ kJ/mol$

21. Why NH_3 and H_2O, give co-ordinate covalent bonds with H^+? (MTN 2014)

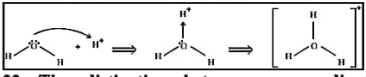
Ans. NH_3 and H_2O, both have lone pair of electrons. Thus they can donate an electron pair to the H^+ ion, and can make co-ordinate covalent bond with it. Therefore NH_3 and H_2O are considered as Lewis bases.

Examples:

NH_3 donates its electron pair to H^+ ion and form NH_4^+ ion.



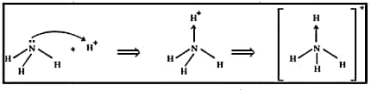
Similarly $H_2\ddot{O}$ can also make a co-ordinate covalent bond with H^+ ion to form H_3O^+ ion.



22. The distinction between a co-ordinate covalent bond and a covalent bond vanishes after bond formation in NH_4^+, H_3O^+ and $CH_3NH_3^+$. (LHR 2011)(DGK 2013)

Ans. (a) NH_4^+ ion;

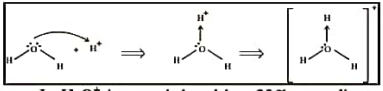
NH_3 have three covalent bonds. It donates its lone pair to H^+ ion to form NH_4^+ ion.



All the four bonds in NH_4^+ ion behave alike and each bond have 25% co-ordinate and 75% covalent character.

(b) H_3O^+ ion;

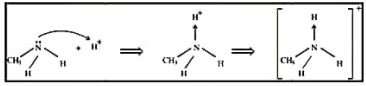
H_2O molecule have two covalent bonds. It forms one co-ordinate covalent bond with one H^+ ion.



In H_3O^+ ion, each bond has 33% co-ordinate covalent and 66.6% covalent character.

(c) CH3N+H3 ion

Methylamines have three covalent bonds. It forms a co-ordinate covalent bond with H+ ion.



All the bonds between N and H are alike.

23. The bond angles of H_2O and NH_3 are not 109.5° like that of CH_4. Although O and N atoms are sp^3 hybridized.

(2009L, 2009G), (LHR 2015), (DGK 2012,14)

Ans. The geometry of a molecule depends upon the hybridization state of the central atom. In CH_4, NH_3 and H_2O, the central atoms (C,N,O) are sp^3 hybridized. Therefore, it is expected that the bond angles in CH_4, NH_3 and H_2O are 109.5°.

In CH_4 all the electron pairs are bonding, so the geometry of the molecule is perfect tetrahedron with a bond angle of 109.5°. But in NH_3 there is one lone pair, and in H_2O there are two lone pairs. These lone pairs cause greater repulsion and hence the bond angles reduced from 109.5° to 107.5° and 104.5° respectively.

24. The abnormality of bond length and bond strength in HI is less prominent than that of HCl. (2007L)

Ans. The bond length and bond energy of a molecule is affected by the bond polarity. Highly polar molecules show greater deviation in the properties like bond length and bond energy.

The polarity of a covalent bond depends upon the difference of electronegativities of bonded atoms.

For example;

HI is a weakly polar molecule (ΔE.N = 2.5 – 2.1 = 0.4) as compared to HCl. (ΔE.N =3.0 – 2.1 = 0.8).

Therefore, due to lesser difference of electronegativity in HI molecule it is less polar and hence the abnormality in the bond length and bond energy is less prominant in HI than HCl.

HCl	HI
Bond energy (cal.) = 336 KJ/Mole	HI Bond energy (Cal.) = 291 KJ/Mole
Bond energy (actual) = 431 kj/mole Difference = 95 kj/mole	Bond energy (actual) = 299 kj/mole Difference = 8 kj/mole

SECTION III

LONG QUESTIONS

1. Define electron affinity. Name the factors affecting it. How does it vary in the periodic table? (LHR 2013) (GRW 2013) (GRW 2018)
2. Define covalent bond. Discuss its types with suitable examples. (GRW 2012)
3. Give four postulates of Valence Shell Electron Pair Repulsion Theory.

   (MTN 2017) (LHR 2017) (DGK 2012)
4. Define the term electronegativity. Discuss its variation in the periodic table.

   (FSD 2011) (MTN 2016) (SWL 2018)
5. Define bond energy and explain the various parameter which determine its strength.

   (FSD 2012)
6. Draw the molecular orbital diagram of N_2 molecule. Give the electronic configuration of N_2 and calculate bond order. (FSD 2016)
7. Define co-ordinate covalent bond. Explain with the help of two examples. (RWP 2011)
8. Describe the structure of methane and ethyne on the basis of hybridization theory.

   (RWP 2012)
9. Explain the paramagnetic behaviour of oxygen using molecular orbital theory.

   (RWP 2013) (LHR 2014)

10. Define hybridization and explain structure of water on its basis. (RWP 2014) (MTN 2013) (GRW 2011, 13, 18) (FSD 2016)
11. Describe sp^2 hybridization giving example of Ethene. (RWP 2016) (FSD 2013)
12. Write a note on Ionic Bond by giving an example of KCl in detail? (SGD 2016)
13. Explain sp^3 hybridization with the help of two examples (DGK 2011)
14. Give the main postulates of VSEPR theory. (DGK 2014) (LHR 2012) (RWP 2016) (SGD 2012) (GRW 2012) (SWL 2014) (BWP 2017) (SGD 2018)
15. Explain Postulates of Molecular orbital theory. (DGK 2016) (LHR 2011) (RWP 2018)
16. Define ionization energy. Give example. Write variation in groups and periods (DGK 2017) (SWL 2015) (MTN 2014) (SGD 2017)
17. Calculate the bond order of O_2 molecule by making energy level diagram. Also show that it is paramagnetic. (LHR 2018) (SWL 2017) (DGK 2018) (SGD 2018)

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Chapter — 7

THERMOCHEMISTRY

SECTION I

Multiple Choice Questions

I) From Exercise:-

(i) If an endothermic reaction is allowed to take place very rapidly in the air, the temperature of the surrounding air.

(a) remains constant (b) increases

(c) decreases (d) remains unchanged

(ii) In endothermic reactions, the heat content of the

(a) products is more than that of reactants

(b) reactants is more than that of products

(c) both (a) and (b)

(d) reactants and products are equal

(iii) Calorie is equivalent to (DGK 2019)

(a) 0.4184J (b) 41.84J

(c) 4.184J (d) 418.4J

(iv) The change in heat energy of a chemical reaction at constant temperature and pressure is called

(a) enthalpy change

(b) heat of sublimation

(c) bond energy

(d) internal energy change

(v) Which of the following statements is contrary to the first law of thermodynamics?

(a) Energy can neither be created nor destroyed.

(a) One orm of energy can be transferred into an equivalent amount of other kinds of energy.

(c) In an adiabatic process, the work done is independent of its path.

(d) Continuous production of mechanical work without supplying an equivalent amount of heat is possible.

(vi) For a given process, the heat changes at constant pressure (q_p) and at constant volume (q_v) are related to each other as

(a) $q_p = q_v$ (b) $q_p < q_v$

(c) $q_p > q_v$ (d) $q_p = q_v/2$

(vii) For the reaction, NaOH+HCl $\longrightarrow$ NaCl+H_2O the change in enthalpy is called

(a) heat of reaction (b) heat of formation

(c) heat of neutralization

(d) heat of combustion

(viii) The net heat change in a chemical reaction is same, whether it is brought about in two or more different ways in one or several steps. It is known as:

(a) Henry's law (b) Joule's principle

(c) Hess'slaw

(d) Law of conservation of energy

(ix) Enthalpy of neutralization of all the strong acids and strong bases has the same value because

(a) Neutralization leads to the formation of salt and water.

(b) Strong acids and bases are ionic substances.

(c) Acids always give rise to H^+ ions and bases always furnish OH ions.

(d) The net chemical change involve the combination of H^+ and OH^- ions to form water.

II) From Punjab Boards:-

1. The exothermic process is: (LHR 2011)

(a) Evaporation (b) Sublimation

(c) Respiration **(d) Boiling**

2. If an endothermic reaction is followed to take place very rapidly in the air, the temperature of the surrounding air:
(LHR 2012) (GRW 2012) (FSD 2013,14) (AJK 2016) (MTN 2014)

(a) Remains constant (b) Increases

(c) Decreases (d) Remains unchanged

3. For the reaction NaOH + HCl $\rightarrow$ NaCl + H_2O, the change in enthalpy is called:
(LHR 2013)(GRW 2014) (DGK 2011, 12, 16) (SWL 2018) (DGK 2018) (GRW 2018)

(a) heat of reaction (b) heat of formation

(c) heat of neutralization

(d) heat of combustion

4. One calorie is equivalent to:
(LHR 2014 G-I, LHR 2015 G-I) (BWP 2016) (DGK 2016) (SGD 2018) (SGD 2014, 15, 16) (RWP 2015) (FSD 2015)

(a) 0.4184 J (b) 41.84 J

(c) 4.184 J (d) 418.4 J

5. For a given process the heat changes at constant pressure (q_p) and constant volume (q_v) are related to each other as:
(LHR 2014 G-I, LHR 15, 18 G-II) (SWL 2016, 17) (GRW 2017, 18) (SGD 2011) (AJK 2018) (AJK 2018)
(a) $q_p > q_v$ (b) $q_p = q_v$
(c) $q_p < q_v$ (d) $q_p = f(q_v,2)$

6. The net heat change in a chemical reaction is same, whether it is brought about in two or more different ways in one or several steps. It is known as: (LHR 2016) (RWP 2011) (DGK 2014) (SLK 2019)
(a) Henry's law (b) Joule's principle
(c) Hess's law
(d) law of conservation of energy

7. The change in heat energy of a chemical reaction at constant temperature and pressure is called.
(LHR 2016, 17) (SGD 2012, 13) (RWP 2017) (FSD 2012) (MTN 2012, 13) (BWP 2017, 18)
(a) Enthalpy change (b) Bond energy
(c) Heat of sublimation (d) Internal energy

8. A state function which describes together the internal energy and the product of pressure and volume is called: (GRW 2011)
(a) Enthalpy (b) Internal energy
(c) work (d) Fluorine

9. The change in heat energy of a chemical reaction at constant temperature and pressure is called: (GRW 2013)
(a) Enthalpy change
(b) heat of sublimation
(c) Bond energy
(d) Internal energy change

10. Which of the following is not a state function: (MTN 2011)
(a) Pressure (b) Volume
(c) Temperature **(d) Heat**

11. In endothermic reactions, the heat content of the: (MTN 2016)
(a) Products is more than that of reactants
(b) Reactants is more than that of products
(c) Reactants and products are equal
(d) Both B and C

12. Standard enthalpy change is measured at: (FSD 2011)
(a) 298 k (b) 273°C (c) 273 k (d) 373 k

13. The pressure of oxygen inside the bomb calorimeter is: (FSD 2016)
(a) 100atm (b) 50atm (c) 125atm **(d) 20atm**

14. For the reaction H+, OH^- the change in enthalpy is called heat of: (RWP 2013)
(a) reaction (b) combustion
(c) Solution **(d) neutralization**

15. Which of the following hydrogen halides has the highest percentage of ionic character? (RWP 2016)(DGK 2019)
(a) HCl (b) HBr (c) **HF** (d) HI

16. The units of heat capacity are: (DGK 2013, 15)
(a) $KJK^{-1}\ mol^{-1}$ (b) $KJK^{-1}g^{-1}$
(c) KJK^{-1} (d) $KJK^{-1}mol^{-2}$

17. The change in heat energy of a chemical reaction at constant temperature and pressure is called. (BWP 2017)
(a) Enthalpy change
(b) Heat of sublimation
(c) Bond energy
(d) Internal energy change

III) From Entry Test:-

(1) Which of the following is not state function?
(a) Enthalpy (b) Temperature
(c) Heat (d) Pressure

(2) Which of the following is endothermic process?
(a) Condensation of steam
(b) Electrolysis of water
(c) Haber's process for the manufacture of NH_3
(d) Freezing of water

(3) Which of the following is not exothermic?
(a) Enthalpy of atomization
(b) Enthalpy of neutralization
(c) Enthalpy of solution
(d) Enthalpy of formation

(4) Which of the following enthalpy changes can be obtained by the Hess's law?
(a) Hydration of anhydrous $CuSO_4$
(b) Formation of methane from the elements
(c) Combustion of glucose
(d) Formation of CO_2

(5) Enthalpy of food and fuel can be measured by:
(a) Glass calorimeter
(b) Bomb calorimeter
(c) Monometer (d) Refractometer

(6) 1 joule is equal to calorie:
(a) 0.239 (b) 0.5 (c) 4.184 (d) 0.932

(7) Heat of neutralization of HCN and NaOH in kJ/mol is:
(a) −57.4 **(b) +45.1** (c) −45.1 (d) +57.4

(8) Which of the following is not a state function?
(a) T **(b) q** (c) H (d) S

(9) If the refrigerator door is kept open, we get:
(a) Room cooled **(b) Room heated**
(c) More heat is passed out
(d) None of these

(10) If water is added to quicklime, the reaction is:
(a) Explosive **(b) Exothermic**
(c) Endothermic (d) None of these

(11) A mixture of 2 moles of CO and 1 mol of O_2 in a closed vessel is ignited to convert CO to CO_2, then:
(a) $\Delta H = \Delta E$ **(b) $\Delta H > \Delta E$**
(c) $\Delta H < \Delta E$
(d) The relation depends upon the capacity of the vessel

(12) Molar heat capacity of water in equilibrium with ice at constant pressure is:
(a) Zero **(b) Infinity**
(c) 40.45 kJ K^{-1} (d) 75.18 kJ mol^{-1}

(13) Total kinetic energy of molecule of gases is due to:
(a) Translational motion
(b) Rotational motion
(c) Vibrational motion **(d) All**

(14) Which equation represents the change corresponding to the enthalpy of atomization of iodine?
(a) $\frac{1}{2} I_{2(s)} \longrightarrow I_{(g)}$ (b) $I_{2(l)} \longrightarrow 2I_{(g)}$
(c) $I_{2(s)} \longrightarrow 2I_{(g)}$ (d) $I_{2(g)} \longrightarrow 2I_{(g)}$

(15) In the bomb-calorimeter, the reactions are carried out at:
(a) Constant volume
(b) Constant pressure
(c) Constant temperature
(d) (a), (b), (c) all

(16) ΔH for the reaction $CH_3COOH + NaOH$ is:
(a) 57 kJ
(b) Less than 57 kJ
(c) Greater than 57 kJ (d) Zero

(17) Which of the following values of heat of formation indicates that product is less stable?
(a) −94 kJ (b) −231.6 kJ
(c) +21.4 kJ **(d) +70 kJ**

(18) Which of the following enthalpies is always an exothermic process?
(a) Enthalpy of atomization
(b) Enthalpy of neutralization
(c) Enthalpy of ionization
(d) Enthalpy of dissociation

(19) Enthalpy of combustion is:
(a) Positive
(b) Negative
(c) Either positive or negative
(d) No correlation

(20) Which property of gas is not state function?
(a) Enthalpy (b) Entropy
(c) Pressure **(d) Heat**

SECTION II

SHORT QUESTIONS

From Exercise:-

QUESTIONS

1. Comment that enthalpy of neutralization is merely the heat of formation of one mole of liquid water.

Ans. The strong acids like HCl and strong bases like NaOH, ionize completely in dilute solutions as follows:

$$HCl_{(aq)} \rightleftharpoons H^{+}_{(aq)} + Cl^{-}_{(aq)}$$

$$NaOH_{(aq)} \rightleftharpoons Na^{+}_{(aq)} + \bar{O}H_{(aq)}$$

When these solutions are mixed together, neutralization takes place. The only change that actually occurs is the formation of liquid water. The Na^+ and Cl^{-1} ions remain free in the solution.

$$H^{+}_{(aq)} + Cl^{-1}_{(aq)} + Na^{+}_{(aq)} + OH^{-1}_{(aq)} \rightarrow Na^{+1}_{(aq)} + Cl^{-1}_{(aq)} + H_2O_{(l)}$$

Net reaction;

$$H^{+}_{(aq)} + OH^{-1}_{(aq)} \rightarrow H_2O_{(l)} \quad \Delta H = -57.32 \text{ kJ.mol}^{-1}$$

Thus, the enthalpy of neutralization is merely the heat of formation of one mole of liquid water from its ionic components.

2. Define enthalpy of reaction (ΔHr), can it be negative?

Ans. Enthalpy of Reaction:

"The enthalpy change which occurs when certain number of moles of reactants as indicated by the balanced chemical equation, react together completely to give the products under standard conditions i.e., 25℃ (298K) and 1atm, is called standard enthalpy of reaction".

➢ Its units are kJ mol^{-1}.

Yes; enthalpy of a reaction can be negative for exothermic reactions. For such reactions the enthalpy of products is less than the enthalpy of the reactants. Hence the enthalpy change for these reactions is negative.

Example;

$2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(l)} \quad \Delta H^o_r = -285.8 \text{ kJ mol}^{-1}$

3. Define internal energy of a system.

Ans. Internal Energy (E):

Substance exist in nature because they posses energy.

A system containing some quantity of matter has definite amount of energy present in it.

"The sum of all the possible kinds of energies (i.e., kinetic energy as well as potential energy) present in the particles of a system is called as internal energy of a system".

It is denoted by "E".

During a chemical reaction, the internal energy of a system is changed. This change in internal energy is denoted by ΔE, and it is a state function.

4. What is the physical significance of equation $\Delta H = q_p$.

Ans. According to Equation:

$$\Delta H = q_p$$

The change in enthalpy of a reaction is equal to the amount of heat absorbed or evolved during a chemical reaction, at a constant pressure.

Significance:

Many chemical reactions which occur in nature or studied in laboratory take place at constant pressure. The heat evolved or absorbed during such reactions is equal to the change in enthalpy of a system. So it is more convenient to measure ΔH rather than ΔE.

Example;

$C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)} \quad \Delta H = -393.7 \text{ kJ.mol}^{-1}$

5. Why is it necessary to mention the physical states of reactants and products in a thermochemical reaction? Apply Hess's law to justify your answer.

Ans. The energy possessed by the particles of a substance is according to its physical state. If a substance is formed from its element in different physical states in two reactions, then enthalpy change will also be different.

Consider the following reactions:

$2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(g)} \quad \Delta H = -241.5 \text{ kJ/mol}$

$2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(l)} \quad \Delta H = -285.8 \text{ kJ/mol}$

In both the cases H_2 and O_2 reacts to form H_2O. When water is formed in gaseous state (in which particles posses greater energy) the enthalpy change is less in comparison to the case when H_2O is formed in liquid state (in which particles posses less energy). In later case enthalpy change is more.

Hence, physical states of reactants and products are necessary to mention because it directly correlates to enthalpy change.

II) From Punjab Boards:-

1. Comment that enthalpy of neutralization is merely the heat of formation of one mole of liquid water. (2008L)

Ans. The strong acids like HCl and strong bases like NaOH, ionize completely in dilute solutions as follows:

$$HCl_{(aq)} \rightleftharpoons H^+_{(aq)} + Cl^-_{(aq)}$$

$$NaOH_{(aq)} \rightleftharpoons Na^+_{(aq)} + \bar{O}H_{(aq)}$$

When these solutions are mixed together, neutralization takes place. The only change that actually occurs is the formation of liquid water. The Na^+ and Cl^{-1} ions remain free in the solution.

$$H^+_{(aq)} + Cl^{-1}_{(aq)} + Na^+_{(aq)} + OH^{-1}_{(aq)} \longrightarrow Na^{+1}_{(aq)} + Cl^{-1}_{(aq)} + H_2O_{(l)}$$

Net reaction;

$$H^+_{(aq)} + OH^{-1}_{(aq)} \longrightarrow H_2O_{(l)}$$

$$\Delta H = -57.32 \text{ kJ.mol}^{-1}$$

Thus, the enthalpy of neutralization is merely the heat of formation of one mole of liquid water from its ionic components.

2. Define enthalpy of reaction (ΔHr), can it be negative? (DGK-2018) (RWP-2018)

Ans. Enthalpy of Reaction:

"The enthalpy change which occurs when certain number of moles of reactants as indicated by the balanced chemical equation, react together completely to give the products under standard conditions i.e., 25℃ (298K) and 1atm, is called standard enthalpy of reaction".

➢ Its units are kJ mol^{-1}.

Yes; enthalpy of a reaction can be negative for exothermic reactions. For such reactions the enthalpy of products is less than the enthalpy of the reactants. Hence the enthalpy change for these reactions is negative.

Example;

$$2H_{2(g)} + O_{2(g)} \longrightarrow 2H_2O_{(l)}$$

$$\Delta H_r^0 = -285.8 \text{ kJ mol}^{-1}$$

3. Define internal energy of a system. (2006G), (LHR 2016), (SWL 2018)

Ans. Internal Energy (E):

Substance exist in nature because they posses energy.

A system containing some quantity of matter has definite amount of energy present in it.

"The sum of all the possible kinds of energies (i.e., kinetic energy as well as potential energy) present in the particles of a system is called as internal energy of a system".

It is denoted by "E".

During a chemical reaction, the internal energy of a system is changed. This change in internal energy is denoted by ΔE, and it is a state function.

4. What is the physical significance of equation $\Delta H = q_p$. (2007G)

Ans. According to Equation:

$$\Delta H = q_p$$

The change in enthalpy of a reaction is equal to the amount of heat absorbed or evolved during a chemical reaction, at a constant pressure.

Significance:

Many chemical reactions which occur in nature or studied in laboratory take place at constant pressure. The heat evolved or absorbed during such reactions is equal to the change in enthalpy of a system. So it is more convenient to measure ΔH rather than ΔE.

Example;

$C_{(s)} + O_{2(g)} \longrightarrow CO_{2(g)}$ $\Delta H = -393.7$ kJ.mol^{-1}

5. Why is it necessary to mention the physical states of reactants and products in a thermochemical reaction? Apply Hess's law to justify your answer. (LHR 2016), (GRW 2017, 18),(FSD 2013) (RWP 2013), (DGK 2014), (AJK 2016)

Ans. The energy possessed by the particles of a substance is according to its physical state. If a substance is formed from its element in different physical states in two reactions, then enthalpy change will also be different.

Consider the following reactions:

$$2H_{2(g)} + O_{2(g)} \longrightarrow 2H_2O_{(g)}$$

$\Delta H = -241.5$ kJ/mol

$$2H_{2(g)} + O_{2(g)} \longrightarrow 2H_2O_{(l)}$$

$\Delta H = -285.8$ kJ/mol

In both the cases H_2 and O_2 reacts to form H_2O. When water is formed in gaseous state (in which particles posses greater energy) the enthalpy change is less in comparison to the case when H_2O is formed in liquid state (in which particles posses less energy). In later case enthalpy change is more.

Hence, physical states of reactants and products are necessary to mention because it directly correlates to enthalpy change.

SECTION III
LONG QUESTIONS

1. State and explain with an example, the Hess's law of constant heat summation. (LHR 2011, 17) (DGK 2014) (SGD 2011) (GRW 2016) (RWP 2013, 16, 18)
2. When 2.00 moles of H_2 and 1.00 mole of O_2 at 100°C and 1 torr pressure react to produce 2.00 moles of gaseous water, 484.5. KJ of energy is evolved? What are the values of i.ΔH ii. ΔE for the production of one mole of $H_2O_{(g)}$. (LHR 2012) (FSD 2012) (SGD 2012)

3. Define enthalpy of reaction. How is it measured by glass calormeter?
(LHR 2013) (MTN 2016) (GRW 2013)
4. Define the following with examples. System, surrounding, endothermic reactions.
(LHR 2015)
5. Define enthalpy and prove that $q_p = \Delta H$.
(LHR 2016) (MTN 2011) (DGK 2011)
(GRW 2018)(LHR 2018)
6. Neutralization of 100cm^3 of 0.5 M NaOH at 25°C with 100cm^3 of 0.5M HCl at 25°C raised the temperature of reaction mixture to 28°C. Find the enthalpy of neutralization. Specific heat of water = $4.2JK^{-1}g^{-1}$.
(GRW 2012) (DGK 2012) (RWP 2011)
7. Define enthalpy of neutralization. Also discuss glass calorimeter in detail.
(GRW 2013)
8. State the construction and functioni8ng of glass calorimeter. (GRW 2014)
9. Describe Bomb Calorimeter. (SGD 2018)
(MTN 2017) (RWP 2014, 18) (FSD 2016)
10. How ΔH can be determined by using bomb calorimeter? (FSD 2011)
11. Describe how the enthalpy of combustion of a substance is measured by bomb calorimeter? (FSD 2013)
12. Explain the term internal energy of a system and also mention how the change in internal energy of a system can occur? (FSD 2014)
13. Differentiate between: (FSD 2016)
Exothermic and endothermic reactions
14. Describe the measurement of enthalpy of a reaction by glass calorimeter? (SGD 2016)
15. Define orbital Hybridization and explain sp^2 hybridization with example. (DGK 2013)
(MTN 2013)
16. Prove that $\Delta H = q_p$ (DGK 2014)
17. Explain Glass Calorimeteric method for the measurement of Enthalpy of a reaction.
(DGK 2016) (SGD 2018)
18. What is meant by the term Enthalpy of a system?
Derive an expression $\Delta H = q_p$ (SWL 2014)
19. How enthalpy of combustion is determined using bomb calorimeter? (SWL 2016)
20. What is the first law of thermodynamics? Give its mathematical form. (LHR 2018)
(SWL 2017) (SGD 2017) (DGK 2017) (BWP 2017) (LHR 2016) (RWP 2017) (DGK 2018)

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Chapter – 8

CHEMICAL EQUILIBRIUM

SECTION I

Multiple Choice Questions

I) From Exercise:-

(i) For which system does the equilibrium constant, K_c has units of (concentration)$^{-1}$?

(a) $N_2 + 3H_2 \rightleftharpoons 2NH_3$

(b) $H_2 + I_2 \rightleftharpoons 2HI$

(c) $2NO_2 \rightleftharpoons N_2O_4$

(d) $2HF \rightleftharpoons H_2 + F_2$

(ii) Which statement about the following equilibrium is correct (DGK 2019)

$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g) \Delta H = -188.3 kJ\ mol^{-1}$

(a) The value of K_p falls with a rise in temperature

(b) The value of K_p falls with increasing pressure

(c) Adding V_2O_5 catalyst increase the equilibrium yield of sulphur trioxide

(d) The value of K_p is equal to K_c

(iii) The pH of 10^{-3} mol dm^{-3} of an aqueous solution of H_2SO_4 is:

(a) 3.0 **(b) 2.7** (c) 2.0 (d) 1.5

(iv) An excess of aqueous sliver nitrate is added to aqueous barium chloride and precipitate is removed by filtration. What are the main ions in the filtrate?

(a) Ag^+ and NO_3 only

(b) Ag^+ and Ba^{2+} and NO_3^-

(c) Ba^{2+} and NO_3 only

(d) Ba^{2+} and NO_3^- and Cl^-

II) From Punjab Boards:-

1. The term pH was introduced by: (LHR 2011, 2012, 2013) (GRW 2011) (SGD 2015)(SWL 2018)

(a) Henderson **(b) Sorenson**

(c) Respiration (d) Boiling

2. The relationship between k_p and k_c is given by: (LHR 2011)

(a) $k_c = k_p (P)^{\Delta n}$ (b) $K_c = K_p \left(\frac{P}{N}\right)^{\Delta n}$

(c) $K_p = K_c (RT)^{\Delta n}$ (d) $K_p = K_c (RT)^{-\Delta n}$

3. For which system does the equilibrium constant K_C has units of (concentration)$^{-1}$: (LHR 2014 G-I) (2017) (GRW 2013) (FSD 2013, 14) (RWP 2015) (SGD 2013) (DGK 2016) (BWP 2017) (LHR 2018)

(a) $N_2 + 3H_2 \rightleftharpoons 2NH_3$

(b) $H_2 + I_2 \rightleftharpoons 2HI$

(c) $2NO_2 \rightleftharpoons N_2O_4$

(d) $2HF \rightleftharpoons H_2 + F_2$

4. The units of K_C for the reaction of NH_3 synthesis is: (LHR 2014 G-II) (FSD 2011)

(a) moles^{-1} dm^6 (b) moles^{-2} dm^3

(c) moles^{-2} dm^2 **(d) moles^{-2} dm^6**

5. When 50% reactants in a reversible reaction are converted into a product, the value of K_C is: (LHR 2015 G-II)

(a) 2 **(b) 1** (c) 3 (d) 4

6. The pH of 10^{-3} mol dm^{-3} of an aqueous solution of H_2SO_4 is: (LHR 2016) (AJK 2017) (RWP 2015) (BWP 2016) (DGK 2014) (GRW 2015) (MTN 2017) (FSD 2013)

(a) 3.0 **(b) 2.7** (c) 2.0 (d) 1.5

7. Which statement about the following equilibrium is correct. (LHR 2016) (BWP 2017)

$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_{3(g)}\ \Delta H = -188.3k\ Jom^{-1}$.

(a) The value of K_p falls with a rise in temperature

(b) The value of K_p falls with increasing pressure

(c) Adding V_2O_5 catalyst increase the equilibrium yield of sulphur trioxide

(d) The value of K_p is equal to K_c

8. pH of human blood is : (GRW 2014 G-II) (SWL 2016) (DGK 2016)

(a) 7.35 (b) 6.35 (c) 5.35 (d) 4.35

9. pH of a buffer can be calculated by using. (MTN 2011)

(a) Moseley's equation

(b) Henderson's equation

(c) De-Broglie equation

(d) Bohr's equation

10. In synthesis of Ammonia by Haber's process the optimum condition for pressure is:

(a) 150 – 160 atm (b) 170 – 200 atm

(c) 200 – 300 atm (d) 300 – 350 atm

11. Which statement about the following equilibrium is correct? (MTN 2012)
(a) The value of Kp falls with rise in temperature
(b) The value of kp falls with increase in pressure
(c) Adding V_2O_5 catalyst increase the equilibrium yield or SO_3
(d) The value of Kp is equal to Kc

12. For the reaction $2SO_2 + O_2 \rightleftharpoons 2SO_3$. (MTN 2013, 2015)
(a) Kc = Kp (b) Kc < Kp
(c) Kc > Kp (d) Kc = Kx

13. _____ million tons ammonia is produced by Haber's process. (MTN 2013)
(a) 110 (b) 120 (c) 115 (d) 200

14. The pH the gastric juice is: (MTN 2014)
(a) 2.0 (b) 3.0 (c) 3.5 (d) 5.6

15. The value of K_W at 25°C is: (MTN 2016)
(a) 0.11×10^{-14} (b) 0.30×10^{-14}
(c) 1×10^{-14} (d) 3×10^{-14}

16. _____ was derived by C.M. Gulberg and P. Waage in 1864. (MTN 2017)
(a) Law of conservation of mass
(b) Law of mass action
(c) Distribution law
(d) Law of conservation of energy

17. The pH of mixture of CH_3COONa and CH_3COOH is: (FSD 2013)
(a) 7 **(b) >7** (c) <7 (d) 1

18. Which aqueous solution has highest pH? (FSD 2016)
(a) 0.1M NaOH (b) 0.1M H_2SO_4
(c) 0.1M HCλ (d) 0.2M HNO_3

19. The pH of human blood is: (RWP 2011, 13) (SWL 2016)
(a) 8.0 (b) 7.53 (c) 7.63 **(d) 7.35**

20. The HCl is added to aqueous solution of H_2S: (RWP 2011)
(a) Increases (b) Remains constant
(c) Decreases
(d) First decreases then increases

21. $pH = pKa + \log \frac{[Salt]}{[Acid]}$ is known as:
(a) Einstein equation (b) Planck equation
(c) Gibb's equation **(d) Henderson equation**

22. Acid having Ka > 1 will be: (RWP 2014)
(a) Weak (b) Very weak
(c) Moderate **(d) Strong**

23. Reaction of $BiCl_3$ with H_2O gives white ppt of BiOCl and HCl is formed. The white ppt disappears by: (SGD 2011)
(a) Adding $BiCl_3$ **(b) Adding HCl**
(c) Increasing temperature
(d) Decreasing temperature

24. The increase in dilution of solution: (DGK 2013, 2015)
(a) Increase the degree of dissociation
(b) Decreases the degree of dissociation
(c) Does not affect the degree of dissociation
(d) Depends upon the nature of the solute

25. pH of soft drinks at 25°C is about. (DGK 2017)
(a) 3.0 (b) 11.0 (c) 1.0 (d) 7.0

III) From Entry Test:-

(1) Which of the following gases reaction will be favoured at low pressure?
(a) $H_2 + I_2 \rightleftharpoons 2HI$
(b) $PCl_5 \rightleftharpoons PCl_3 + PCl_2$
(c) $N_2 + 3H_2 \rightleftharpoons 2NH_3$
(d) $N_2 + O_2 \rightleftharpoons 2NO$

(2) For the reaction $CO_{(g)} + 2H_{2(g)} \longrightarrow CH_3OH_{(g)}$:
(a) $K_p > K_c$ **(b) $K_p < K_c$**
(c) $K_p = K_c$ (d) $K_c = 0$, $K_p \neq 0$

(3) Which of the following is not acidic salt?
(a) NaH_2PO_2 (b) Na_2HPO_4
(c) NaH_2PO_3 (d) $NaHCO_3$

(4) When HCl is added to H_2S aqueous solution, its ionization:
(a) Increases **(b) Decreases**
(c) Remains constant
(d) First increases and then decreases

(5) For what value of K_c, almost forward reaction is complete?
(a) $K_c = 10^{-30}$ **(b) $K_c = 10^{30}$**
(c) $K_c = 1$ (d) $K_c = 0$

(6) Units of K_c for the reaction $N_2 + 3H_2 \rightleftharpoons 2NH_3$:
(a) mol dm^{-3} (b) mol^{-1} dm^{+3}
(c) mol^2 dm^{-6} **(d) mol^{-2} dm^{+6}**

(7) H_2SO_4 (dibasic acid) dissociate completely in water. What will be the molarity if pH of this acid is equal to 1?
(a) 0.05 M (b) 1.0 M
(c) 0.1 M (d) 0.5 M

(8) Which of the following has highest pH?

(a) 0.1 M HCl **(b) 0.1 M NaOH**

(c) 0.1 M HNO_3 (d) 0.2 M H_2SO_4

(9) Four aqueous solutions have pH values shown below P = 2, Q = 6, R = 8, S = 10. If pairs of solutions are mixed, which pair produce acidic mixture:

(a) P + Q (b) Q + R

(c) P + R (d) R + S

(10) A buffer solution contains 0.1 ml dm^{-3} of CH_3COOH and CH_3COONa each. PK_a for CH_3COOH is 4.74. What is the pH of the buffer?

(a) 4.74 (b) 5.76 (c) 3.76 (d) 9.52

(11) Which of the following solutions have zero pH?

(a) 0.5 M HCl **(b) 0.5 M H_2SO_4**

(c) 0.1 M HNO_3 (d) 0.5 M CH_3COOH

(12) pH of milk is:

(a) 5.5 **(b) 6.5** (c) 7.5 (d) 8.5

(13) The pH of 10^{-3} mol. dm^{-3} of H_2SO_4 solution is:

(a) 3.0 **(b) 2.7** (c) 2.0 (d) 1.5

(14)Strength of an acid can be determined by:

(a) pKa (b) pH

(c) Ka **(d) All of these**

(15) Strength of an acid is directly related to the value of:

(a) pKa (b) Ph **(c) Ka** (d) Kw

(16) The value of PK_w at 25°C is:

(a) 10^{14} (b) 10^{-14} **(c) 14** (d) 7

(17) The sum of $[H^+]$ and $[OH^-]$ in pure water is:

(a) 7 (b) 14 (c) 10^{-14} **(d) 2×10^{-7}**

(18) Almost forward reaction is complete when:

(a) K_C is very large

(b) K_C is very small

(c) Moderate K_C value

(d) None of these

(19) Ka value for acetic acid CH_3COOH at 25°C is:

(a) 1.85×10^{-5} (b) 1.85×10^{-10}

(c) 1.85×10^{-15} (d) 1.85×10^{-20}

SECTION II

SHORT QUESTIONS

From Exercise:-

QUESTIONS

1. Differentiate between reversible and irreversible reactions.

Ans.

	Reversible Reactions	Irreversible Reactions
(i)	Those chemical reactions which can move in both directions (i.e. forward and reverse) under same conditions are called as reversible reactions.	(i) Those chemical reactions which can proceed only in the forward direction in the given conditions are called as irreversible reactions.
(ii)	These reactions are represented by a double headed arrow. ($\rightleftharpoons$)	(ii) These reaction are represented by a single arrow, pointing from reactants towards the products ($\longrightarrow$)
(iii)	A reversible reaction, always stop at the equilibrium point.	(iii) An irreversible reactions, always goes for completion.
(iv)	At equilibrium stage both the reactants and the products are present in the reaction mixture.	(iv) All the reactants are converted into product.
	Example. $N_{2(g)} + 3H_{2(g)} \overset{450°C}{\rightleftharpoons} 2NH_{3(g)}$	**Example.** $2Na_{(s)} + 2H_2O_{(l)} \rightarrow 2NaOH_{(aq)} + H_{2(g)}$

2. Give statement of Le-Chatelier's principle.

Ans. Le-Chatelier's principle states that.

"If a stress is applied to a system at equilibrium, the system acts in such a way so as to nullify, as for as possible, the effect of that stress".

The system cannot completely cancel the effect of the change, but moves in that direction where it minimize its effect.

Example.

If KCl is added to a solution of $KClO_3$, the reaction moves in backward direction to re-attain the equilibrium.

$$KClO_3 \rightleftharpoons K^+_{(aq)} + ClO^-_{(aq)}$$

$$KCl \rightleftharpoons K^+_{(aq)} + Cl^-_{(aq)}$$

3. How NaCl is purified by common ion effect?

Ans. Impure NaCl can be purified by common ion effect as follows.

The impure NaCl is dissolved in water to form a saturated solution called brine. The NaCl is fully ionized in water producing Na^+ and Cl^- ions.

$$NaCl(s) \rightleftharpoons Na^+_{(aq)} + Cl^-_{(aq)}$$

The equilibrium constant expression for this process is written as.

$$Kc = \frac{[Na^+]\,[Cl^-]}{[NaCl]}$$

Now if HCl gas is passed through the concentrated NaCl solution, HCl gas ionizes completely in the solution as.

$$HCl_{(g)} \rightleftharpoons H^+_{(aq)} + Cl^-_{(aq)}$$

On passing HCl gas, the concentration of Cl^- ions increase in the solution. Due to increased conc. of Cl^- ions the ionization of NaCl is suppressed and solid NaCl crystallizes out of the solution to maintain the constant value of equilibrium constant.

4. Describe the effect of common ion on solubility by giving examples.

Ans. The solubility of less soluble salts in water is suppressed by the addition of more soluble salts due to common ion effect.

e.g.,

(i) The solubility of less soluble $KClO_3$ salt is decreased by the addition of KCl.

$$KClO_{3(s)} \rightleftharpoons K^+_{(aq)} + ClO^{-1}_{3(aq)}$$

$$KCl_{(aq)} \rightleftharpoons K^{+1}_{(aq)} + Cl^{-1}_{(aq)}$$

(ii) The solubility of sparingly soluble $PbCrO_4$ is decreased by the addition of Na_2CrO_4.

$$PbCrO_{4(s)} \rightleftharpoons Pb^{+2}_{(aq)} + CrO^{-1}_{4(aq)}$$

$$Na_2CrO_{4(aq)} \rightleftharpoons 2Na^{+1}_{(aq)} + CrO^{-1}_{4(aq)}$$

5. Why the equilibrium constant value has its units for some of the reversible reactions but has no units for some other reactions?

Ans. The equilibrium constant is equal to the ratio of the concentration of products to the concentration of the reactants.

For a general reversible reaction i.e.

$$aA + bB \rightleftharpoons cC + dD$$

The equilibrium constant is written as.

$$Kc = \frac{[C]^c\,[D]^d}{[A]^a\,[B]^b}$$

(i) Since Kc is a ratio of two concentrations, so it has no units, when number of moles of reactants and products are equal.

$$CH_3COOH_{(aq)} + C_2H_5OH_{(aq)} \rightleftharpoons CH_3COOC_2H_{5(aq)} + H_2O_{(l)}$$

$$Kc = \frac{[CH_3COOC_2H_5]\,[H_2O]}{[CH_3COOH]\,[C_2H_5OH]}$$

$$= \frac{(\text{moles. dm}^{-3})\,(\text{moles dm}^{-3})}{(\text{moles. dm}^{-3})\,(\text{moles dm}^{-3})} = \text{no units}$$

(ii) If number of moles of reactants and products are not equal then equilibrium constant (Kc) has units according to the reaction.

$$PCl_{5(g)} \rightleftharpoons PCl_{3(g)} + Cl_{2(g)}$$

$$Kc = \frac{[PCl_3]\,[Cl_2]}{[PCl_5]}$$

$$Kc = \frac{(\text{moles dm}^{-3})\,(\text{moles dm}^{-3})}{(\text{moles dm}^{-3})} = \text{moles dm}^{-3}$$

6. How would you prove that at 25°C, 1dm^3 of water contains 10^{-7} moles of H_3O^+ and 10^{-7} moles of OH^{-1} ions?

Ans. Water undergoes self ionization as follows.

$$H_2O + H_2O \rightleftharpoons H_3O^+ + OH^{-1}$$

The ionic product of water have a value of 10^{-14} at 25°C i.e.,

$$K_w = [H_3O^+][OH^{-1}] = 10^{-14} \text{ at } 25°C$$

In neutral water, the concentration of H_3O^+ ions is equal to the concentration of OH^{-1} ions.

i.e., $[H_3O^+] = [OH^{-1}]$

Since,

$$[H_3O^+]\,[OH^{-1}] = 10^{-14}$$

We can write.

$$[H_3O^+]\,[H_3O^+] = 10^{-14}$$

or, $$[H_3O^+]^2 = 10^{-14}$$

Taking square root on both sides.

$$[H_3O^+] = 10^{-7} \text{ mol. dm}^{-3}$$

and $$[OH^{-1}] = 10^{-7} \text{ mol. dm}^{-3}$$

Hence proved that $1dm^3$ of water at 25°C has 10^{-7} moles of H_3O^+ ions and 10^{-7} moles of OH^{-1} ions.

7. How equilibrium constant "K_c" is used to predict the direction of reaction.

Ans. The direction of a chemical reaction at any particular time can be predicted by means of [Products]/[Reactants] ratio, calculated before the reaction attains equilibrium.

$$\frac{[\text{Products}]}{[\text{Reactants}]} = \text{Ratio}$$

The ratio leads to one of the following possibilities.

(a) The Ratio is Less Than K_c:

This shows that more of the product is required to attain the equilibrium, therefore, the reaction will proceed in the forward reaction.

(b) The Ratio is Greater Than K_c:

It means concentration of products is greater, so reaction will move in reverse direction.

(c) The Ratio is Equal to K_c:

This shows that reaction is at equilibrium.

8. How equilibrium constant, K_c explains the extent of reaction?

Ans. Extent of Reaction:

i) If the equilibrium constant is very large;

If the equilibrium constant is very large, this indicates that the reaction is almost complete. e.g.,

K_c for decomposition of ozone to oxygen is 10^{55} at 25°C.

$$2O_3 \rightleftharpoons 3O_2 \quad K_c = 10^{55} \text{ at } 25°C$$

It shows that O_3 is unstable and decompose rapidly to O_2. This reaction is almost complete.

ii) If the equilibrium constant is small;

If the value of K_c is small, the reaction does not proceed appreciably in forward reaction.

iii) If the equilibrium constant is very large;

If the value of K_c is very small, the reaction in forward direction is almost not possible.

e.g.,

The K_c for decomposition of HF at 2000°C is 10^{-13}

$$2HF_{(g)} \rightleftharpoons H_{2(g)} + F_{2(g)} \quad K_c = 10^{-13} \text{ at } 2000°C$$

9. A catalyst does not affect the equilibrium constant comment on it?

Ans. A catalyst does not affect the equilibrium constant of a chemical reaction. A catalyst increases the rate of both forward and backward reactions and reduces the time to attain the state of equilibrium. The concentration of reactants and the products at equilibrium remain same.

As,

$$K_c = \frac{[\text{Products}]}{[\text{Reactants}]}$$

Since concentrations of reactants and products are not affected, the equilibrium constant (K_c) remain constant.

10. What is concentration of OH^{-1} ion in a solution whose pH is 10.

Ans. We know that,

$$pH + pOH = 14$$
$$pOH = 14 - pH$$
$$pOH = 14 - 10 = 4$$

So, pOH of the solution is 4.

We know.

$$pOH = -\log [OH^{-1}]$$

or $$[OH^{-1}] = 10^{-pOH}$$

$$[OH^{-1}] = 10^{-4} \text{ moles. dm}^{-3}$$

The concentration of hydroxide ion in the solution of pH = 10 is 10^{-4} moles dm^{-3}.

11. The change of volume disturbs the equilibrium position for some of the gaseous phase reactions but not the equilibrium constant.

Ans. Consider following reaction and its equilibrium expression:

$$2SO_{2(g)} + O_{2(g)} \rightleftharpoons 2SO_{3(g)}$$

t = 0	a	b	0
t = eq	$\frac{(a-2x)}{V}$	$\frac{(b-x)}{V}$	$\frac{2x}{V}$

$$K_c = \frac{4x^2V}{(a-2x)^2(b-x)}$$

If we decrease the volume for the above reaction, equilibrium position will shift in forward direction (where lesser no. of moles are being formed).

The decrease of volume 'V' in equilibrium expression increases the value of 'x'. Therefore the value of K_c remains constant.

Hence, the equilibrium position shifted but value of equilibrium constant remains the same.

Note: Change of volume affects the equilibrium position of only those reactions in which no. of moles of reactants and products are different.

Increase of volume shifts equilibrium in a direction where more no. of moles are formed and vice versa.

12. The change of temperature disturbs both the equilibrium position and the equilibrium constant of a reaction.

Ans. Increase of temperature favours endothermic reaction because it requires heat and decrease of temperature favours exothermic reaction.

For example:

Consider the following exothermic reversible reaction.

$$CO_{(g)}+H_2O_{(g)} \rightleftharpoons CO_{2(g)}+H_{2(g)}\ \Delta H=-41.84\ KJ/mol$$

Increase of temperature favours the backward endothermic reaction and equilibrium is shifted to left. This shift continues until new equilibrium position is established with new concentration of reactants (increased) and that of products (decreased). As,

$$K_c = \frac{[Products]}{[Reactants]}$$

Hence, the value of K_c is also changed at new equilibrium position because.

13. The solubility of glucose in water is increased by increasing the temperature.

Ans. The dissolution of glucose in water is an endothermic process. Heat is absorbed to break the strong cohesive forces present in the crystal lattice.

$$C_6H_{12}O_{6(s)}+H_2O_{(l)} \rightleftharpoons C_6H_{12}O_{6(aq)}\ \Delta H=+ve$$

When temperature is increased, more heat is available to break the forces of attraction in the lattice and the reaction moves in the forward direction. Hence, the solubility of sugar increases with the rise of temperature.

14. How would you prove that at 25°C 1 dm^3 of water contains 10^{-7} moles of H_3O^+ and 10^{-7} moles of OH^-.

Ans. Ionic product of water is:

$K_w = [H^+][OH^-]$

$10^{-14} = [H^+][OH^-]$

since, $K_w = 10^{-14}$ Water ionizes as

$$H_2O \rightleftharpoons H^+ + OH^-$$

It shows that in case of pure water:

$[H^+] = [OH^-]$

Hence, we can write eq. (1) as:

$10^{-14} = [H^+][H^+]$ since $[H^+] = [OH^-]$

$10^{-14} = [H^+]^2$

Taking square root on both sides:

$10^{-7} = [H^+]$ moles/dm^3 since, $[H^+] = [H_3O^+]$

Hence, $10^{-7} = [OH^-]$ moles/dm^3

II) From Punjab Boards:-

Q.1- Differentiate between reversible and irreversible reactions. (LHR 2011)

Ans.	Reversible Reactions	Irreversible Reactions
(i)	Those chemical reactions which can move in both directions (i.e., forward and reverse) under same conditions are called as reversible reactions.	(i) Those chemical reactions which can proceed only in the forward direction in the given conditions are called as irreversible reactions.
(ii)	These reactions are represented by a double headed arrow. ($\rightleftharpoons$)	(ii) These reaction are represented by a single arrow, pointing from reactants towards the products ($\longrightarrow$)
(iii)	A reversible reaction, always stop at the equilibrium point.	(iii) An irreversible reactions, always goes for completion.
(iv)	At eq. stage both the reactants and the products are present in the reaction mixture.	(iv) All the reactants are converted into product.
	Example. $N_{2(g)} + 3H_{2(g)} \overset{450°C}{\rightleftharpoons} 2NH_{3(g)}$	***Example.*** $2Na_{(s)} + 2H_2O_{(l)} \longrightarrow 2NaOH_{(aq)} + H_{2(g)}$

2. Give statement of Le-Chatelier's principle. (2005L,2009G)(LHR 2015, 16)

Ans. Le-Chatelier's principle states that.

"If a stress is applied to a system at equilibrium, the system acts in such a way so as to nullify, or undo, the effect of that stress".

The system cannot completely cancel the effect of the change, but moves in that direction where it minimize its effect.

Example.

If KCl is added to a solution of $KClO_3$, the reaction moves in backward direction to re-attain the equilibrium.

$$KClO_3 \rightleftharpoons K^+_{(aq)} + ClO^-_{(aq)}$$

$$KCl \rightleftharpoons K^+_{(aq)} + Cl^-_{(aq)}$$

3. How NaCl is purified by common ion effect? (2006G)

Ans. Impure NaCl can be purified by common ion effect as follows.

The impure NaCl is dissolved in water to form a saturated solution called brine. The NaCl is fully ionized in water producing Na+ and Cl– ions.

$$NaCl(s) \rightleftharpoons Na^+_{(aq)} + Cl^-_{(aq)}$$

The equilibrium constant expression for this process is written as.

$$Kc = \frac{[Na^+][Cl^-]}{[NaCl]}$$

Now if HCl gas is passed through the concentrated NaCl solution, HCl gas ionizes completely in the solution as.

$$HCl_{(g)} \rightleftharpoons H^+_{(aq)} + Cl^-_{(aq)}$$

On passing HCl gas, the concentration of Cl^- ions increase in the solution. Due to increased conc. of Cl^- ions the ionization of NaCl is suppressed and solid NaCl crystallizes out of the solution to maintain the constant value of equilibrium constant.

4. Describe the effect of common ion on solubility by giving examples. (2009L)(FSD 2012)(LHR 2018)

Ans. The solubility of less soluble salts in water is suppressed by the addition of more soluble salts due to common ion effect.

e.g.,

(i) The solubility of less soluble $KClO_3$ salt is decreased by the addition of KCl.

$$KClO3_{(s)} \rightleftharpoons K^+_{(aq)} + ClO^{-1}_{3(aq)}$$

$$KCl_{(s)} \rightleftharpoons K^{+1}_{(aq)} + Cl^{-1}_{(aq)}$$

(ii) The solubility of sparingly soluble $PbCrO_4$ is decreased by the addition of Na_2CrO_4.

$$PbCrO_{4(s)} \rightleftharpoons Pb^{+2}_{(aq)} + CrO^{-1}_{4(aq)}$$

$$Na_2CrO_{4(aq)} \rightleftharpoons 2Na^{+1}_{(aq)} + CrO^{-1}_{4(aq)}$$

5. Why the equilibrium constant value has its units for some of the reversible reactions but has no units for some other reactions? (2007G), (GRW 2011), (DGK 2013)

Ans. The equilibrium constant is equal to the ratio of the concentration of products to the concentration of the reactants.

For a general reversible reaction i.e.

$$aA + bB \rightleftharpoons cC + dD$$

The equilibrium constant is written as.

$$Kc = \frac{[C]^c[D]^d}{[A]^a[B]^b}$$

(i) Since Kc is a ratio of two concentrations, so it has no units, when number of moles of reactants and products are equal.

$$CH_3COOH_{(aq)} + C_2H_5OH_{(aq)} \rightleftharpoons CH_3COOC_2H_{5(aq)} + H_2O_{(l)}$$

$$Kc = \frac{[CH_3COOC_2H_5][H_2O]}{[CH_3COOH][C_2H_5OH]}$$

$$= \frac{(\text{moles. dm}^{-3})(\text{moles dm}^{-3})}{(\text{moles. dm}^{-3})(\text{moles dm}^{-3})} = \text{no units}$$

(ii) If number of moles of reactants and products are not equal then equilibrium constant (Kc) has units according to the reaction.

$$PCl_{5(g)} \rightleftharpoons PCl_{3(g)} + Cl_{2(g)}$$

$$Kc = \frac{[PCl_3][Cl_2]}{[PCl_5]}$$

$$Kc = \frac{(\text{moles dm}^{-3})(\text{moles dm}^{-3})}{(\text{moles dm}^{-3})} = \text{moles dm}^{-3}$$

6. Define buffer capacity. (2007G, 2010L) (RWP 2018) (GRW 2018)

Ans. **Buffer Capacity:**

The buffer capacity of a solution is defined as.

"The ability of a buffer solution to resist the change in its pH, when an acid or a base is added to it".

Generally the buffer capacity of an acidic buffer for a base is equal to the concentration of weak acid present in the buffer solution and for an acid is equal to the concentration of salt present in the buffer solution.

7. When the concentration of salt is increased in an acidic buffer than the pH of the solution increases. Why? (2007L)

Ans. Consider the example of an acidic buffer consisting of CH_3COOH and CH_3COONa.

CH_3COOH is a weak electrolyte and dissociated to a very little extent in water. When CH_3COONa (Salt), which is a strong electrolyte is added to CH_3COOH solution, the dissociation of CH_3COOH is suppressed due to common ion effect of CH_3COO^{-1} ions.

$$CH_3COOH_{(aq)} + H_2O_{(l)} \rightleftharpoons CH_3COO^-_{(aq)} + H_3O^+_{(aq)}$$

$$CH_3COONa_{(aq)} \rightleftharpoons CH_3COO^-_{(aq)} + Na^+_{(aq)}$$

Since, dissociation of CH_3COOH is suppressed, the conc. of H_3O^+ ions in the solution decreases and the pH of the solution increases.

Example.

[CH_3COOH]	[CH_3COONa]	pH
0.1 mol dm^{-3}	0.00 mole dm^{-3}	2.89
0.1 mol. dm^{-3}	0.10 mol. dm^{-3}	4.74

8. What will be the effect of change in pressure on NH_3 synthesis? (2008L) (LHR 2012)

Ans. NH_3 gas can be prepared on industrial scale by Haber process. In the process N_2 and H_2 gases are reacted together to produce ammonia gas in a reversible reaction.

$$N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)} \qquad \Delta H = -92.46\ kJ$$

In the reaction four moles of reactants produce two moles of product (NH_3). Therefore the reaction proceed with decrease in number of moles and decrease in volume. Now if we increase the pressure, the volume of reaction vessel will decrease. Due to decrease in volume, the equilibrium position shifts towards right. Hence increase in pressure will move the reaction in forward direction and yield of NH_3 is increased.

9. What is an ionic product of water? What is its value at 25°C. (2006L, 2008L) (GRW 2013)

Ans. Water undergoes self ionization as follows.

$$H_2O \rightleftharpoons H^+ + OH^{-1}$$

The equilibrium constant for this reaction can be written as.

$$K_c = \frac{[H^+][OH^{-1}]}{[H_2O]} = 1.8 \times 10^{-16} \text{ mol. } dm^{-3}$$

Since H_2O is present in very large excess, so its concentration remains constant. So it can be taken on L.H.S and multiplied with Kc to get another constant.

$$K_c \times [H_2O] = [H^+][OH^{-1}] \therefore K_c \times [H_2O] = K_w$$

$$K_w = [H^+]\,[OH^{-1}]$$

"K_w" is called ionic product of water or dissociation constant of water.

Value of Kw at 25°C:

Since K_w is the product of eq. constant K_c and concentration of H_2O, its value can be calculated on.

$$K_w = [H_2O] \times K_c$$

$$K_w = 55.5 \times 1.8 \times 10^{-16}$$

$$K_w \approx \mathbf{1.0 \times 10^{-14}\ at\ 25°C}$$

10. How would you prove that at 25°C, 1dm^3 of water contains 10^{-7} moles of H_3O^+ and 10^{-7} moles of OH^{-1} ions? (2009G)

Ans. Water undergoes self ionization as follows.

$$\mathbf{H_2O + H_2O \rightleftharpoons H_3O^+ + OH^{-1}}$$

The ionic product of water have a value of 10^{-14} at 25°C

i.e.,

$K_w \approx [H_3O^+][OH^{-1}] = 10^{-14}$ at 25°C

In neutral water, the concentration of H_3O^+ ions is equal to the concentration of OH^{-1} ions.

i.e., $[H_3O^+] = [OH^{-1}]$

Since,

$[H_3O^+]\,[OH^{-1}] = 10^{-14}$

We can write.

$[H_3O^+]\,[H_3O^+] = 10^{-14}$

or, $[H_3O^+]^2 = 10^{-14}$

Taking square root on both sides.

$[H_3O^+] = 10^{-7}$ mol. dm^{-3}

and $[OH^{-1}] = 10^{-7}$ mol. dm^{-3}

Hence proved that 1dm^3 of water at 25°C has 10^{-7} moles of H_3O^+ ions and 10^{-7} moles ofO H^{-1} ions.

11. How equilibrium constant "K_c" is used to predict the direction of reaction.
(LHR 2014), (RWP 2012),(MTN 2013)

Ans. The direction of a chemical reaction at any particular time can be predicted by means of [Products]/[Reactants] ratio, calculated before the reaction attains equilibrium.

$$\frac{[\text{Products}]}{[\text{Reactants}]} = \text{Ratio}$$

The ratio leads to one of the following possibilities.

(a) The Ratio is Less Than Kc:
This shows that more of the product is required to attain the equilibrium, therefore, the reaction will proceed in the forward reaction.

(b) The Ratio is Greater Than Kc:
It means concentration of products is greater, so reaction will move in reverse direction.

(c) The Ratio is Equal to Kc:
This shows that reaction is at equilibrium.

12. How equilibrium constant, Kc explains the extent of reaction? (LHR 2018)

Ans. Extent of Reaction:

i) If the equilibrium constant is very large;
If the equilibrium constant is very large, this indicates that the reaction is almost complete.
e.g.,
K_c for decomposition of ozone to oxygen is 10^{55} at 25°C.

$$2O_3 \rightleftharpoons 3O_2 \quad K_c = 10^{55} \text{ at } 25°C$$

It shows that O_3 is unstable and decompose rapidly to O_2. This reaction is almost complete.

ii) If the equilibrium constant is small;
If the value of K_c is small, the reaction does not proceed appreciably in forward reaction.

iii) If the equilibrium constant is very large;
If the value of K_c is very small, the reaction in forward direction is almost not possible.
e.g.,
The K_c for decomposition of HF at 2000°C is 10^{-13}

$$2HF_{(g)} \rightleftharpoons H_{2(g)} + F_{2(g)}$$

$$K_c = 10^{-13} \text{ at } 2000°C$$

13. A catalyst does not affect the equilibrium constant comment on it? (2008G)
(SWL 2016),(DGK 2014),(RWP 2013)

Ans. A catalyst does not affect the equilibrium constant of a chemical reaction. A catalyst increases the rate of both forward and backward reactions and reduces the time to attain the state of equilibrium. The concentration of reactants and the products at equilibrium remain same.
As,

$$K_c = \frac{[\text{Products}]}{[\text{Reactants}]}$$

Since concentrations of reactants and products are not affected, the equilibrium constant (K_c) remain constant.

14. What is concentration of OH^{-1} ion in a solution whose pH is 10.
(2004L) (RWP 2013)

Ans. We know that,

$$pH + pOH = 14$$
$$pOH = 14 - pH$$
$$pOH = 14 - 10 = 4$$

So, pOH of the solution is 4.
We know.

$$pOH = -\log [OH^{-1}]$$

or

$$[OH^{-1}] = 10^{-pOH}$$
$$[OH^{-1}] = 10^{-4} \text{ moles. dm}^{-3}$$

The concentration of hydroxide ion in the solution of pH = 10 is 10^{-4} moles dm^{-3}.

15. The change of volume disturbs the equilibrium position for some of the gaseous phase reactions but not the equilibrium constant.
(SWL 2014),(GRW 2011),(BWP 2013)

Ans. Consider following reaction and its equilibrium expression:

$$2SO_{2(g)} + O_{2(g)} \rightleftharpoons 2SO_{3(g)}$$

t = 0	a	b	0
t = eq	$\frac{(a-2x)}{V}$	$\frac{(b-x)}{V}$	$\frac{2x}{V}$

$$K_c = \frac{4x^2V}{(a-2x)^2(b-x)}$$

If we decrease the volume for the above reaction, equilibrium position will shift in forward direction (where lesser no. of moles are being formed).
The decrease of volume 'V' in equilibrium expression increases the value of 'x'. Therefore the value of K_c remains constant.
Hence, the equilibrium position shifted but value of equilibrium constant remains the same.

Note: Change of volume affects the equilibrium position of only those reactions in which no. of moles of reactants and products are different.

Increase of volume shifts equilibrium in a direction where more no. of moles are formed and vice versa.

16. The change of temperature disturbs both the equilibrium position and the equilibrium constant of a reaction.

(2010L, 2004G) (LHR 2014) (MTB 2011)

Ans. Increase of temperature favours endothermic reaction because it requires heat and decrease of temperature favours exothermic reaction.

For example;

Consider the following exothermic reversible reaction.

$$CO_{(g)} + H_2O_{(g)} \rightleftharpoons CO_{2(g)} + H_{2(g)} \quad \Delta H = -41.84 \text{ KJ/mol}$$

Increase of temperature favours the backward endothermic reaction and equilibrium is shifted to left. This shift continues until new equilibrium position is established with new concentration of reactants (increased) and that of products (decreased). As,

$$K_c = \frac{[\text{Products}]}{[\text{Reactants}]}$$

Hence, the value of K_c is also changed at new equilibrium position because.

17. The solubility of glucose in water is increased by increasing the temperature.

(2010L) (DGK 2012)

Ans. The dissolution of glucose in water is an endothermic process. Heat is absorbed

to break the strong cohesive forces present in the crystal lattice.

$$C_6H_{12}O_{6(s)} + H_2O_{(l)} \rightleftharpoons C_6H_{12}O_{6(aq)} \quad \Delta H = +ve$$

When temperature is increased, more heat is available to break the forces of attraction in the lattice and the reaction moves in the forward direction. Hence, the solubility of sugar increases with the rise of temperature.

SECTION III
LONG QUESTIONS

1. Write a note on synthesis of ammonia gas by Haber's process keeping in mind the applications of chemical equilibrium in industry. (LHR 2012)
2. Define common ion effect. Give its two applications. (GRW 2012) (LHR 2018) (SWL 2018)
3. $N_{2(g)}$ and $H_{2(g)}$ combine to give $NH_{3(g)}$. The value of K_c in this reaction is 6.0×10^{-2}. Calculate the value of K_p for this reaction. (GRW 2013 G-II) (RWP 2018)
4. Prove that: $pK_a + pK_b = pK_w$. (FSD 2012)
5. What is the percentage ionization of acetic acid in a solution in which 0.1 moles of it has been dissolved per dm^3 of the solution. (SGD 2011)
6. Define law of mass action and derive equilibrium constant for a general chemical reaction. (SGD 2012)
7. Calculate the percentage ionization of acetic acid in a solution in which 0.1 moles of its has been dissolved per dm^3 of the solution. $K_a = 1.85 \times 10^{-5}$. (SGD 2017) (FSD-2018) (RWP 2018)
8. Define Le. Chaterlier's Principle. Discuss effect of: (DGK 2012)
   (i) Change in Volume
   (ii) Change in temperature on the formation of ammonia.
9. $N_{2(g)}$ and $H_{2(g)}$ combine to give $NH_{3(g)}$. The value of Kc in this reaction at 500°C is 6.0×10^{-2} Calculate the value of Kp for this reaction. (DGK 2013)
10. What is the percentage ionization of acetic acid in a solution in which 0.1 moles of it has been dissolved per dm^3 of the solution where Ka is 1.85×10^{-5}. (SWL 2014)

❖❖❖❖

Chapter — 9

SOLUTION

SECTION I

Multiple Choice Questions

I) From Exercise:-

(i) 18 g glucose is dissolved in 90 g of water. The relative lowering of vapour pressure is equal to: (MTN, SAK 2019)

(a) $\frac{1}{5}$ (b) 5.1 **(c) $\frac{1}{51}$** (d) 6

(ii) An azeotropic mixture showing positive deviation from Raoult's law, the volume of the mixture is:

(a) Slightly more than the total volume of the components

(b) Slightly less than the total volume of the components

(c) Equal to the total volume of the components

(d) None of these

(iii) Which of the following solutions has the highest boiling point:

(a) 5.85 percent solution of sodium chloride

(b) 18.0 percent solution of glucose

(c) 6.0 percent solution of urea

(d) All have the same boiling point

(iv) Two solutions of NaCl and KCl are prepared separately by dissolving same amount of the solute in water. Which of the following statements is true for these solutions:

(a) KC1 solution will have higher boiling point than NaCl solution

(b) Both of the solutions have different boiling points

(c) KC1 and NaCl solution possess same vapour pressure

(d) KCl solution possesses lower freezing point than NaCl solution

(v) The molal boiling constant is the ratio of the elevation in boiling point to: (DGK 2019)

(a) Molarity **(b) Molality**

(c) Mole fraction of solvent

(d) Mole fraction of solute

(vi) Colligative properties are the properties of:

(a) Dilute solution which behave as nearly ideal solutions

(b) Concentrated solutions which behave as nearly non-ideal solutions

(c) Both (a) and (b) (d) Neither (a) nor (b)

II) From Punjab Boards:-

1. Which one is not equation of Raoult's law: (LHR 2011)

(a) $\Delta p = p^o x$ **(b) $P_v = n_2 RT$**

(c) $\frac{\Delta P}{P^o} = x_2$ (d) $P = P^o x_1$

2. 18 g glucose is dissolved in 90 g of water. The relative lowering of vapour pressure is equal to: (LHR 2016, 17) (AJK 2016) (GRW 2012, 13) (RWP 2012) (MTN 2014, 15, 17, 19) (FSD 2013, 15, 16) (SGD 2015) (AJK 2018) (GRW 2018)

(a) $\frac{1}{5}$ (b) 5.1 **(c) $\frac{1}{51}$** (d) 6

3. In order to mention the boiling point of water at 110°C, the external pressure should be: (LHR 2016)

(a) Between 760 torr and 1200 torr

(b) Between 200 torr and 760 torr

(c) 765 torr (d) 320 torr

4. The molar boiling point constant is the ratio of the elevation in boiling point to: (GRW 2014 G-II)(DGK 2016) (SGD 2017)

(a) molarity **(b) molality**

(c) mole fraction of solvent

(d) mole faction of solute

5. Which of the following pair of liquids is not completely miscible? (MTN 2013)

(a) Alcohol and water

(b) Alcohol and ether

(c) Phenol and water

(d) Benzene and cyclohexane

6. Which one of the following gives acidic solution when dissolved in H_2O: (RWP 2011)

(a) NaCl (b) Na_2SO_4

(c) NH_4Cl (d) CH_3COONH_4

7. A thermometer used in Landsberger's method can read upto: (RWP 2013)

(a) 0.1K (b) 0.01F **(c) 0.01K** (d) 0.01°C

8. Melting point of ice can be lowered by the use of: (RWP 2014)

(a) LiCl (b) $BeCl_2$ **(c) NaCl** d) AgCl

9. The mass of glucose required to prepare 1 dm^3 of 20% glucose solution is: **(DGK 2011, 2012)**

(a) 18g (b) 180g **(c) 36g** (d) 200g

10. The consulate temperature of water aniline system is: **(DGK 2013)**

(a) 69.5°C (b) 64.5°C

(c) 167°C (d) 49.1°C

III) From Entry Test:-

1. Which cation has least heat of hydration?

(a) Li^+ (b) Na^+ **(c) K^+** (d) Mg^{++}

2. Which of the following is partially miscible?

(a) Benzene + Toluene (b) Ethanol + H_2O

(c) 1-butanol + H_2O (d) HCl + H_2O

3. Solder is alloy of:

(a) Cu + Zn (b) Cu + Sn

(c) Cu + Ni + Zn **(d) Pb + Sn**

4. Which of the following is not colligative property?

(a) Lowering of vapour pressure

(b) Ebullioscopy

(c) Cryoscopy **(d) Freezing point**

5. The properties which do not depend upon the amount of the substance:

(a) Colligative properties

(b) Additive properties

(c) Intensive properties

(d) Constitutive properties

6. Azeotropic mixture can be separated by:

(a) Simple distillatio

(b) Fractional distillation

(c) Vacuum distillation (d) None

7. Cheese is type of solution:

(a) Solid in a gas (b) Gas in a solid

(c) Liquid in a solid (d) Solid in a liquid

8. In the Landsberger's method, the solvent is boiled by:

(a) Latent heat of sublimation

(b) Latent heat of vaporization

(c) Latent heat of condensation

(d) None of these

9. Beckman's thermometer reads upto:

(a) 1.0 K (b) 0.1 K **(c) 0.01 K** (d) 0.02 K

10. Which of the following is miscible?

(a) Benzene + Water (b) CS_2 + Water

(c) $CCl_4 + H_2O$ **(d) Benzene + Toluene**

11. 18 g glucose is dissolved in 90 g of water. The relative lowering of vapour pressure is equal to: **(MTL, SLK 20119)**

(a) $\frac{1}{5}$ (b) 5.1 (c) $\frac{1}{51}$ (d) 6

12. Which of the following liquid pairs will obey the Raoult's law:

(a) $C_2H_5OH + H_2O$

(b) $CH_3COCH_3 + CHCl_3$

(c) $C_2H_5I + C_2H_5Br$

(d) $HCl + H_2O$

SECTION II

SHORT QUESTIONS

From Exercise:-

QUESTIONS

1. Why a non-volatile solute in a volatile solvent lowers the vapour pressure of solution?

Ans. The vapour pressure of a liquid is decreased, when a non-volatile solute is dissolved in a volatile solvent due to following reasons.

(i) Due to the presence of solute particles at the surface of the solution, the escaping tendency of solvent particles from the surface of the solution decreases and its vapour pressure is lowered

(ii) Forces of attraction are produced between solute and solvent particles, which also hinders the evaporation of solvent molecules and its vapour pressure decreases.

2. Give any two points which show the ideality of a solution.

Ans. When two liquid substances are mixed together, the solution formed may be ideal or non-ideal. A solution is called ideal, if it obeys the following conditions.

(i) If the forces of attractions between the molecules of different components are same as when they were in the pure state, the solution is ideal.

(ii) If the volume of the solution is equal to the sum of the individual volumes of the components, then the solution is called ideal solution.

3. What are conjugate solutions? Give an example.

Ans. Conjugate solutions:

"When two partially miscible liquids are mixed together in equal volumes, they form two separate layers due to limited solubilities. Each layer in the mixture is a saturated solution of other liquid. Such solutions are called conjugate solutions".

Example:

If equal volumes of water and phenol are mixed together, they show partial miscibility and form two layers. At 25°C, the lower layer is a 30% solution of water in phenol, while upper layer is a 5% solution of phenol in water.

4. Define hydration energy. On what factors does it depends.

Ans. Hydration Energy:

"The amount of heat evolved or absorbed when one mole of gaseous ions are dissolved in water to form an infinitely dilute solution is called hydration energy".

Example;

$$H^+_{(g)} + H_2O(l) \longrightarrow H^+_{(aq)} \quad \Delta H = -1075 kJ\ mol^{-1}$$

Factors Affecting Hydration Energy:

Generally the hydration energies of ions depend upon their charge densities.

$$\text{Charge density} = \frac{\text{Charge of ion}}{\text{Size of ion}}$$

Ions having high charge density have high values of hydration energies and vice versa. So hydration energy of Li^+ ion is greater than Na^+ ion.

5. Give the list of colligative properties.

Ans. Colligative properties:

"The properties of solutions which depend upon the number of solute and solvent particles are called as colligative and properties."

Following are the colligative properties of dilute solutions.

(i) Lowering of vapour pressure.
(ii) Elevation of boiling point.
(iii) Depression of freezing point.
(iv) Osmotic pressure.

6. Boiling points of the solvents increase due to the presence of solutes.

Ans. Boiling Point:

"The temperature at which the vapour pressure of a liquid becomes equal to the external atmospheric pressure is called as boiling point".

When a non-votile solute is dissolved in a solvent, its vapour pressure decreases due to following reasons:

(i) Force of attractions are produced between solute and solvent particles.
(ii) The escaping tendency of solvent particles from the surface of solution decrease due to pressure of solute molecules.

Since vapour pressure of solution has decreased, so more amount of heat is required to equalize its vapour pressure to the external atmospheric pressure. Therefore, boiling point of a solution is greater than pure solvent.

Example:

Boiling point of water = 100°C
Boiling point of 1 Molal glucose solution = 100.52°C

II) From Punjab Boards:-

1. Give any two points which show the ideality of a solution.

(2008L)(BWP 2014)(DGK 2013)

Ans. When two liquid substances are mixed together, the solution formed may be ideal or non-ideal. A solution is called ideal, if it obeys the following conditions.

(i) If the forces of attractions between the molecules of different components are same as when they were in the pure state, the solution is ideal.
(ii) If the volume of the solution is equal to the sum of the individual volumes of the components, then the solution is called ideal solution.

2. What are conjugate solutions? Give an example.

(2008L) (RWP 2012,15) (FSD 2018)

Ans. Conjugate solutions;

"When two partially miscible liquids are mixed together in equal volumes, they form two separate layers due to limited solubilities. Each layer in the mixture is a saturated solution of other liquid. Such solutions are called conjugate solutions".

Example:

If equal volumes of water and phenol are mixed together, they show partial miscibility and form two layers. At 25°C, the lower layer is a 30% solution of water in phenol, while upper layer is a 5% solution of phenol in water.

3. Define hydration energy. On what factors does it depends.

(FSD 2014,15),(DGK 2014,16)

Ans. Hydration Energy:

"The amount of heat evolved or absorbed when one mole of gaseous ions are dissolved in water to form an infinetly dilute solution is called hydration energy".

Example:

$$H^{+}_{(g)} + H_2O(l) \longrightarrow H^{+}_{(aq)} \quad \Delta H = -1075 \text{ kJ mol}^{-1}$$

Factors Affecting Hydration Energy:

Generally the hydration energies of ions depend upon their charge densities.

$$\text{Charge density} = \frac{\text{Charge of ion}}{\text{Size of ion}}$$

Ions having high charge density have high values of hydration energies and vice versa. So hydration energy of Li^{+} ion is greater than Na^{+} ion.

4. Give the list of colligative properties.

(LHR 2014),(GRW 2013),(SWL 2014)
(DGK 2016),(GRW 2018)

Ans. Colligative properties.

"The properties of solutions which depend upon the number of solute and solvent particles are called as colligative properties."

Following are the colligative properties of dilute solutions.

(i) Lowering of vapour pressure.
(ii) Elevation of boiling point.
(iii) Depression of freezing point.
(iv) Osmotic pressure.

5. Non-ideal solution don't obey the Raoult's law.

Ans. If a solution is prepared by mixing two liquids A and B, the vapour pressure of the solution can be calculated from Raoult's law as.

$$Pt = (P^{o}_{A} - P^{o}_{B})\, X_A + P^{o}_{B}.$$

A solution would be ideal if it obeys Raoult's law and its vapour pressure is equal to the vapour presure calculated from the above equation, otherwise it would be non-ideal.

In non-ideal solutions the attractive forces among the solute and solvent particles are either stronger or weaker than the pure components. So the vapour pressure of the solution, increases or decreases. Since vapour pressure of such solutions are not equal to calculated values. Therefore, we can say that non-ideal solutions does not obey Raoult's law.

SECTION III

LONG QUESTIONS

1. What are ideal solutions? Explain the fractional distillation of ideal mixture of two liquids. (LHR 2012)
2. Define solubility and make clear difference between continuous and discontinuous solubility curves. (GRW 2011)
3. Explain elevation of boiling point with the help of figure. (MTN 2011)
4. Define the following terms: (MTN 2013)
   i. Upper Consulate temperature
   ii. Hydration energy
5. What are Azeotropic mixtures? What types of deviation are shown by them? Explain with the help of graphs. (MTN 2014)
6. Define colligative properties. Explain elevation of boiling point.
   (FSD 2011) (MTN 2017) (RWP 2017)
7. Explain Rault's law when both components are volatile. (RWP 2018)
   (FSD 2013) (GRW 2014) (LHR 2013, 17)
   (RWP 2016) (SGD 2011) (BWP 2017, 18)
8. How lowering of vapour pressure as colligative property is used to find out molecular mass of solute? (LHR 2015)
   (FSD 2014) (GRW 2014, 18) (GRW 2012)
9. Describe the measurement of depression of freezing point by using Beckmann's freezing point apparatus. (FSD 2016)

10. What is solubility? Explain solubility curves. (FSD 2016)

11. Give the graphical explanation for the elevation of boiling point of solution. (RWP 2011)

12. What is the difference between ideal and non ideal solution. Give two points for each. Also define Raoults law in two ways mathematically. (DGK 2013)

13. What is hydration and hydrolysis? Explain with examples. (SWL 2013) (LHR 2016)

14. Describe Landsberger's method for measurement of boiling point elevation. (SWL 2017) (DGK 2014, 17) (RWP 2013) (GRW 2012) (SGD 2016, 18)

Chapter — 10

ELECTROCHEMISTRY

SECTION I

Multiple Choice Questions

I) From Exercise:-

(i) The cathodic reaction in the electrolysis of dil. H_2SO_4 with Pt electrodes is:-
(a) Reduction (b) Oxidation
(c) Both oxidation and reduction
(d) Neither oxidation or reduction

(ii) Which of the following statements is not correct about galvanic cell?
(a) Anode is negatively charged
(b) Reduction occurs at anode
(c) Cathode is positively charged
(d) Reduction occurs at cathode

(iii) Stronger the oxidizing agent, greater is the:
(a) oxidation potential
(b) reduction potential
(c) redox potential (d) E.M.Fofcell

(iv) If the salt bridge is not used between two half cells, then the voltage.
(a) Decrease rapidly
(b) Decrease slowly
(c) Does not change **(d) Drops to zero**

(v) If a strip of Cu metal is placed in a solution of $FeSO_4$: (SLK 2019)
(a) Cu will be deposited
(b) Fe is precipitated out
(c) Cu and Fe both dissolve
(d) No reaction take place

II) From Punjab Boards:-

1. Which one is not an electrolyte: (LHR 2011)
(a) Aqueous NaCl (b) Aqueous $CuSO_4$
(c) Cu-metal (d) H_2SO_4

2. Oxidation state of Mn in MnO_4^{-2} is: (LHR 2011)
(a) +4 (b) +6 (c) +5 (d) −6

3. The oxidation number of Chromium is $K_2Cr_2O_7$ is: (LHR 2012)
(a) 14 (b) 12 **(c) 6** (d) 13

4. Reduction always takes place at: (LHR 2012)
(a) Anode **(b) Cathode**
(c) Both (d) Salt bridge

5. In H_2SO_4, the oxidation number of S is: (LHR 2015 G-I)
(a) 2 **(b) 6** (c) 8 (d) 4

6. The oxidation number of Cl in $HClO_4$ is: (LHR 2015 G-II)
(a) +2 (b) +3 (c) +5 **(d) +7**

7. Electrode potential of SHE arbitrarily taken in volts is: (GRW 2011)(DGK 2019)
(a) 0.00 (b) 1.00 (c) 0.01 (d) 0.50

8. In H_2O_2, the oxidation state of oxygen is: (GRW 2011)
(a) +1 **(b) −1** (c) +2 (d) −2

9. The cathodic reaction in electrolysis of dil H_2SO_4 with pt electrode is: (GRW 2012) (LHR 2-17)(RWP 2015)(BWP 2017) (AJK 2016) (MTN 2014)
(a) reduction
(b) both oxidation and reduction
(c) oxidation (d) none

10. Stronger the oxidizing agent, greater is the: (GRW 2013, 2014 G-I) (FSD 2016) (LHR 2013, 14, 18) (DGK 2017) (FSD 2012, 13) (SGD 2014)
(a) oxidation potential
(b) reduction potential
(c) redox potential (d) E.M.F. of cell

11. If a strip Cu metal is placed in a solution of $FeSO_4$:(GRW 2013) (LHR 2016) (FSD 2014) (MTN 2011, 12, 18) (SLK 2019)
(a) Cu will be deposited
(b) Fe is precipitated out
(c) Cu and Fe both dissolve
(d) No reaction occurs

12. Loss of electrons from a substance is called: (GRW 2014 G-II)
(a) oxidation (b) reduction
(c) redox reaction (d) none of these

13. Which statement is not correct about galvanic cell? (GRW 2014 G-II) (SGD 2012) (DGK 2015)
(a) anode is negatively charged
(b) reduction occurs at anode
(c) cathode is positively charged
(d) reduction occurs at cathode

14. If the salt bridge is not used between two half cells, the voltage: (FSD 2012,13) (GRW 2015) (SGD 2012, 13, 17, 18) (LHR 2016) (SWL 2016) (MTN 2016, 18)
(a) decreases rapidly
(b) decreases slowly
(c) does not change **(d) drops to zero**

15. In which of the following oxidation number of Cr is not +6: (GRW 2016)
(a) $Cr_2O_7^{2-}$ (b) $K_2Cr_2O_7$
(c) $Cr_2(SO_4)_3$ **(d) K_2CrO_4**

16. Which process is used for extraction of Al? (MTN 2013, 2015)
(a) Caster-Kellinar process
(b) Thernite process
(c) Hall-Beroult process
(d) Combustion process

17. An oxidizing agent: (MTN 2013, 2014)
(a) Losses electrons (b) is oxidized
(c) Neither gains nor loses electrons
(d) Gains electrons

18. The potential standard hydrogen electrode is arbitrarily taken as. (MTN 2017)
(a) 1.00 **(b) 0.00** (c) 5.00 (d) 3.00

19. Percentage of H_2SO_4 used in load accumulator is: (FSD 2011)
(a) 40% (b) 25% **(c) 30%** (d) 50%

20. Oxidation number of Cl in $Ca(ClO_3)_2$ is : (FSD 2015)
(a) **−1** (b) **+5** (c) +3 (d) 3+1

21. The highest reduction potential in electrochemical series is of F_2 and its value is: (RWP 2011)
(a) −3.87v (b) −2.87v **(c) +2.87v** (d) +3.87v

22. The process during which one metal is deposited on the surface of an other metal by using electric current is called. (RWP 2011)
(a) Electrolysis **(b) Electroplating**
(c) Electrolytic refining
(d) Electrolytic purification

23. Oxidation number of chromium in $Cr_2O_7^{-2}$ is: (RWP 2013)
(a) +3 **(b) +4** (c) +5 **(d) +6**

24. Standard Hydrogen electrode (SHE) is made up of: (RWP 2013)
(a) Ag foil (b) Au foil (c) Cu foil **(d) Pt foil**

25. In silver oxide battery, the cathode is made up of: (RWP 2014)
(a) Ago **(b) Ag_2O** (c) Ag_2O_3 (d) Ag

26. Oxidation number of phosphorous in the compound HPO_3 is: (RWP 2014)
(a) +3 (b) +4 **(c) +5** (d) +6

27. The oxidation number of 'O' atom in OF_2 is: (RWP 2016)(LHR 2019)
(a) +2 (b) −2 (c) +1 (d) −1

28. The catholic reaction in the electrolysis dil H_2SO_4 with pt electrode is: (SGD 2011, 2015)
(a) Oxidation **(b) Reduction**
(c) Both oxidation and reduction
(d) Neither oxidation nor reaction

29. In Na_2O_2, the oxidation state of oxygen is: (SGD 2011, 2013)
(a) −2 (b) +2 **(c) −1** (d) +1

30. Which of the following statements is correct about Galvanic cell? (SGD 2012)
(a) Anode is negatively charged
(b) Reduction occurs at anode
(c) Cathode is positively charged
(d) Reduction occurs at cathode

31. The oxidation number of nitrogen in HNO_3 is: (DGK 2011)
(a) +3 (b) −3 (c) −5 **(d) +5**

32. The best reducing agent is: (DGK 2011)
(a) F^{-1} (b) Cl^{-1} (c) Br^{-1} (d) I^{-1}

33. The electrolysis of aqueous solution of $NaNO_3$ at cathode liberator: (DGK 2013, 2015)
(a) Na metal **(b) H_2 gas**
(c) O_2 gas (d) NO_2 gas

III) From Entry Test:-

(1) The oxidation state of carbon in sucrose ($C_{12}H_{22}O_{11}$) is:
(a) Zero (b) 3 (c) +4 (d) −4

(2) The number of electrons involved in a reaction at anode when one Faraday of electricity is passed through an electrolytic cell:
(a) 96500 **(b) 6.02×10^{23}**
(c) $\frac{96500}{6.02 \times 10^{23}}$ (d) $\frac{6.02 \times 10^{23}}{96500}$

(3) NaCl is strong electrolyte because:
(a) It dissolves readily in water
(b) It completely dissociates into ions at all concentrations
(c) It conducts electricity
(d) It dissociates into its constituents

(4) The mass of copper in grams deposited during the passage of 2.5 ampere current through copper (II) sulphate solution for 1 hour is:
(a) 5.96 **(b) 2.93** (c) 29.8 (d) 59.6

(5) Which of the following metals cannot displace copper from copper sulphate solution?
(a) Iron (b) Aluminium
(c) Sodium (d) Magnessium

(6) In which of the following does sulphur show highest oxidation state?
(a) S **(b) Na_2SO_4**
(c) SO_2 (d) SO_2Cl

(7) In which of the following reactions, hydrogen behaves as oxidizing agent?
(a) $H_2 + Cl_2 \longrightarrow 2HCl$
(b) $C_2H_4 + H_2 \longrightarrow C_2H_6$
(c) $2Na + H_2 \longrightarrow 2NaH$
(d) $N_2 + 3H_2 \longrightarrow 2NH_3$

(8) When aluminium electrode is coupled with copper electrode in the galvanic cell:
(a) Reduction takes place at copper electrode
(b) Oxidation takes place at copper electrode
(c) Reduction takes place at aluminium electrode
(d) Both (b) and (c)

(9) When fused $PbBr_2$ is electrolysed:
(a) Bromine appears at the cathode
(b) Lead is deposited at the cathode
(c) Lead appears at the anode
(d) None of these

(10) Cell potential depends upon:
(a) Temperature
(b) Concentration of ions
(c) Nature of electrolyte **(d) All**

(11) The best electrolyte used in the salt-bridge is:
(a) $NaNO_3$ **(b) KNO_3** (c) KCl (d) NaCl

(12) The oxidation state of carbon is $C_6H_{12}O_6$ is:
(a) O (b) +6 (c) −6 (d) +12

(13) Which of the following has same oxidation state in all of its compounds:
(a) Be (b) Br (c) Cl (d) N

(14) In which of the following reactions, hydrogen behave as an oxidizing agent:
(a) $H_2 + Cl_2 \longrightarrow 2HCl$
(b) $C_2H_4 + H_2 \longrightarrow C_2H_6$
(c) $2Na + H_2 \longrightarrow 2NaH$
(d) $N_2 + 3H_2 \longrightarrow 2NH_3$

(15) The change in oxidation state of nitrogen in the following reaction is:
$Cu + HNO_3 \longrightarrow Cu(NO_3)_2 + NO_2 + H_2O$
(a) +5 to −2 **(b) +5 to +4**
(c) +5 to 0 (d) 0 to −4

(16) The colour of K_2MnO_4 solution is:
(a) Pink (b) Violet
(c) Green (d) Purple

(17) The oxidation state of Mn in K_2MnO_4 is:
(a) +7 **(b) +6** (c) +5 (d) +4

(18) The overall positive reaction potential value predicts that process is:
(a) Not feasible **(b) Feasible**
(c) Impossible (d) No indication

(19) Value of standard reduction potential for strong reducing agent is:
(a) Large and positive (b) Zero
(c) Large & negative (d) Any of above

SECTION II

SHORT QUESTIONS

From Exercise:-

QUESTIONS

1. Differentiate between oxidation and reduction.

Ans.	Oxidation	Reduction
(i)	The addition of oxygen in a substance is called as oxidation. $CH_4 + [O] \xrightarrow[\Delta]{Cu} H_3C-OH$	The addition of hydrogen in a substance is called as reduction. $C_2H_4 + H_2 \xrightarrow[\Delta]{Ni} C_2H_6$
(ii)	Removal of hydrogen from a substance is also called oxidation. $C_6H_{12} \xrightarrow{Pt} C_6H_6 + 3H_2$	Removal of oxygen from a substance is called reduction. $2NaNO_3 \rightarrow NaNO_2 + O_2$

(iii)	Oxidation involves loss of electrons by a subtance. $Na_{(g)} \rightarrow Na^{+1}_{(g)} + 1e^-$	Reduction involves gain of electron by a substance. $Cl_{(g)} + 1e^- \rightarrow Cl^{-1}_{(g)}$
(iv)	There is an increase in oxidation Number of the element. $Zn_{(s)} \rightarrow Zn^{+2} + 2e^-$	There is a decease in the oxidation Number of an element. $Cu^{+2} + 2e^- \rightarrow Cu^o$

2. How anodized aluminium is prepared?

Ans. Anodized aluminium is prepared by making it an anode in an electrolytic cell containing sulphuric or chromic acid, which coats a thin layer of oxide on it.

- The aluminium oxide layer resists attack for corrosive agents.

The freshly anodized aluminium is hydrated and can absorb dyes.

3. What is a Daniel cell and write the electrode reactions of Daniel cell (Zn-Cu cell).

Ans. Daniel cell is a galvanic cell Zn metal dipped in $ZnSO_4$ solution act as anode, while Cu metal placed in a $CuSO_4$ solution act as a cathode. The electrodes are connected through an external circuit, while electrolytes are connected by the salt bridge.

Following reactions occur at electrodes.

At anode:

$$Zn_{(s)} \longrightarrow Zn^{+2}_{(aq)} + 2e^- \quad \text{(Oxidation)}$$

At cathode:

$$Cu^{+2}_{(aq)} + 2e^- \longrightarrow Cu_{(s)} \quad \text{(Reduction)}$$

Over all reaction:

$$Zn_{(s)} + Cu^{+2}_{(aq)} \rightarrow Zn^{+2}_{(aq)} + Cu_{(s)} \quad E^o = 1.10V$$

4. Differentiate between oxidizing agent and reducing agent.

Ans.	Oxidizing agent		Reducing agent
i)	A specie which oxidize a substance in a redox reaction is called an oxidizing agent or oxidant.	i)	A specie which reduces a substance in a redox reaction is called as a reducing agent or reluctant.
ii)	In the process, the oxidizing agent is reduced itself.	ii)	In the process, the reducing agent is oxidized itself.
iii)	An oxidizing agent gain electrons and its oxidation number decreases in the reaction.	iii)	The reducing agent lose electrons and its oxidation number is increased.
iv)	e.g., $KMnO_4/H_2SO_4$, $K_2Cr_2O_7/H_2SO_4$, HNO_3, Cl_2, Br_2 etc.	iv)	e.g., $FeSO_4$, HI, SO_2, Na, K etc.

5. How caustic soda can be prepared by electrolysis process?

Ans. Caustic soda is obtained on industrial scale by the electrolysis of concentrated aqueous solution of sodium chloride (Brine solution) using titanium anode and mercury or steel cathode. The electrolysis is carried out in Nelson cell or Hg-cell.

$$2NaCl_{(s)} \overset{H_2O}{\rightleftharpoons} 2Na^{+1}_{(aq)} + 2Cl^{-1}_{(aq)}$$

Anode:

$$2Cl^{-1}_{(aq)} \rightarrow Cl_{2(g)} + 2e^- \quad \text{(Oxidation)}$$

Cathode:

$$2H_2O_{(l)} + 2e^- \rightarrow H_{2(g)} + 2OH^{-1}_{(aq)} \quad \text{(Reduction)}$$

Overall Reaction:

$$2Na^{+1}_{(aq)} + 2Cl^{-1}_{(aq)} + 2H_2O_{(l)} \rightarrow 2Na^{+1}_{(aq)} + 2OH^{-1}_{(aq)} + Cl_{2(g)} + H_{2(g)}$$

6. Why alkali metals react vigrously with water while coinage metals does not react.

Ans. Smaller the value of reduction potential, greater is its tendency to lose electron and hence greater is its reactivity.

Na, K, Rb have high negative values of standard reduction potentials, so these are highly reactive metals. Therefore these metals react vigrously with water and liberate H_2 gas.

$$2Na_{(s)} + 2H_2O_{(l)} \longrightarrow 2NaOH_{(aq)} + H_{2(g)} \uparrow$$

Coinage metals (Cu, Ag, Au) have high positive values of reduction potential. So these metals have very little tendency to lose electrons and are considered as least reactive metals. These metals cannot reduce water to liberate hydrogen gas.

$Cu_{(s)} + H_2O_{(l)} \longrightarrow$ No reaction

7. What is emf and how we calculate the emf of a galvanic cell.

Ans. **Electromotive force or emf:**

"The force with which electrons moves from anode towards the cathode through an external circuit in a galvanic cell is called the electronmotive force (emf)."

- It measures the tendency of the cell reaction to takes place.

Calculation of emf of a Cell:

Let us find the emf or cell potential of Daniel cell. The half cell reactions are.

$Zn_{(s)} \longrightarrow Zn^{+2}_{(aq)} + 2e^-$ (Oxidation half)

$Cu^{+2}_{(aq)} + 2e^- \longrightarrow Cu_{(s)}$ (Reduction half)

The overall cell reaction is.

$Zn_{(s)} + Cu^{+2}_{(aq)} \longrightarrow Cu_{(s)} + Zn^{+2}_{(aq)}$

The cell voltage or emf of the cell is given by.

$E^o_{cell} = E^o_{oxd} + E^o_{red}$

$E^o_{cell} = 0.76V + 0.34V$

$\boxed{E^o_{cell} = 1.10V}$

8. What is meant by SHE?

Ans. SHE or standard hydrogen electrode is a reference electrode, which is used to determine the electrode potential of different substances.

It consists of Platinum (Pt) foil coated with finely divided Pt-black suspended in 1 molar HCl solution. H_2 gas at 1 atmospheric pressure is bubbled into 1M HCl.

- The potential of this electrode is arbitrarily taken a zero.

The cell reactions are given as,

$H_{2(g)} \rightarrow 2H^{+1}_{(aq)} + 2e^-$ (Oxidation) $E^o = 0.00V$

$2H^{+1}_{(aq)} + 2e^- \rightarrow H_{2(g)}$ (Reduction) $E^o = 0.00V$

9. Calculate the oxidation numbers of Mn in K_2MnO_4 and MnO_2.

Ans. **(i) K_2MnO_4:**

Oxidation number of Mn = x
Oxidation number of K = +1
Oxidation number of O = −2
Formula of Compound = K_2MnO_4
Putting Values;

$(+1 \times 2) + (x) + (-2 \times 4) = 0$

$+2 + x - 8 = 0$

$\boxed{x = +6}$

(ii) MnO_2:

Oxidation number of Mn = x
Oxidation number of O = −2
Formula of compound = MnO_2
Putting Values;

$(x) + (-2 \times 2) = 0$

$x - 4 = 0$

$\boxed{x = +4}$

10. The standard oxidation potential of Zn is 0.76 V and its reduction potential is-0.76 V.

Ans. When a Zn electrode is attached with standard hydrogen electrode (SHE) through an external circuit, a galvanic cell is established. Zn metal having greater tendency to lose electrons act as anode, while SHE act a cathode. Since oxidation takes place at Zn electrode, the electrode potential of Zinc is called oxidation potential and its value is +0.76V.

e.g., $Zn_{(s)} \longrightarrow Zn^{+2}_{(aq)} + 2e^-$ $E^o_{oxd} = +0.76V$

The reverse of the electrode potential (measured as compared to SHE) is shown by negative sign. Since reverse of the oxidation is reduction. Hence reduction potential of Zinc is also −0.76V, but it is shown with a negative sign.

$Zn^{+2}_{(aq)} + 2e^- \longrightarrow Zn_{(s)}$ $E_{red} = -0.76V$

11. The equilibrium is set up between metal atoms of electrode and ions of metal in a cell.

Ans. When a metal plate is dipped in an aqueous solution of it sown ions, there are two tendencies.

(i) Some of the neutral atoms of the metal lose electrons to the piece of metal and pass into the solution as positive ions.

e.g., $Zn_{(s)} \longrightarrow Zn^{+2}_{(aq)} + 2e^-$ (Oxidation)

(ii) At the same time, some of the metal cations (already present in the electrolyte solution) pick up electrons from the metal piece and deposit on the metal as neutral atom.

e.g., $Zn^{+2}_{(aq)} + 2e^- \longrightarrow Zn_{(s)}$ (Reduction)

The oxidation and reduction continues, untill a stage is reached when, the rate of oxidation becomes equal to the rate of reduction. So, when the rate of these opposing reactions become equal, the system attain a state of dynamic equilibrium.

12. A salt bridge maintains the electrical neutrality in the cell.

Ans. A galvanic cell consists of two half cells which are connected by a salt bridge.

In the left half cell, the oxidation of metal atoms produce positive ions, which tends to accumulate in the left compartment. While in the right half cell, the positive ions of electrolyte pick electrons and deposit as neutral atom. So there is a net negative charge accumulation in the right beaker.

The purpose of the salt bridge is to prevent any net charge accumulation in either beaker by allowing negative ions to leave the right beaker, diffuse through the salt bridge and enter the left beaker. So a salt bridge maintains the electrical neutrality in the two half cells.

13. How impure Cu can be purified by electrolytic process?

Ans. **Purification of Copper:**

Impure copper can be purified by the electrolysis of $CuSO_{4(aq)}$, using copper electrodes. The impure block of copper is made the anode and a thin sheet of pure copper is made the cathode. Copper sulphate solution is used as an electrolyte.

At Anode:

The atoms of Cu from impure Cu anode are converted to Cu^{+2} ions by losing two electrons.

$Cu_{(s)} \longrightarrow Cu^{+2}_{(aq)} + 2e^-$ (oxidation)

At Cathode:

The Cu^{+2} ions from the electrolyte, migrates towards the cathode and deposit as pure copper by picking two electrons.

$Cu^{+2}_{(aq)} + 2e^- \longrightarrow Cu_{(s)}$ (reduction)

Hence pure copper is obtained at the cathode and impurities are left behind at anode.

14. SHE acts as anode when connected with Cu electrode but as cathode with Zn electrode.

Ans. The electrode potential of SHE is taken as zero. It can act as anode or cathode depending upon the nature of electrode which is coupled with it.

(i) As Cathode:

When SHE is coupled with Zn electrode, it will act as a cathode. Since Zinc metal has a greater tendency to lose electrons by 0.76V, than hydrogen. The neutral Zn atoms lose electrons and dissolved in electrolyte as Zn^{+2} ions. The electrons moves through the external circuit towards the SHE, where H^+ ions pick up these electrons and form H_2 gas.

Anode: $Zn_{(s)} \longrightarrow Zn^{+2}_{(aq)} + 2e^-$ (Oxidation)

$E_{oxd} = +0.76V$

Cathode: $2H^+_{(aq)} + 2e^- \longrightarrow H_{2(g)}$ (reduction)

$E_{red} = 0.0V$

(ii) As Anode:

When SHE is coupled with Cu electrode, it will act as anode. Copper ions have a greater tendency to gain electron by 0.34V than H^+ ions. So oxidation occur at SHE and electrons moves through external circuit towards copper electrode, where Cu^{+2} ion pick these electrons and deposit as Cu metal.

Anode: $H_{2(g)} \longrightarrow 2H^{+1}_{(aq)} + 2e^-$ (Oxidation)

$E_{oxd} = 0.0V$

Cathode: $Cu^{+2}_{(aq)} + 2e^- \longrightarrow Cu_{(s)}$ (Reduction)

$E_{red} = +0.34V$

II) From Punjab Boards:-

Q.1 Differentiate between oxidation and reduction.(2008L)(GRW 2014)(RWP 2012) (DGK 2014)

Ans.	Oxidation		Reduction
(i)	The addition of oxygen in a substance is called as oxidation. $CH_4 + [O] \xrightarrow[\Delta]{Cu} H_3C{-}OH$	(i)	The addition of hydrogen in a substance is called as reduction. $C_2H_4 + H_2 \xrightarrow[\Delta]{Ni} C_2H_6$

(ii)	Removal of hydrogen from a substance is also called oxidation. $C_6H_{12} \xrightarrow{Pt} C_6H_6 + 3H_2$	(ii)	Removal of oxygen from a substance is called reduction. $2NaNO_3 \longrightarrow NaNO_2 + O_2$
(iii)	Oxidation involves loss of electrons by a subtance. $Na_{(g)} \longrightarrow \overset{+1}{Na}_{(g)} + 1e^-$	(iii)	Reduction involves gain of electron by a substance. $Cl_{(g)} + 1e^- \longrightarrow \overset{-1}{Cl}_{(g)}$
(iv)	There is an increase in oxidation Number of the element. $Zn_{(s)} \longrightarrow Zn^{+2} + 2e^-$	(iv)	There is a decease in the oxidation Number of a n element. $Cu^{+2} + 2e^- \longrightarrow Cu^o$

2. How anodized aluminium is prepared? (RWP 2011) (BWP 2013) (DGK 2016)

Ans. Anodized aluminium is prepared by making it an anode in an electrolytic cell containing sulphuric acid or chormic acid, which coats a thin layer of oxide on it.

- The aluminium oxide layer resists attack for corrosive agents.
- The freshly anodized aluminium is hydrated and can absorb dyes.

3. What is a Daniel cell and write the electrode reactions of Daniel cell (Zn-Cu cell). (LHR 2012) (GRW 2014)

Ans. Daniel cell is a galvanic cell Zn metal dipped in $ZnSO_4$ solution act as anode, while Cu metal placed in a $CuSO_4$ solution act as a cathode. The electrodes are connected through an external circuit, while electrolytes are connected by the salt bridge.

Following reactions occur at electrodes.

At anode:

$$Zn_{(s)} \longrightarrow \overset{+2}{Zn}_{(aq)} + 2e^- \quad \text{(Oxidation)}$$

At cathode:

$$\overset{+2}{Cu}_{(aq)} + 2e^- \longrightarrow Cu_{(s)} \quad \text{(Reduction)}$$

Over all reaction:

$$\overset{+2}{Zn}_{(s)} + \overset{+2}{Cu}_{(aq)} \rightarrow \overset{+2}{Zn}_{(aq)} + Cu_{(s)} \quad E^o = 1.10V$$

4. Differentiate between oxidizing agent and reducing agent. (G2008) (LHR 2012) (RWP 2014), (SWL 2012), (BWP 2013)

Ans.

	Oxidizing agent		Reducing agent
i)	A specie which oxidize a substance in a redox reaction is called an oxidizing agent or oxidant.	i)	A specie which reduces a substance in a redox reaction is called as a reducing agent or reductant.
ii)	In the process, the oxidizing agent is reduced itself.	ii)	In the process, the reducing agent is oxidized itself.
iii)	An oxidizing agent gain electrons and its oxidation number decreases in the reaction.	iii)	The reducing agent lose electrons and its oxidation number is increased.
iv)	e.g., $KMnO_4/H_2SO_4$, $K_2Cr_2O_7/H_2SO_4$, HNO_3, Cl_2, Br_2 etc.	iv)	e.g., $FeSO_4$, HI, SO_2, Na, K etc.

5. How caustic soda can be prepared by electrolysis process? (RWP-2018)

Ans. Caustic soda is obtained on industrial scale by the electrolysis of concentrated aqueous solution of sodium chloride (Brine solution) using titanium anode and mercury or steel cathode. The electrolysis is carried out in Nelson cell or Hg-cell.

$$2NaCl_{(s)} \overset{H_2O}{\rightleftharpoons} \overset{+1}{2Na}_{(aq)} + \overset{-1}{2Cl}_{(aq)}$$

Anode:

$$\overset{-1}{2Cl}_{(aq)} \longrightarrow Cl_{2(g)} + 2e^- \quad \text{(Oxidation)}$$

Cathode:

$$2H_2O_{(l)} + 2e^- \longrightarrow H_{2(g)} + \overset{-1}{2OH}_{(aq)} \quad \text{(Reduction)}$$

Overall Reaction:

$$\overset{+1}{2Na}_{(aq)} + \overset{-1}{2Cl}_{(aq)} + 2H_2O_{(l)} \longrightarrow \overset{+1}{2Na}_{(aq)} + \overset{-1}{2OH}_{(aq)} + Cl_{2(g)} + H_{2(g)}$$

6. What is emf and how we calculate the emf of a galvanic cell.

(SGD 2011, 13, 18),(FSD 2014, 18)

Ans. **Electromotive force or emf:**

"The force with which electrons moves from anode towards the cathode through an external circuit in a galvanic cell is called the electronmotive force (emf)."

- It measures the tendency of the cell reaction to takes place.

Calculation of emf of a Cell:

Let us find the emf or cell potential of Daniel cell. The half cell reactions are.

$Zn_{(s)} \longrightarrow Zn^{+2}_{(aq)} + 2e^-$ (Oxidation half)

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The overall cell reaction is.

$Zn_{(s)} + Cu^{+2}_{(aq)} \longrightarrow Cu_{(s)} + Zn^{+2}_{(aq)}$

The cell voltage or emf of the cell is given by

$$E^o_{cell} = E^o_{oxd} + E^o_{red}$$

$$E^o_{cell} = 0.76V + 0.34V$$

$$\boxed{E^o_{cell} = 1.10V}$$

7. What is meant by SHE? (2010L)

Ans. SHE or standard hydrogen electrode is a reference electrode, which is used to determine the electrode potential of different substances.

It consists of platinum (Pt) foil coated with finelly divided Pt-black suspended in 1 molar HCl solution. H_2 gas at 1 atmospheric pressure is bubbled into 1M HCl.

- The potential of this electrode is arbitrarily taken a zero.

The cell reactions are given as,

$H_{2(g)} \longrightarrow 2H^{+1}_{(aq)} + 2e^-$ (Oxidation) $E^o = 0.00V$

$2H^{+1}_{(aq)} + 2e^- \longrightarrow H_{2(g)}$ (Reduction) $E^o = 0.00V$

8. Calculate the oxidation numbers of Mn in K_2MnO_4 and MnO_2. (2005G)

(LHR 2016) (RWP 2012)

Ans.

(i) K_2MnO_4:

Oxidation number of Mn = x

Oxidation number of K = +1

Oxidation number of O = −2

Formula of Compound = K_2MnO_4

Putting Values;

$(+1 \times 2) + (x) + (-2 \times 4) = 0$

$+2 + x - 8 = 0$

$\boxed{x = +6}$

(ii) MnO_2:

Oxidation number of Mn = x

Oxidation number of O = −2

Formula of compound = MnO_2

Putting Values;

$(x) + (-2 \times 2) = 0$

$x - 4 = 0$

$\boxed{x = +4}$

9. The standard oxidation potential of Zn is 0.76 V and its reduction potential is-0.76 V. (2008L)(RWP 2013)

Ans. When a Zn electrode is attached with standard hydrogen electrode (SHE) through an external circuit, a galvanic cell is established. Zn metal having greater tendency to lose electrons act as anode, while SHE act a cathode. Since oxidation takes place at Zn electrode, the electrode potential of Zinc is called oxidation potential and its value is +0.76V.

e.g.,

$Zn_{(s)} \longrightarrow Zn^{+2}_{(aq)} + 2e^-$ $E^o_{oxd} = +0.76V$

The reverse of the electrode potential (measured as compared to SHE) is shown by negative sign. Since reverse of the oxidation is reduction. Hence reduction potential of Zinc is also 0.76V, but it is shown with a negative sign.

$Zn^{+2}_{(aq)} + 2e^- \longrightarrow Zn_{(s)}$ $E_{red} = -0.76V$

10. A salt bridge maintains the electrical neutrality in the cell. (2006G, 2010G) (LHR 2011, 12) (GRW 2012, 13, 14, 16) (BWP 2014) (RWP 2011) (DGK 2013)

Ans. A galvanic cell consists of two half cells which are connected by a salt bridge.

In the left half cell, the oxidation of metal atoms produce positive ions, which tends to accumulate in the left compartment. While in the right half cell, the positive ions of electrolyte pick electrons and deposit as neutral atom. So there is a net negative charge accumulation in the right beaker.

The purpose of the salt bridge is to prevent any net charge accumulation in either beaker by allowing negative ions to leave the right beaker, diffuse through the salt bridge and enter the left beaker. So a salt bridge maintain the electrical neutrality in the two half cells.

11. Impure Cu can be purified by electrolytic process. (2009G) (GRW 2014, 18) (BWP 2012)

Ans. Purification of Copper:

Impure copper can be purified by the electrolysis of $CuSO_{4(aq)}$, using copper electrodes. The impure block of copper is made the anode and a thin sheet of pure copper is made the cathode. Copper sulphate solution is used as an electrolyte.

At Anode:

The atoms of Cu from impure Cu anode are converted to Cu^{+2} ions by losing two electrons.

$$Cu_{(s)} \longrightarrow Cu^{+2}_{(aq)} + 2e^- \quad \text{(oxidation)}$$

At Cathode:

The Cu^{+2} ions from the electrolyte, migrates towards the cathode and deposit as pure copper by picking two electrons.

$$Cu^{+2}_{(aq)} + 2e^- \longrightarrow Cu_{(s)} \quad \text{(reduction)}$$

Hence pure copper is obtained at the cathode and impurities are left behind at anode.

12. SHE acts as anode when connected with Cu electrode but as cathode with Zn electrode. (LHR 2011, 12) (GRW 2015)

Ans. The electrode potential of SHE is taken as zero. It can act as anode or cathode depending upon the nature of electrode which is coupled with it.

(i) As Cathode:

When SHE is coupled with Zn electrode, it will act as a cathode. Since Zinc metal has a greater tendency to lose electrons by 0.76V, than hydrogen. The neutral Zn atoms lose electrons and dissolved in electrolyte as Zn^{+2} ions. The electrons moves through the external circuit towards the SHE, where H^+ ions pick up these electrons and form H_2 gas.

Anode:

$$Zn_{(s)} \longrightarrow Zn^{+2}_{(aq)} + 2e^-$$

(Oxidation) $E_{oxd} = +0.76V$

Cathode:

$$2H^+_{(aq)} + 2e^- \longrightarrow H_{2(g)}$$

(reduction) $E_{red} = 0.0V$

(ii) As Anode:

When SHE is coupled with Cu electrode, it will act as anode. Copper ions have a greater tendency to gain electron by 0.34V than H^+ ions. So oxidation occur at SHE and electrons moves through external circuit towards copper electrode, where Cu^{+2} ion pick these electrons and deposit as Cu metal.

Anode;

$$H_{2(g)} \longrightarrow 2H^{+1}_{(aq)} + 2e^-$$

(Oxidation) $E_{oxd} = 0.0V$

Cathode;

$$Cu^{+2}_{(aq)} + 2e^- \longrightarrow Cu_{(s)}$$

(Reduction) $E_{red} = +0.34V$

SECTION III

LONG QUESTIONS

1. How can you measure electrode potential of an element with the help of standard hydrogen electrode (SHE). (LHR 2012)
2. Describe the electrolysis of molten sodium chloride and a concentrated solution of sodium chloride. (LHR 2013) (GRW 2013, 18)
3. Balance the following equation by oxidation number method: (GRW 2011)
4. What is electrochemical series? Give its applications. (GRW 2013, 16)
5. Describe the electrolysis of fused NaCλ salts and aqueous solutions of NaCλ salts. (FSD 2016)

6. What are electrolytic cells? Explain with diagram and give an example of electrolysis of fused salt. (RWP 2011)
7. Write a note on Nickel Cadmium cell.
(RWP 2016) (LHR 2014)
8. Briefly explain the any four industrial importance of electrolysis processes.
(RWP 2017, 18) (GRW 2014) (SGD 2016)
9. Define standard electrode potential. Explain the measured of electrode potential of copper.
(SGD 2017) (MTN 2011)
10. State rules for assigning oxidation number of elements with examples.
(DGK 2014) (MTN 2013)
11. Explain the phenomena of electrolysis of aqueous solution of NaCl.
(DGK 2017) (RWP 2013)
(LHR 2013) (GRW 2018) (RWP 2018)
12. Describe a galvanic cell and explain the functions of salt bridge.
(SWL 2013) (RWP 2016)
13. Calculate the oxidation numbers of the elements underlined in the following compounds: (SWL 2014)
    i. $H\underline{N}O_3$ ii. $Na_2\underline{C}O_3$
    iii. $H\underline{P}O_3$ iv. $K_2\underline{Mn}O_4$
14. What is Standard Hydrogen Electrode (SHE)? How is it used to measure the electrode potential of Zinc?
(SWL 2016) (DGK 2014, 16) (GRW 2012)
(FSD 2018) (MTN 2014) (DGK 2013)

❋❋❋❋

Chapter — 11

REACTION KINETICS

SECTION I

Multiple Choice Questions

I) From Exercise:-

(i) In zero order reaction, the rate is independent of:

(a) temperature of reaction
(b) concentration of reactants
(c) concentration of products
(d) none of these

(ii) If the rate equation of a reaction $2A + B \rightarrow$ products is, rate = $k[A]^2[B]$, and A is present in large excess, then order of reaction is: (MTN 2019)

(a) 1 (b) 2
(c) 3 (d) none of these

(iii) The rate of reaction:

(a) increases as the reaction proceeds
(b) decreases as the reaction proceeds
(c) remains the same as the reaction proceeds
(d) may decrease or increase as the reaction proceeds

(iv) With increase of 10°C temperature the rate of reaction doubles. This increase in rate of reaction is due to:

(a) decrease in activation energy y of reaction.
(b) decrease in the number of collisions between reactant molecules.
(c) increase in activation energy of reactants.
(d) increase in number of effective collisions.

(v) The unit of the rate constant is the same as that of the rate of reaction in:

(a) first order reaction
(b) second order reaction
(c) zero order reaction
(d) third order reaction

II) From Punjab Boards:-

1. In zero order reaction, the rate is independent of : (RWP 2016) (SLK 2019) (LHR 2012) (SWL 2017) (GRW 2015, 18) (MTN 2012, 16) (FSD 2012, 14, 15)

(a) Temperature of the reaction
(b) Concentration of reactants
(c) Concentration of products
(d) Concentration of reactants and products

2. The unit of the rate constant is the same as that of the rate of reaction in: (LHR 2013,G-I,2014 G-I,II)(SGD 2011, 13, 17) (SWL 2016) (AJK 2016) (GRW 2011,13, 14) (DGK 2014, 16) (LHR 2018)

(a) First order reaction
(b) Second order reaction
(c) Third order reaction
(d) Zero order reaction

3. The rate of reaction: (LHR 2015, 17 G-I) (RWP 2015, 18) (DGK 2012, 16) (BWP 2017)

(a) Increases as the reaction proceeds
(b) Decreases as the reaction proceeds
(c) Remains the same as the reaction proceeds
(d) May decrease or increase as the reaction proceeds

4. If the rate equation of a reaction $A + 2B \rightarrow$ products is, rate = $K|A|\ |B|_2$ and A is present in large excess, then order of reaction is: (GR

(a) 1 **(b) 2**
(c) 3 (d) pseudo 1st order

5. The rate of reaction _____ as the reaction proceeds. (MTN 2014, 2015)

(a) Increases (b) Decreases
(c) Remains the same
(d) May decrease a increase

6. If the rate equation of a reaction $2A + B \rightarrow$ products is $k\ (A)^2\ (B)$ and A is present in large excess, then order of reaction is: (FSD 2013)(SGD 2015) (RWP 2017)

(a) 1 (b) 2
(c) 3 (d) None of these

7. The order of decomposition of nitrogen pentoxide $2N_2O_5 \rightarrow 2N_2O_4 + O_2$ is: (FSD 2016)

(a) First order (b) Second order
(c) Third order (d) Zero order

8. The energy of activated complex is: (RWP 2011)

(a) Greater than the reactants and products
(b) Less than the reactants and products
(c) Equal to the products
(d) Equal to the reactions

9. Velocity constant is the rate of reaction when the concentrations. (DGK 2013, 15)

(a) Zero **(b) Unity** (c) Two (d) Three

10. The rate of reaction:
(DGK 2012) (LHR 2017) (BWP 2017)
(a) Increases as the reaction proceeds
(b) Decreases as the reaction proceeds
(c) Remains the same as the reaction proceeds
(d) May decrease or increase as the reaction proceeds

III) From Entry Test:-

(1) The half life period and initial concentration for 3rd order reaction is related to:
(a) $\left[\frac{1}{2}\right] \propto \frac{1}{a^0}$ (b) $\left[\frac{1}{2}\right] \propto \frac{1}{a}$
(c) $\left[\frac{1}{2}\right] \propto \frac{1}{a^2}$ (d) None of these

(2) The reaction in which rate of reaction is independent of concentration is:
(a) Zero order (b) 1st order
(c) 2nd order (d) 3rd order

(3) The Arrhenius equation accounts for the rate of chemical reaction in terms of:
(a) Concentration of reactants
(b) Activation energy
(c) Order of reaction
(d) Physical state of reactants

(4) The specific rate constant for the 1st order reaction depends upon:
(a) Concentration of reactants
(b) Concentration of products
(c) Time **(d) Temperature**

(5) The rate of reaction is doubled for every 10° rise in temperature. The increase in reaction rate as a result of temperature rise from 10° → 100° is:
(a) 112 (b) 400 **(c) 512** (d) 614

(6) The order of reaction of radioactive decay is:
(a) Zero **(b) 1** (c) 2 (d) 3

(7) If the rate of decay of radioactive isotope decreases from 200 cpm to 25 cpm after 24 hours. What is its half-life?
(a) 3 hours (b) 4 hours
(c) 6 hours **(d) 8 hours**

(8) Decomposition of ozone takes place according to the equation: $2O_3 \rightleftharpoons 3O_2$ Rate equation is Rate = $K[O_3]^2 [O_2]^{-1}$ What is the order of reaction?
(a) Zero **(b) 1** (c) 2 (d) 3

(9) The rate equation of a reaction is: Rate = K[A][B] If concentration units are mol dm^{-3}. What are the units of rate constant 'K'?
(a) mol dm^{-3} s **(b) $mol^{-1} dm^3 s^{-1}$**
(c) $mol^{-2} dm^3 s^{-1}$ (d) $mol^{-1} s^{-1}$

(10) The unit of rate constant 'K' for a first order reaction:
(a) sec^{-1} (b) $mol.dm^{-3}.sec$
(c) $mol.dm^{-3}.sec^{-1}$ (d) $mol^{-1}.dm^3.sec$

(11)In a multistep reaction, the slowest step is:
(a) Mechanism step
(b) Rate determing step
(c) Enthalpy determing step
(d) None of above

(12) The rate of reaction between two specific time intervals is called:
(a) Rate of reaction **(b) Average rate**
(c) Instantaneous rate (d) None

(13) Rate = $K[A]^2[B]$ for the reaction 2A + B ⟶ Product and 'A' is present in large excess, then order of reaction is:
(a) 1 (b) 2 (c) 3 (d) 4

(14) The unit of the rate constant is the same as that of the rate of reaction is:
(a) 1st order reaction
(b) 2nd order reaction
(c) Zero order reaction
(d) 3rd order reaction

(15) The rate equation for a reaction is Rate = K[A], what are the units of K:
(a) S^{-1} (b) $mol.dm^{-3}$
(c) $mol.dm^{-3}.s^{-1}$ (d) $mol^{-1}.dm^3.s^{-1}$

(16) The half life of zero order reaction is:
(a) Proportional to initial concentration of reactants
(b) Independent of initial concentration of reactant
(c) Inversely proportional to initial concentration of reactant
(d) None of these

(17) Photosynthesis has order of reaction:
(a) 0 (b) 1
(c) 2 (d) Fractional order

SECTION II
SHORT QUESTIONS

From Exercise:-

QUESTIONS

1. What is energy of activation.

Ans. Energy of activation;

"The minimum amount of energy in addition to the average energy of reacting molecules, which is required for an effective collision is called as activation energy."

- It is denoted by Ea.
- Its units are kJ mol^{-1}
- It will always have a positive value for a chemical reaction.

2. What is rate determining step.

Ans. If a chemical reaction occurs in several steps, one of the steps is the slowest. The rate of this step determines the overall rate of reaction.

This slowest step is called the rate determining or rate limiting step.

Example:

The oxidation of CO with NO_2 takes place in two steps.

(i) $NO_{2(g)} + NO_{2(g)} \xrightarrow{\text{Slow}} NO_{3(g)} + NO_{(g)}$

(ii) $NO_{3(g)} + CO_{(g)} \xrightarrow{\text{Fast}} NO_{2(g)} + CO_{2(g)}$

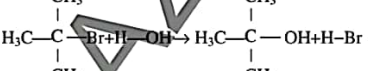
Step (i) is slowest step. So it will determine the overall rate of reaction. So step (i) is the rate determining step.

3. What are pseudo first order reactions.

Ans. The reactions which involve two reacting species but the rate of the reaction depend on the reactant present in lesser amount and does not depend on the reactant present in large excess. Such reactions are called pseudo-first order reactions.

Example:

Hydrolysis of tertiary butyl bromide.



The rate of reaction depends on concentration of $(CH_3)_3CBr$ and remains effectively independent of the concentration of water. (as it is present in very large orexcess amount).

4. Differentiate between average and instantaneous rate of reaction.

Ans.

Average Rate	Instantaneous Rate
(1) The rate of a reaction between two specific time intervals is called the average rate of a reaction.	(1) The rate of reaction at any one instant during the interval is called instantaneous rate of a reaction.
(2) Mathematically; Average rate $= \frac{\Delta C}{\Delta t}$	(2) Mathematically; Instantaneous rate $= \frac{dx}{dt}$
(3) Average rate has a constant value for a particular reaction at a specific temperature.	(3) Instantaneous rate of a reaction changes every instant during the reaction.
(4) It can be calculated after the completion of the reaction.	(4) It can be calculated during the chemical reaction.

5. What do you mean by chemical kinetics?

Ans. Chemical kinetics;

"The branch of chemistry which deals with the study of rate of chemical reactions and the factors that affect the rates of chemical reactions is called chemical kinetics".

These studies also throw light on the mechanisms of the reactions.

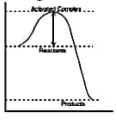
The rates of reactions and their control is very important in industry. They might be the deciding factor that determines whether a certain chemical reaction may be used economically or not.

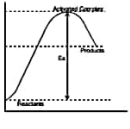
6. Why the reactions having lower energy of activation have faster rates.

Ans. Energy of activation;

"The minimum amount of energy required for an effective collision is called activation energy".

It is denoted by "Ea" and it appears as a potential energy hill between the reactants and the products.





Only those molecules which have proper energy will be able to climb up the hill and give the products. Reactions having lower Ea values, require very little energy to cross the energy barrier, therefore they have higher rates.

7. Rate of chemical reaction is an ever changing parameter under the given conditions.

Ans. According to Law of mass action:

"The rate of a reaction is directly proportional to concentration of reactants."

As the concentration of reactants is maximum at start, the rate is fast. As the time passes, the concentration of reactants decreases and rate of reaction also slows down.

During the progress of reaction, the rate of reaction slows down every moment with the decreasing concentration of reactants. Hence, it is ever changing parameter.

8. The reaction rate decreases every moment but rate constant 'k' of the reaction is a constant quantity, under the given conditions.

Ans. As, rate of a chemical reaction depend upon the concentration of the reactants, the rate of reaction decreases every moment with decreasing concentration of reactants.

For rate constant (k), consider the following hypothetical reaction.

$$A + B \longrightarrow C + D$$

$$\text{Rate} = K[A][B]$$

$$\text{or } K = \frac{\text{Rate}}{[A][B]}$$

From above equation, it is clear that rate constant "K" is the ratio of rate of reaction and concentration of reactants. As the concentration of reactants decreases, rate of reaction also decreases but the ratio remains constant.

Hence, rate constant "K" is constant quantity.

9. 50% of a hypothetical first order reaction completes in one hour. The remaining 50% needs more than one hour to complete.

Ans. For 1st order reaction, the half life period is independent of the initial concentration of the reactants. So, whatever the initial concentration, the half life remains constant.

Now if half life of a hypothetical reaction is one hour, then 50% of 1 kg of the reactant will be converted into products in one hour.

After one hour the initial concentration is 0.5 kg. Now 50% of this amount (i.e. 0.25 kg of the reactants) will be converted into products in next hour. Similarly in the next hour, 0.125 kg of the reactant is converted into products.

Hence proved that remaining 50% of product requires more than one hour to complete.

II) From Punjab Boards:-

1. Define order of reaction with example.
(LHR 2011) (MTN 2016) (DGK 2016)

Ans. Order of Reaction:

"The sum of all the exponents to which the concentration in the rate equation are raised is called order of reaction."

Example:

$2N_2O_5 \rightarrow 2N_2O_4 + O_2$

Rate = $K[N_2O_5]$ = 1st order reaction

2. Define rate of chemical reaction and give its unit. (LHR 2012) (DGK 2014)

Ans. "The change in concentration of reactants or products per unit time".

$$\text{Rate of reaction} = \frac{\Delta C}{\Delta t} = \text{mol. dm}^{-3}.\ \text{sec}^{-1}$$

3. The sum of the coefficients of a balanced chemical equation is not necessarily important to give the order of reaction. Justify.
(LHR 2015) (GRW 2014) (SGD 2014) (MTN 2018)

Ans. The number of molecules which take part in rate determining step (slow step) of a reaction is called order of reaction. It is determined experimentally. Consider the reaction.

$$2H_2 + 2NO \rightarrow 2H_2O + N_2$$

rate of reaction = $dx/dt = k[H_2][NO_2]$ By experiment the order of reaction is 3 but sum of coefficients of balanced equation is 4.

4. What do you mean by activation energy of reaction? (LHR 2016 G-I)
(AJK 2016) (MTN 2016) (FSD 2012, 16)

Ans. Energy of activation;

"The minimum amount of energy in addition to the average energy of reacting molecules, which is required for an effective collision is called as activation energy."

- It is denoted by Ea.
- Its units are kJ mol^{-1}
- It will always have a positive value for a chemical reaction.

5. State rate of chemical reaction and give its units. (LHR 2016 G-II)

Ans. Definition:

"The change in concentration of reactants or products per unit times". is called rate of chemical reaction.

Unit:

$$\text{Rate of reaction} = \frac{\Delta C}{\Delta t} = \text{mol. dm}^{-3}. \text{ sec}^{-1}$$

6. Define 2nd order reaction with example. (LHR 2016 G-II)

Ans. A reaction in which sum of exponents of rate equation is two is called second order reaction.

e.g., $2NO_{2(g)} \longrightarrow 2NO_{(g)} + O_{2(g)}$

$\text{Rate} = K[NO_2]^2$

Order of reaction = 2

7. The radio active decay is always first order reaction. (LHR 2016 G-II)
(SGD 2011, 12, 18) (GRW 2012, 14)
(RWP 2014) (MTN 2012) (SWL 2012)

Ans. Radioactive decay of the radioactive substance does not depend upon the amount of the substance. Therefore, the radioactive decay is always a first order reaction.

8. Write rate equation for the following reactions. (GRW 2012)

(a) $NO + O_3 \rightarrow NO_2 + O_2$

(b) $CHCl_3 + Cl_2 \rightarrow CCl_4 + HCl$

Ans. (a) $\text{Rate} = k(NO)(O_3)$

(b) $\text{Rate} = k(CHCl_3)(Cl_2)$

9. What happens to the rate of chemical reaction with the passage of time? (MTN 2011) (BWP 2014)

Ans. When the reaction progresses, the reaction is very fast at the beginning, slow somewhere in the middle and very slow at the end. The reason is that rate depends upon concentrations according to law of mass action. The concentrations decrease every moment, so rate decreases every moment.

10. Differentiate between Average and instantaneous rate of reaction.
(SGD 2014, 17) (BWP 2012) (RWP 2013)
(MTN 2013, 17) (SWL 2017) (DGK 2014)

Ans.

Average Rate	Instantaneous Rate
The rate of reaction between specific time intervals is called the average rate of reaction. Let amount of product formed at t_1 is c_1 and at t_2 is c_2 then. $\text{Average} = \frac{c_2 - c_1}{t_2 - t_1} = \frac{\Delta c}{\Delta t}$	The rate at any instant during the interval is called instantaneous rate. Let 'x' is the amount of product produced at any time 't' then instantaneous rate can be expressed as. $\text{Instantaneous Rate} = \frac{dx}{dt}$

11. The units of rate constant of second order reaction is $dm^3\ mole^{-1}\ s^{-1}$ but the unit of rate of reaction is mole $dm^{-1}\ s^{-1}$ Justify. (MTN 2013)

Ans. $\text{Rate of reaction} = \frac{\text{Change in Concentration}}{\text{Time}}$

$$\text{or rate of reaction} = \frac{\text{mol dm}^{-3}}{\text{sec}} = \text{mol dm}^{-3}\ \text{s}^{-1}$$

So unit of rate of reaction is mol $dm^{-3}s^{-1}$

Consider a second order reaction $A + B \rightarrow$ Product.

$\text{Rate of reaction} = K[A][B]$

$\text{Mol dm}^{-3}\ \text{s}^{-1} = K\ [\text{concentration}]^2$

$\text{Mol dm}^{-3}\ \text{s}^{-1} = K\ (\text{mol dm}^{-3})^2$

$$\text{Or } K = \frac{-s^{-1}}{\text{mol dm}^{-3}}$$

$K = dm^{+3}\ mol^{-1}\ s^{-1}$

12. Under what condition activated complex is formed? (BWP-2018)

Ans. Activated complex is the collection of molecules of reactants at the time of collision having greater energy than the reactants and products. At this stage old bonds become weak and the possibilities for the new bonds are there. Molecules of the reactants should guide with one another with certain amount of energy and they approach each other with proper orientation.

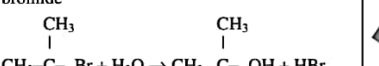
13. Define reaction kinetic and rate of reaction. (BWP 2012, 17)

Ans. Reaction kinetics: The studies concerned with a rates of chemicals reactions and the factors that affect the rates of chemical reactions constitute the subject matter of reaction kinetics.

Rate of reaction: The rate of the reactions is defined as changing concentration of a reactant or product divided by the time taken for the change.

14. What is pseudo first order reaction? Give one example. (BWP 2017)

Ans. The reactions which involve more than one molecules but they obey (satisfy) first order rate equation are called pseudo first order reaction e.g. hydrolysis of tertiary butyl bromide



15. Differentiate between Fast Step, and Rate determining step. (FSD 2014)

Ans. Fast step: The step of a chemical reaction which take place fastely and have no role in rate of reaction is called fast step.

Rate determining step: When a reaction is occur in several steps, then one of the step is slowest this slowest step is called rate determining step consider the reaction $NO_2 + CO_2 \rightarrow NO + CO_2$.

16. What is half life period? Give an example. (FSD 2016 G-II)

Ans. The time required to convert 50% of reactants into products is called half life period e.g, the half life period of decomposition of N_2O_5 at 45°C is 24 minutes.

17. Why photochemical reactions have generally zero order reaction? (RWP 2016 G-II)

Ans. In these reactions it does not depends upon the concentration of the reactants but it depends upon some other factors like light, temperature. So, due to that reason, they are called zero order reactions.

18. Some of Co-efficient of a balanced chemical equation is not necessary important to give the order to reaction? (RWP 2016 G-II)

Ans. Justification:

The number of molecules which take part in rate determining step (slow step) of a reaction is called order of reaction. It is determined experimentally consider the reaction.

$$2H_2 + 2NO \rightarrow 2H_2O + N_2$$

rate of reaction, $dm/dt = k\,[H_2]\,[NO_2]$ (By experiment). The order of reaction is 3 but sum of coefficients of balanced equation is 4.

19. Define instantaneous rate of reaction. (SGD 2016)

Ans. Instantaneous rate of reaction: The rate at any one instant during the interval is called instantaneous rate of reaction.

20. Rate of reaction is an ever changing parameter under the given conditions. Justify it. (SGD 2016)

Ans. According to Law of mass action:

"The rate of a reaction is directly proportional to concentration of reactants."

As the concentration of reactants is maximum at start, the rate is fast. As the time passes, the concentration of reactants decreases and rate of reaction also slows down.

During the progress of reaction, the rate of reaction slows down every moment with the decreasing concentration of reactants. Hence, it is ever changing parameter.

21. The unit of rate constant of a second order reaction is $dm^3\ mol^{-1}\ s^{-1}$ but the unit of rate of reaction is mole $dm^{-3}\ s^{-1}$. Give reason. (SWL 2013)

Ans. The rate of a reaction is the rate of change of concentration with respect of time.

$$\text{Rate} = \frac{\Delta c}{\Delta t} = \frac{\text{mol.dm}^3}{\text{sec.}} = \text{moles. dm}^3\text{ . sec}^{-1}$$

In case of 2nd order reaction

$$\text{Rate} = K\,[A]\,[B]$$

$$K = \frac{\text{Rate}}{[A][B]} = \frac{\text{moldm}^{-3}\text{ . sec}^{-1}}{[\text{mole.dm}^{-3}]\text{ . }[\text{mole.dm}^{-3}]}$$

$$K = \text{dm}^3\ \text{mol}^{-1}\text{ . sec}^{-1}$$

22. The radioactive decay is always a first order reaction. Explain. (AJK 2016)

Ans. During the radioactive decay, nuclei of one type are broken up and no other species is involved. The rate of this decaying depends upon concentration of nuclei of any type. Hence it follows the first order kinetics.

SECTION III

LONG QUESTIONS

1. Name various methods for finding order of reaction. Explain half life method for determining order of reaction. (LHR 2011) (RWP 2017, 18) (DGK 2018) (GRW 2012)(SWL 2013)
2. Explain Arrhenius equation. How does it help us to calculate the energy of activation of a reaction? (SGD 2018) (SWL 2018) (LHR 2012) (DGK 2016) (GRW 2014, 18)
3. Define order of reaction and explain 2nd and zero order reactions. (LHR 2016, 18) (DGK 2017) (SWL 2016)
4. Write a detailed note on activation energy. Explain with graphs. (FSD 2018) (GRW 2013) (SGD 2011) (MTN 2013)
5. Define these terms: (FSD 2011)
   i. Rate of reaction ii. Order of reaction
6. Explain effect of temperature on rate of reaction by Arrhenius equation. (FSD 2014)

1A

FUNDAMENTAL CONCEPTS

Multiple Choice Questions

Entry Test Questions:

1. In mass spectrometer, detector or collector measures the: (2011)
(a) Masses of isotopes
(b) Percentages of isotopes
(c) Relative abundances of isotopes
(d) Mass numbers of isotopes

2. How many 'Cl' (chlorine) atoms are in two moles of chlorine? (2011)
(a) $2 \times 6.02 \times 10^{-23}$ atoms
(b) $35.5 \times 6.02 \times 10^{23}$ atoms
(c) 2×10^{23} atoms
(d) $2 \times 6.02 \times 10^{23}$ atoms

3. An organic compound has empirical formula C_3H_3O, if molar mass of compound is 110.15 $gmol^{-1}$. The molecular formula of this organic compound is (A, of C=12, H=1.008 and O=16) (2012)
(a) $C_6H_6O_2$ (b) C_3H_3O
(c) $C_9H_9O_3$ (d) $C_6H_6O_3$

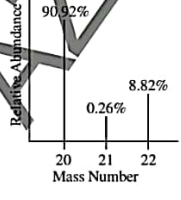
4. When 8 grams (4 moles) of H_2 react with 2 moles of O_2, how many moles of water will be formed? (2012)
(a) Five (b) Four
(c) Six (d) Three

5. Hydrogen burns in chlorine to produce hydrogen chloride. The ratio of masses of reactants in chemical reaction is:(2013)

$$H_2 + Cl_2 \longrightarrow 2HCl$$

(a) 1:35.5 (b) 2:35.5
(c) 1:71 (d) 2:70

6. A sample of Neon is found to exist as ^{20}Ne, ^{21}Ne, ^{22}Ne. Mass spectrum of 'Ne' is as follow:



What is the relative atomic mass (A, value) of Neon? (2013)
(a) 20.18 (b) 20.28
(c) 20.10 (d) 20.22

7. A polymer of empirical formula CH_2 has molar mass of 28000 g mol^{-1}. Its molecular formula will be (2014)
(a) 100 times that of its empirical formula
(b) 200 times that of its empirical formula
(c) 500 times that of its empirical formula
(d) 2000 times that of its empirical formula

8. The number of molecules in 9 g of ice (H_2O) is (2014)
(a) 6.02×10^{24} (b) 6.02×10^{23}
(c) 3.01×10^{24} (d) 3.01×10^{23}

9. How many moles of sodium are present in 0.1 g of sodium? (2015)
(a) 4.3×10^{-3} (b) 4.03×10^{-1}
(c) 4.01×10^{-2} (d) 4.3×10^{-2}

10. With the help of spectral data given calculate the mass of Neon and encircle the best option. (Percentage of $_{10}Ne^{20}$, $_{10}Ne^{21}$ and $_{10}Ne^{22}$ are 90.92%, 0.26% and 8.82% respectively). (2015)
(a) 22.18 amu (b) 21.18 amu
(c) 20.18 amu (d) 22.20 amu

11. The substance for the separation of isotopes is firstly converted into the: (2016)
(a) Neutral state (b) Free state
(c) Vapour state (d) Charged state

12. The number of moles of CO_2 which contain 8.00 gm of oxygen is: (2016)
(a) 0.75 (b) 1.50
(c) 0.25 (d) 1.00

Answers:

1.	c	2.	d	3.	a	4.	b
5.	a	6.	b	7.	d	8.	d
9.	a	10.	c	11.	c	12.	c

2A

STATES OF MATTER

Multiple Choice Questions

Entry Test Questions:

1. **In mass spectrometer, detector or collector measures the: (2011)**
   (a) Masses of isotopes
   (b) Percentages of isotopes
   (c) Relative abundances of isotopes
   (d) Mass numbers of isotopes

1. **Melting point of water is higher than petrol, because intermolecular forces in water are: (2011)**
   (a) Weaker than petrol
   (b) Stronger than petrol
   (c) Same as in petrol
   (d) Negligible

2. **DNA molecule is double stranded, in which two chains of DNA are twisted around each other by: (2011)**
   (a) Hydrogen bonds
   (b) Vander Waal's force
   (c) Covalent bonds
   (d) Dative bonds

3. **The number of molecules in 22.4 dm^3 of H_2 gas at 0 °C and 1 atm are: (2012)**
   (a) 60.2×10^{23} (b) 6.02×10^{22}
   (c) 6.02×10^{23} (d) 6.02×10^{22}

4. **Correct order of boiling points of the given liquid is (2012)**
   (a) $H_2O > HF > HCl > NH_3$
   (b) $HF > H_2O > HCl > NH_3$
   (c) $H_2O > HF > NH_3 > HCl$
   (d) $HF > H_2O > NH_3 > HCl$

5. **The coordination number of Na^+ in NaCl crystal is: (2013)**
   (a) 6 (b) 2
   (c) 4 (d) 8

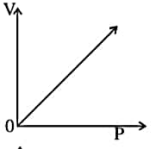
6. **There are four gases H_2, He, N_2 and CO_2 at 0 °C. Which gas shows greater non-ideal behavior? (2013)**
   (a) He (b) CO_2
   (c) H_2 (d) N_2

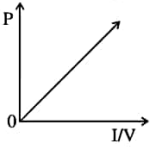
7. **Ice is less dense than water at: (2014)**
   (a) 0 °C (b) 4 °C
   (c) −4 °C (d) 2 °C

8. **At a given temperature and pressure, the one which shows marked deviation from ideal behavior is: (2014)**
   (a) N_2 (b) N_3
   (c) CO_2 (d) He

9. **If the volume of a gas collected at a temperature of 600 oC and pressure of 1.05×10^5 Nm^{-2} is 60 dm^3, what would be the volume of gas at STP ($P=1.01\times10^5$ Nm^{-2}, T = 273 K)? (2015)**
   (a) 25 cm^3 (b) 75 cm^3
   (c) 100 cm^3 (d) 51 cm^3

10. **Which graph represents Boyle's law? (2015)**

(a)


(b)


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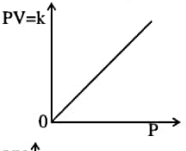
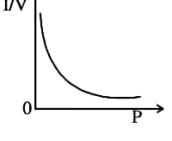


(d)


11. London dispersion forces are the only forces present among the: (2016)

(a) Molecules of H_2O in liquid state

(b) Molecules of HCl gas

(c) Atoms of helium in gaseous state at high temperature

(d) Molecules of solid chlorine

12. Electrical conductivity of graphite is greater in one direction that in other due to:

(a) Isomorphism

(b) Cleavage plane

(c) Anisotropy

(d) Symmetry

Answers:

1.	b	2.	a	3.	a	4.	c
5.	a	6.	b	7.	a	8.	c
9.	d	10.	b	11.	c	12.	c

—★—★—★—

3A

ATOMIC STRUCTURE

Multiple Choice Questions

Entry Test Questions:

1. The elements for which the value of ionization energy is low, can: (2011)

(a) Gain electrons readily

(b) Gains electron with difficulty

(c) Loss electrons less readily

(d) Lose electrons readily

2. The nature of cathode rays in discharge tube: (2011)

(a) Depends on the nature of gas taken in the discharge tube

(b) Depends upon the nature of cathode in discharge tube

(c) Is independent of the nature pf the gas in discharge tube

(d) Depends upon the nature of anode in the discharge tube

3. The relative energies of 4s, 4p and 3d orbitals are in the order (2012)

(a) $3d < 4p < 4s$

(b) $4s < 3d < 4p$

(c) $4p < 4s < 3d$

(d) $4p < 3d < 4s$

4. With increase in the value of Principal Quantum Number 'n', the shape of the s-orbitals remains the same although their sizes (2012)

(a) Decrease

(b) Increase

(c) Remain the same

(d) May or may not remain the same

5. Correct order of energy in the given subshells is: (2013)

(a) $5s > 3d > 3p > 4s$

(b) $5s > 3d > 4s > 3p$

(c) $3p > 3d > 5s > 4s$

(d) $3p > 3d > 4s > 5s$

6. Number of electrons in the outermost shell of chloride ion (Cl—) is: (2013)

(a) 17 (b) 3

(c) 1 (d) 8

7. According to the number of protons, neutrons and electrons given in the table, which one of the following options is correct? (2014)

Species	Proton	Neutron	Electron
As	33	42	30
Ga	31	39	28
Ca	20	20	20

(a) As^{+3}, Ga^{+3}, Ca

(b) As^{+1}, Ga^{+2}, Ca

(c) As^{+3}, Ga^{+3}, Ca^{+2}

(d) As^{+1}, Ga, Ca^{+2}

8. If the e/m value of electron is 1.7588 x 1011 coulombs Kg^{-1}, then what would be the mass of electron in grams (charge on electron is 1.6022×10^{-19} coulombs)? (2014)

(a) 9.1095×10^{-31} g

(b) 91.095×10^{-31} g

(c) 9.1095×10^{-28} g

(d) 0.919095×10^{-33} g

9. **Which one of the following pairs has the same electronic configuration as possessed by Neon (Ne-10)? (2015)**

(a) Na^+, Cl^- (b) K^+, Cl^-

(c) Na^+, Mg^{2+} (d) Na^+, F^-

10. **There are four orbitals s, p, d and f. Which order is correct with respect to the increasing energy of the orbitals? (2015)**

(a) 4s < 4p < 4d < 4f

(b) 4p < 4s < 4f < 4d

(c) 4s < 4f < 4p < 4d

(d) 4f < 4s < 4d < 4p

11. **Number of neutrons in $^{66}_{30}Zn$ will be: (2016)**

(a) 30 (b) 35

(c) 38 (d) 36

12. **The maximum number of electrons in electronic configuration can be calculated by using formula: (2016)**

(a) 2l + 1 (b) $2n^2 + 2$

(c) $2n^2$ (d) $2n^2 + 1$

Answers:

1.	d	2.	c	3.	b	4.	b
5.	b	6.	d	7.	a	8.	c
9.	c,d	10.	a	11.	d	12.	c

★ ★ ★

4A

CHEMICAL BONDING

Multiple Choice Questions

Entry Test Questions:

1. **The ability of an atom in a covalent bond to attract the bonding electrons is called: (2011)**

(a) Ionization energy

(b) Ionic bond energy

(c) Electronegativity

(d) Electron affinity

2. **The paramagnetic character of a substance is due to: (2011)**

(a) Bond pairs of electrons

(b) Lone pairs of electrons

(c) Unpaired electrons in atom or molecule

(d) Paired electrons in valence shells of electrons

3. **The angle between unhybridized p-orbital and three sp^2 hybrid orbitals of each carbon atom in ether is: (2012)**

(a) 120° (b) 90°

(c) 109.5° (d) 180°

4. **In 'H-F' bond electronegativity difference is '1.9'. What is the type of this bond? (2012)**

(a) Polar covalent bond

(b) Non-polar covalent bond

(c) Pi (π) bond

(d) Co-ordinate covalent bond

5. **According to valence shell electron pair repulsion theory, the repulsive forces between the electron pair of central atom of molecule are in the order:(2013)**

(a) Lone Pair - Lone-Pair > Lone Pair - Bond Pair > Bond Pair - Bond Pair

(b) Lone Pair - Bond Pair > Lone Pair - Lone Pair > Bond Pair - Bond Pair

(c) Bond Pair - Bond Pair > Lone Pair - Lone Pair > Lone Pair - Bond Pair

(d) One Pair - Bond Pair > Bond Pair - Bond Pair > Lone Pair - Lone Pair

6. **In crystal lattice of ice, each O-atom of water molecule is attached to: (2013)**

(a) Four H-atoms

(b) Three H-atoms

(c) One H-atom

(d) Two H-atoms

7. **The suitable representation of dot structure of chlorine molecule is: (2014)**

(a) $:\ddot{\underset{\cdot\cdot}{Cl}}:$ (b) $\ddot{\underset{\cdot\cdot}{Cl}}\,\|\,\ddot{\underset{\cdot\cdot}{Cl}}$

(c) $:\ddot{\underset{\cdot\cdot}{Cl}}\,:\,\ddot{\underset{\cdot\cdot}{Cl}}:$ (d) $\ddot{\underset{\cdot\cdot}{Cl}}\,:\,\ddot{\underset{\cdot\cdot}{Cl}}$

8. When the two partially filled atomic orbitals overlap in such a way that the probability of finding electron is maximum around the line joining the two nuclei, the result is the formation of: (2014)
(a) Sigma Bond (b) Pi-Bond
(c) Hydrogen Bond (d) Metallic Bond

9. Which one of the following hydrogen bonds is stronger than others? (2015)
(a) $N^{\delta-}—H^{\delta+}$ ..... $N^{\delta-}—H^{\delta+}$
(b) $F^{\delta-}—H^{\delta+}$ ..... $F^{\delta-}—H^{\delta+}$
(c) $O^{\delta-}—H^{\delta+}$ ..... $O^{\delta-}—H^{\delta+}$
(d) $N^{-}—H^{\delta+}$ ..... $O^{\delta-}—H^{\delta+}$

10. Which of the following is the correct dot and cross diagram of bonding between two chlorine atoms? (2015)
(a)
(b)
(c)
(d)

11.

Choose the right molecule: (2016)
(a) CH_3 (b) CO
(c) H_2O (d) NH_3

12.

Calculate the number of σ bonds and π bonds in the molecule. (2016)
(a) 1π and 5σ bonds
(b) 2π and 4σ bonds
(c) 3π and 3σ bonds
(d) 6π and 6σ bonds

Answers:

1.	c	2.	c	3.	b	4.	a
5.	a	6.	a	7.	b	8.	a
9.	b	10.	c	11.	d	12.	a

—★—★—★—

5A

CHEMICAL ENERGETICS

Multiple Choice Questions

Entry Test Questions:

1. Lattice energy of an ionic crystal is the enthalpy of: (2011)
(a) Combustion (b) Dissociation
(c) Dissolution (d) Formation

2. In standard enthalpy of atomization, heat of the surrounding: (2011)
(a) Remains unchanged
(b) Increases
(c) Increases than decreases
(d) Decreases

3. 'ΔH°' will be given a negative sign in: (2012)
(a) Exothermic reactions
(b) Decomposition reactions
(c) Dissociation reaction
(d) Endothermic reactions

4. Lattice energy of an ionic crystal is the enthalpy of: (2012)
(a) Combustion (b) Dissociation
(c) Dissolution (d) Formation

5. Heat of formation (ΔHf°) for CO_2 is: (2013)
(a) -394 kJ/mole (b) +394 kJ/mole
(c) -294 kJ/mole (d) -390 kJ/mole

6. Reactants have high energy than products in: (2013)
(a) Exothermic reactions
(b) Endothermic reactions
(c) Photochemical reactions
(d) Non-spontaneous reactions

7. $2H_2 + O_2 \longrightarrow 2H_2 \quad \Delta H = +285.5 \text{ kJ mol}^{-1}$
What will be the enthalpy change in the above reaction? (2014)
(a) 205.5 kJ/mol (b) Zero kJ/mol
(c) -205.5 kJ/mol (d) 1 kJ/mol

8. **Combustion of graphite to form CO_2 can be done by two ways. Reactions are given as follows: (2014)**

$C+O_2 \longrightarrow CO_2 \quad \Delta H=-393.7 kJmol^{-1}$

$C+ \frac{1}{2}O_2 \longrightarrow CO \quad \Delta H = ?$

$CO + \frac{1}{2}O_2 \longrightarrow CO \quad \Delta H = -283\ kJmol^{-1}$

What will be enthalpy of formation of CO?

(a) $-676\ kJ\ mol^{-1}$ (b) $-110\ kJ\ mol^{-1}$

(c) $110\ kJ\ mol^{-1}$ (d) $676\ kJ\ mol^{-1}$

9. **The equation that represents standard enthalpy of atomization of hydrogen is: (2015)**

(a) $\frac{1}{2}H_2O_{(l)} \longrightarrow H_{2(g)} + \frac{1}{2}O_{(g)} + 218 kJmol^{-1}$

(b) $\frac{1}{2}H_2O_{(l)} \longrightarrow H_{2(g)} \frac{1}{2}O_{(g)} - 218 kJ\ mol^{-1}$

(c) $\frac{1}{2}H_{2(g)} \longrightarrow H_{(g)} + 218\ kJ\ mol^{-1}$

(d) $\frac{1}{2}H_{2(g)} \longrightarrow H_{(g)} - 218\ kJ\ mol^{-1}$

10. **Standard enthalpy of combustion of graphite at 25 oC is –393.51 kJ mol^{-1} and that of diamond is –395.41 kJ mol^{-1}. The enthalpy change for graphite is: (2015)**

(a) – 1.91 (b) +2.1

(c) –2.1 (d) +1.91

11. $\frac{1}{2}H_{2(g)} \longrightarrow H_{(g)} \quad \Delta H = 218\ kJmol^{-1}$ **(2016)**

In this reaction, ΔH will be called:

(a) Enthalpy of atomization

(b) Enthalpy of decomposition

(c) Enthalpy of formation

(d) Enthalpy of the dissociation

12. $Mg + \frac{1}{2}O_{2(g)} \longrightarrow MgO_{(g)} + -692\ kJmol^{-1}$ **at STP. (2016)**

Enthalpy of the above reaction will be called:

(a) ΔH°at (b) ΔH°s

(c) ΔH°sol (d) ΔH°l

Answers:

1.	d	2.	d	3.	a	4.	d
5.	a	6.	a	7.	c	8.	b
9.	c	10.	d	11.	a	12.	d

★ ★ ★

6A

SOLUTIONS

Multiple Choice Questions

Entry Test Questions:

1. **Mole fraction of any compound us the ratio of moles of all components in a: (2011)**

(a) Compound (b) Solution

(c) Molecule (d) Solid

2. **Molarity is defined as the number of moles of any substance dissolved: (2011)**

(a) Per dm^3 of water

(b) In one gram of water

(c) Per m^3 of water

(d) In 100 ml of water

3. **As number of solute particles increases, freezing point of the solution: (2012)**

(a) Remains the same

(b) Increases

(c) First increases, then decreases

(d) Decreases

4. **Boiling point constants help us to determine: (2012)**

(a) Molar masses (b) Volumes

(c) Pressures (d) Masses

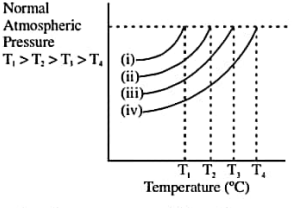
5. **If 18.0 g of glucose is dissolved in 1 kg of water, boiling point of this solution should be: (2013)**

(a) 100.52 °C (b) 100.00 °C

(c) 100.052 °C (d) Less than 100 °C

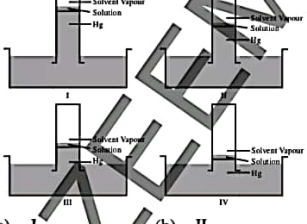
6. **Molal freezing point constant of water is:** **(2013)**
   (a) 1.86 (b) 2.86
   (c) 11.86 (d) 0.52

7. **The vapor pressure lines for pure as well as solutions of different concentrations are shown. Which line represents pure water?** **(2014)**



   (a) (i) (b) (ii)
   (c) (iii) (d) (iv)

8. **One mole of glucose was dissolved in 1 kg of water, ethanol, ether and benzene separately and the molal boiling point constant of each individual solution was found to be 0.52, 1.75, 2.16 and 2.70 in the units of / °C kg mol-1 respectively. Which of the following figures shows benzene as solvent in solution?** **(2014)**



   (a) I (b) II
   (c) III (d) IV

9. **10.0 grams of glucose are dissolved in water to make 100 cm3 of its solution, its molarity is:** **(2015)**
   (a) 0.55 (b) 0.1
   (c) 10 (d) 1

10. **Given solution contains 16.0 g of CH_3OH, 92.0 g of C_2H_5OH and 36 g of water. Which statement about mole fraction of the components is true?** **(2015)**
    (a) Mole fraction of CH_3OH is highest among all components
    (b) Mole fraction of C_2H_5OH and H_2O is the same
    (c) Mole fraction of CH_3OH and C_2H_5OH is same
    (d) Mole fraction of H_2O is the lowest among all

11. **Freezing point will also be defined as that temperature at which its solid and liquid phases have the same:** **(2016)**
    (a) Concentration
    (b) Ratio between the particles
    (c) Vapour pressure
    (d) Attraction between the phases

12. **What mass of NaOH is present in 0.5 mol of sodium hydroxide?** **(2016)**
    (a) 40 gm (b) 2.5 gm
    (c) 15 gm (d) 20 gm

Answers:

1.	b	2.	a	3.	d	4.	a
5.	c	6.	a	7.	a	8.	a
9.	a	10.	b	11.	c	12.	d

★ ★ ★

7A

ELECTROCHEMISTRY

Multiple Choice Questions

Entry Test Questions:

1. **In electrolytic cell, a salt bridge is used in order to:** **(2011)**
   (a) Pass the electric current
   (b) Prevent the flow of ions
   (c) Mix solution of two half cells
   (d) Allow movement of ions b/w two half cells

2. In all oxidation reactions, atoms of an element in a chemical species lose electrons and increase their: (2011)

(a) Oxidation states
(b) Reductions
(b) Electrode
(d) Negative charges

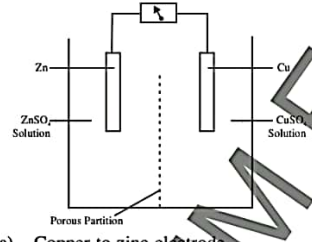
3. In electrolysis of aqueous $CuCl_2$, the metal deposited at cathode is (2012)

(a) Sodium (b) Aluminium
(c) Lead (d) Copper

4. In $MgCl_2$, the oxidation state of 'Cl' is: (2012)

(a) Zero (b) +2
(c) −2 (d) −1

5. In the figure given below, the electron flow in external circuit is from: (2013)



(a) Copper to zinc electrode
(b) Right to left
(c) Porous partition to zinc electrode
(d) Zinc to copper electrode

6. Which one of the following is a redox reaction? (2013)

(a) $NaCl + AgNO_3 \longrightarrow NaNO_3 + AgCl_2$
(b) $2Cl^- \longrightarrow Cl_2 + 2e^-$
(c) $2Na + Cl_2 \longrightarrow 2NaCl$
(d) $Na^+ + 1e \longrightarrow Na$

7. In SO_4^{-2} the oxidation number of Sulphur is: (2014)

(a) −8 (b) +8
(c) −6 (d) +6

8. Coinage metals Cu, Ag, and Au are the least reactive because they have: (2014)

(a) Negative reduction potential
(b) Positive reduction potential
(c) Negative oxidation potential
(d) Positive oxidation potential

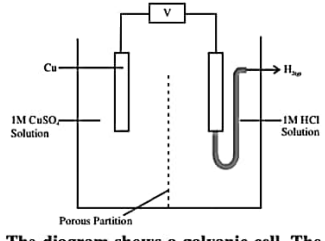
9. Positive oxidation potential (2015)

$Zn \longrightarrow Zn^{+2} + 2e^-$ $E^o = +0.76V$
$Cu \longrightarrow Cu^{+2} + 2e^-$ $E^o = -0.34$ V

(a) $Cu + Zn^{+2} \longrightarrow Cu^{+2} + Zn$
(b) $Cu^{+2} + Zn^{+2} \longrightarrow Cu + Zn$
(c) $Cu^{+2} + Zn \longrightarrow Cu + Zn^{+2}$
(d) $Cu^{+2} + Zn^{+2} \longrightarrow Cu + Zn^{+2}$

10. Keeping in mind the electrode potential, which one of the following reactions is feasible? (2015)

(a) $Zn^{+2} + Cu \longrightarrow Cu^{+2} + Zn$
(b) $Zn + MgSO_4 \longrightarrow ZnSO_4 + Mg$
(c) $Fe + CuSO_4 \longrightarrow FeSO_4 + Cu$
(d) $Cd + MgSO_4 \longrightarrow CdSO_4 + Mg$



11. The diagram shows a galvanic cell. The current will flow from: (2016)

(a) Hydrogen electrode to copper electrode
(b) Copper electrode to hydrogen electrode
(c) Hydrogen electrode to HCl solution
(d) $CuSO_4$ solution to hydrogen electrode

12. Study the following redox reaction:(2016)

$10Cl^- + 16H^+ + 2MnO_4^- \rightarrow 5Cl_2 + 2Mn^{+2} + 8H_2O$

(a) Manganese is oxidized from +7 to +2
(b) Chlorine ions are reduced from −1 to zero
(c) Chlorine is reduced from zero to −1
(d) Manganese is reduced from +7 to +2

Answers:

1.	d	2.	a	3.	d	4.	d
5.	d	6.	c	7.	d	8.	b
9.	c	10.	c	11.	a	12.	d

—★—★—★—

8A

CHEMICAL EQUILIBRIUM

Multiple Choice Questions

Entry Test Questions:

1. In 'AgCl' solution. Some salt of NaCl is added, 'AgCl' will be precipitated due to: (2011)

(a) Solubility (b) Electrolyte
(c) Unsaturation effect
(d) Common ion effect

2. 'Ka' for an acid is higher, the stronger is the acid; relate the strength an acid with 'pKa' (2011)

(a) Higher pKa, weaker the acid
(b) Lower pKa, stronger the acid
(c) pKa has no relation with acid strength
(d) Both A and B

3. Formation of NH_3 is reversible and exothermic process, what will happen on cooling? (2012)

(a) More reactant will form
(b) More N_2 will be formed
(c) More H_2 will be formed
(d) More product (NH_3) will be formed

4. A buffer solution is that which resists/minimizes the change in: (2012)

(a) pOH (b) pH
(c) pKa (d) pKb

5. The chemical substance, when dissolved in water, gives "H^+" is called: (2013)

(a) Acid (b) Base
(c) Amphoteric (d) Neutral

6. The 'pH' of our blood is: (2013)

(a) 6.7 – 8 (b) 7.9
(c) 7.5 (d) 7.35 – 7.4

7. The value of equilibrium constant (Kc) for the reaction $2HF_{(g)} \rightleftharpoons H_{2(g)} + F_{2(g)}$ is 10^{-13} at 2000 °C. Calculate the value of Kp for this reaction:

(a) 2×10^{-13} (b) 10^{-13}
(c) 186×10^{-13} (d) 3.48×10^{-9}

8. What will be the pH of a solution of NaOH with a concentration of 10^{-3} M? (2014)

(a) 3 (b) 14
(c) 11 (d) 7

9. What is the correct relation between pH and pK? (2015)

(a) $pH = pKa + \log \left[\frac{Acid}{Base}\right]$
(b) $pH = pKa - \log \left[\frac{Acid}{Base}\right]$
(c) $pH = pKa - \log \left[\frac{Base}{Acid}\right]$
(d) $pH = pKa + \log \left[\frac{Base}{Acid}\right]$

10. Which one of the following is the correct presentation for Ksp? (2015)

$AgCl \longrightarrow Ag^+ + Cl^-$

(a) $Ksp = \frac{[AgCl]}{[Ag+1]\,[Cl^-]}$
(b) $Ksp = [Ag+1]\,[Cl\text{-}1]$
(c) $Ksp = \frac{[Ag^{+1}][Cl^{-1}]}{[AgCl]}$
(d) $Ksp = [AgCl]$

11. Human blood maintains its pH between: (2016)

(a) 6.50 – 7.00 (b) 7.20 – 7.25
(c) 7.50 – 7.55 (d) 7.35 – 7.40

12. Value of Ksp for $PbSO_4$ system at 25 °C is equal to: (2016)

(a) 1.6×10^{-5} mol^2dm^{-6}
(b) 1.6×10^{-6} mol^2dm^{-6}
(c) 1.6×10^{-8} mol^2dm^{-6}
(d) 1.6×10^{-7} mol^2dm^{-6}

Answers:

1.	d	2.	d	3.	d	4.	b
5.	a	6.	d	7.	b	8.	c
9.	b,d	10.	b	11.	d	12.	c

★ ★ ★

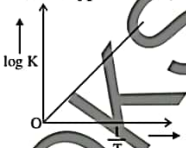
9A

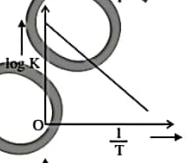
REACTION KINETICS

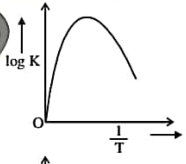
Multiple Choice Questions

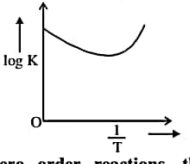
Entry Test Questions:

1. **It is experimentally found that a catalyst is used to: (2011)**
   (a) Lower the activation energy
   (b) Increase the activation energy
   (c) Lower the pH
   (d) Decrease the temp of the reaction
2. **According to collision theory of bimolecular reaction sin gas phase, the minimum amount of energy required for an effective collision is known as: (2011)**
   (a) Heat of reaction
   (b) Rate of reaction
   (c) Has no effect on the reaction
   (d) Energy of activation
3. **In some reactions, a product formed acts as a catalyst. The phenomenon is called: (2012)**
   (a) Negative Catalysis
   (b) Activation of Catalyst
   (c) Hetergeneous catalysis
   (d) Autocatalysis
4. **The reaction rate in forward direction decreases with the passage of time because: (2012)**
   (a) Concentration of reactants decrease
   (b) Concentration of product decreases
   (c) The order of reaction changes
   (d) Temperature of the system changes
5. **By considering Arrhenius equation, the graph between $\frac{1}{T}$ and 'log K' given a curve of the type: (2013)**

(a)


(b)


(c)


(d)


6. **In zero order reactions, the rate is independent of: (2013)**
   (a) Concentration of the product
   (b) Concentration of the reactant
   (c) Temperature of the reaction
   (d) Surface area of the product
7. **If the reactant or product of a chemical reaction can absorb ultraviolet, visible or infrared radiation, then the rate of a chemical reaction can best be measured by which one of the following methods? (2014)**
   (a) Chemical method
   (b) Spectrometry
   (c) Graphical method
   (d) Differential method

8. For the reaction $2NO + O_2 \rightleftharpoons 2NO_2$, the rate equation for the forward reaction is: **(2014)**

(a) Rate = k [NO] [O_2]

(b) Rate = k [NO]2[O_2]

(c) Rate = k [NO_2]^2

(d) Rate = k [NO_2]

9. The half-life of N_2O_5 at 0 oC is 24 minutes. How long will it take for sample of N_2O_5 to decay to 25% of its original concentration? **(2015)**

(a) 24 minutes (b) 72 minutes

(c) 120 minutes (d) 48 minutes

10. When the change in concentration is 6×10^{-4} mol dm^{-3} and time for that change is 10 seconds, the rate of reaction will be: **(2015)**

(a) 6×10^{-3} mol dm^{-3} sec^{-1}

(b) 6×10^{-4} mol dm^{-3} se^{-1}

(c) 6×10^{-2} mol dm^{-3} sec^{-1}

(d) 6×10^{-5} mol dm^{-3} sec^{-1}

11. 2A + B ⟶ Product **(2016)**

If the reactant 'B' is in excess, the order of reaction with respect to 'A' in given rate law, Rate = k [A]^2 [B] is:

(a) 2nd order reaction

(b) 1st order reaction

(c) Pseudo 1st order reaction

(d) 3rd order reaction

12. The rate constant 'k' is 0.693 min^{-1}. The half-life for the 1st order reaction will be: **(2016)**

(a) 1 min (b) 2 min

(c) 0.693 min (d) 4 min

Answers:

1.	a	2.	d	3.	d	4.	a
5.	b	6.	b	7.	b	8.	b
9.	d	10.	d	11.	a	12.	a

——★——★——★——

1B

PERIODS

Multiple Choice Questions

Entry Test Questions:

1. Carbon exists as allotropes, which are different crystalline or molecular forms of the same substance. Graphite and diamond are allotropes of carbon. Diamond is a non-conductor whereas graphite is a good conductor because: **(2011)**

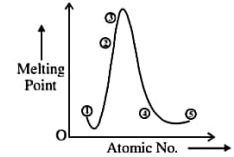
(a) Graphite has a layered structure

(b) In graphite, all valence electrons are tetrahedrally bound

(c) In graphite one of valence electron is free to move

(d) Graphite is soft and greasy

2. The diagram below is a plot of melting points of elements of second period against their atomic numbers. Lithium and fluorine are placed at the extreme ends of the plot, on the basis of melting points where will you place Carbon among the empty slots on the plot? **(2011)**



(a) 1 (b) 2

(c) 4 (d) 3

3. Which one remains same along a period? **(2012)**

(a) Atomic radius

(b) Melting point

(c) Number of shells (orbits)

(d) Electrical conductivity

4. More the ionization energy of an element: **(2012)**

(a) More the electropositivity

(b) More the reducing power

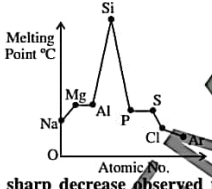
(c) Less the metallic character

(d) Bigger the atomic radius

5. What is the trend of melting and boiling point of the elements of short periods as we move from left to right in a periodic table? (2013)
(a) Melting and boiling points first decrease then increase
(b) Melting and boiling points increase gradually
(c) Melting and boiling points first increase then decrease
(d) Melting and boiling points decrease gradually

6. Along a period, atomic radius decreases. This gradual decrease in radius is due to: (2013)
(a) Increase in number of electrons in valence shells
(b) Increase in number of protons in the nucleus
(c) Decrease in number of shells
(d) Increase in number of shells

7. The trends, in melting points of the elements of 3rd period, are depicted in figure below. (2014)



The sharp decrease observed from 'Si' to 'P' is due to
(a) Decrease in atomic radius from 'Si' to 'P'
(b) Change in bonding and structure of two elements
(c) Different universities of two elements
(d) Increase in electron density from 'Si' to 'P'

8. Arrange the following elements according to the trend of ionization energies. (C, N, Ne, B) (2014)
(a) Ne < N < C < B
(b) B < N < C < Na
(c) B < C < N < Na
(d) Ne < B < C < N

9. Which one of the following will have the smallest radius? (2015)
(a) Al^{+3} (b) Si^{+4}
(c) Mg^{+2} (d) Na^{+1}

10. Keeping in view the size of atoms, which order is correct? (2015)
(a) N > C (b) P > Si
(c) Ar > Cl (d) Li > Be

11. Melting points of group II-A elements are higher than those of group I-A because: (2016)
(a) Atoms of II-A elements have smaller size
(b) II-A elements are more reactive
(c) Atoms of II-A elements provide two binding electrons
(d) I-A elements have smaller atomic radius

12. The ionic radius of fluoride ion is: (2016)
(a) 72 pm (b) 95 pm
(c) 136 pm (d) 157 pm

Answers:

1.	c	2.	d	3.	c	4.	c
5.	c	6.	d	7.	b	8.	c
9.	b	10.	d	11.	c	12.	c

★ ★ ★

2B

GROUPS

Multiple Choice Questions

Entry Test Questions:

1. When elements of group II-A (alkaline earth metals) are exposed to air, they quickly become coated with a layer of oxide. What is the purpose of this oxide layer? (2011)
(a) The oxide layer exposes the metal to Atmospheric attack
(b) The oxide layer increases the reactivity of metal
(c) The oxide layer protects the metal from further atmospheric attack
(d) The oxide layer gives the metal a shiny silvery appearance

2. **In silicon dioxide each silicon atom is tetrahedrally bonded to four oxygen atoms and each oxygen atom is bonded to two silicon atoms. The ratio of silicon to oxygen atoms is: (2011)**

(a) 2:2 (b) 1:2
(c) 2:1 (d) 1:4

3. **Alkaline earth metal hydroxides decompose on heating. Which of the following reactions is a correct representation of this decomposition? (2012)**

(a) $M(OH)_{2(s)} \longrightarrow MO_{(s)} + H_2O_{(l)}$
(b) $MOH_{(s)} \longrightarrow M_2O_{(s)} + H_2O_{(l)}$
(c) $2MOH_{2(s)} \longrightarrow 2MO_{(s)} + H_{2(l)}$
(d) $4MOH(s) \longrightarrow 4M_{(s)} + 2H_2O_{(l)} + O_2$

4. **Carbon has the unique ability to form long chains by bonding with other carbon atoms. This property of self-linking in carbon is known as: (2012)**

(a) Condensation
(b) Polymerization
(c) Cyclization (d) Catenation

5. **Alkaline earth metal oxides react with water to give hydroxides. The solubility of alkaline earth metal oxides in water increases as we move from top to bottom in a group. Which of the following alkaline earth metal oxides is least soluble in water? (2013)**

(a) MgO (b) CaO
(c) BaO (d) SrO

6. **The electronic structure of carbon monoxide is represented as: (2013)**

(a) :C⋮⋮O: (b) :C⋮⋮Ö:
(c) C⋮⋮Ö: (d) Ċ⋮⋮Ö

7. **Radon is ..... emitter and being radioactive is used in treatment in radiotherapy: (2014)**

(a) β, cancer (b) α, cancer
(c) α, kidney stone (d) β,kidney stone

8. **Which one of the following noble gases is used for providing an inert atmosphere for welding? (2014)**

(a) Helium (b) Neon
(c) Argon (d) Krypton

9. **On the basis of oxidizing power of halogens, which reaction is possible? (2015)**

(a) $I_2 + 2Cl^- \longrightarrow Cl_2 + 2I^-$
(b) $Br_2 + 2I^- \longrightarrow I_2 + 2Br^-$
(c) $Cl_2 + 2F^- \longrightarrow F_2 + 2Cl^-$
(d) $I_2 + 2Br^- \longrightarrow Br_2 + 2I^-$

10. **Which one of the following gases is used as mixture for breathing by sea divers? (2015)**

(a) Oxygen and Nitrogen
(b) Nitrogen and Helium
(c) Helium and Oxygen
(d) Helium and Hydrogen

11. **$2NaOH_{(aq)} + Cl_{2(g)} \longrightarrow NaCl + NaClO + H_2O$ proceed at: (2016)**

(a) 500 °C (b) 200 °C
(c) −10 °C (d) 15 °C

12. **Which halogen molecule 'X_2' has lowest dissociation energy? (2016)**

(a) Cl_2 (b) Br_2
(c) I_2 (d) F_2

Answers:

1.	c	2.	b	3.	a	4.	d
5.	a	6.	a	7.	b	8.	a
9.	b	10.	c	11.	d	12.	d

★ ★ ★

3B

TRANSITION ELEMENTS

Multiple Choice Questions

Entry Test Questions:

1. **Hydrogenation of unsaturated oils is done by using: (2011)**

(a) Finally divided nickel
(b) Finally divided iron
(c) Vanadium pentaoxide
(d) Copper

2. Pick the correct statement: (2011)
(a) Chelates are usually more stable than ordinary complexes
(b) Ordinary complexes are more stable than chelates
(c) Monodentate ligands form the chelates
(d) Chelates have no ring structures

3. Oxidation state of 'Mn' in $KMnO_4$, K_2MnO_4, MnO_2 and $MnSO_4$ is in the order: (2012)
(a) +7, +6, +2, +4 (b) +6, +7, +2, +4
(c) +7, +6, +4, +2 (d) +4, +6, +7, +2

4. Which pair of transition elements shows abnormal electronic configuration? (2012)
(a) Sc and Zn (b) Cu and Sc
(c) Zn and Cu (d) Cu and Cr

5. Which one pair has the same oxidation state of 'Fe'? (2013)
(a) $FeSO_4$ and $FeCl_3$ (b) $FeCl_2$ and $FeCl_3$
(c) $FeSO_4$ and $FeCl_2$ (d) $Fe_2(SO_4)_3$ and $FeSO_4$

6. Oxidation state of 'Fe' in $K_3[Fe(CN)_6]$ is: (2013)
(a) +2 (b) +3
(c) −6 (d) −3

7. Electronic configuration of Manganese (Mn) is: (2014)
(a) Mn (Ar) 3d 4s
(b) Mn (Ar) 3d 4s
(c) Mn (Ar) 3d 4s
(d) Mn (Ar) 3d 4s

8. The percentage of carbon in different types of iron products is in the order of (2014)
(a) Cast Iron > Wrought Iron > Steel
(b) Wrought Iron > Steel > Cast Iron
(c) Cast Iron > Steel > Wrought Iron
(d) Cast Iron > Steel > Wrought Iron

9. $[Ti(HO)_6]^{+3}$ transmits: (2015)
(a) Yellow and Red light
(b) Yellow and Blue light
(c) Red and white light
(d) Red and blue light

10. Electronic configuration of Gold [Au79] is: (2015)
(a) [Xe] $4f^{14}, 5d^{10}, 6s^1$
(b) [Xe] $4f^{10}, 5d^{10}, 6s^2$
(c) [Xe] $4f^{14}, 5d^9, 6s^2$
(d) [Xe] $4f^{14}, 5d^{10}, 6s^2$

11. The anomalous electronic configuration shown by chromium and copper among 3-d series of elements is due to: (2016)
(a) Colour of ions of these metals
(b) Variable oxidation states of metals
(c) Stability associated with this configuration
(d) Complex formation tendency of metals

12. Which element of 3d series of periodic table shows the electronic configuration of $3d^6, 4s^2$? (2016)
(a) Copper (b) Cobalt
(c) Zinc (d) Nickel

Answers:

1.	a	2.	a	3.	c	4.	d
5.	c	6.	b	7.	a	8.	c
9.	d	10.	a	11.	c	12.	d

★ ★ ★

4B

ELEMENTS OF BIOLOGICAL IMPORTANCE

Multiple Choice Questions

Entry Test Questions:

1. Hydrogenation of unsaturated oils is done by using: (2011)
(a) Finally divided nickel
(b) Finally divided iron
(c) Vanadium pentaoxide
(d) Copper

1. In contact process, the catalyst used for the conversion of Sulphur dioxide to Sulphur trioxide is: (2011)

(a) Magnesium oxide
(b) Aluminum oxide
(c) Silicon dioxide
(d) Vanadium pentoxide

2. The unpolluted natural rain water is slightly acidic due to the reaction of rain water with: (2011)

(a) Sulphur dioxide
(b) Oxides of nitrogen
(c) Carbon dioxide
(d) Hydrogen present in air

3. In the Haber's process for the manufacturing of ammonia, nitrogen is taken from: (2011)

(a) Proteins occurring in living bodies
(b) Ammonium salts obtained industrially
(c) Air
(d) Mineral containing nitrates

4. In comparison with oxygen gas, a strong triple bond is present between two nitrogen atoms in a molecule and therefore nitrogen gas is: (2011)

(a) Highly reactive gas
(b) Completely inert like noble gases
(c) Very less reactive gas
(d) Moderately reactive gas

5. The acid rain water has pH: (2012)

(a) Below 5 (b) 7
(c) Between 5 and 7 (d) Between 7 and 14

6. In Contact Process for manufacturing sulphuric acid, Sulphur trioxide (SO_3) is not absorbed in water because (2012)

(a) The reaction does not go to completion
(b) The reaction is highly exothermic
(c) The reaction is quite slow
(d) SO_3 is insoluble in water

7. In modern Haber Process Plants, the temperature maintained during the process is (2012)

(a) 670 – 770 K (400 °C – 500 °C)
(b) 270 – 370 K (0 °C – 100 °C)
(c) 370 – 470 K (100 °C – 200 °C)
(d) 570 – 600 K (300 °C – 380 °C)

8. In the Haber process for manufacturing of ammonia, Nitrogen is taken from : (2012)

(a) Proteins occurring in living bodies
(b) Ammonium salts obtained industrially
(c) Air
(d) Minerals containing nitrates

9. The nature of an aqueous solution of ammonia (NH_3) is: (2013)

(a) Amphoteric (b) Neutral
(c) Acidic (d) Basic

10. Unpolluted rain water has a pH of: (2013)

(a) 4.9 (b) 5.6
(c) 5.3 (d) 7.0

11. In comparison with oxygen gas, a strong triple bond is present between two nitrogen atoms in a molecule and therefore nitrogen gas is: (2013)

(a) Highly reactive gas
(b) Completely inert like noble gases
(c) Moderately reactive gas
(d) Very less reactive gas

12. The catalyst used in the Haber's process is: (2013)

(a) Magnesium oxide
(b) Aluminium oxide
(c) Silicon oxide
(d) Iron crystals with metal oxide promoters

13. Which one of the following is correct equation of 1st ionization of sulphuric acid? (2013)

(a) $H_2SO_{4(aq)}+H_2O_{(l)} \longrightarrow 2H^+ + SO^{2-}$
(b) $H_2SO_{4(aq)}+H_2O_{(l)} \longrightarrow H^+_{(aq)} + HSO^-_4$
(c) $H_2SO_{4(aq)}+H_2O_{(l)} \longrightarrow 2H^+ + SO^{2-}_4$
(d) $H_2SO_{4(aq)}+H_2O_{(l)} \longrightarrow H_3O^+ + SO^{2-}_4$

14. Which one of the following is the correct chemical reaction for Ammonia formation by Haber process? (2014)

(a) $N_{2(g)} + 3H2(g) \longrightarrow 2NH3(g)$

(b) $2N_{(g)} + 3H_{2(g)} \rightleftharpoons NH_{3(g)}$

(c) $2N_{(g)} + 3H_{2(g)} \longrightarrow 2NH_{3(g)}$

(d) $N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$

15. pH of acid rain is (2014)

(a) 7 (b) Between 5 and 7

(c) Below 5 (d) Between 7 and 14

16. Which one of the following products is obtained when sulphur trioxide is absorbed in concentrated sulphuric acid? (2014)

(a) Oleum (b) Aqua Regia

(c) Hydrogen sulphide (d) Sulphate ion

17. About 80% of ammonia is used for the production of (2015)

(a) Explosives (b) Fertilizers

(c) Nylon (d) Polymers

18. Urea is the most widely used nitrogen fertilizer in Pakistan. Its composition is: (2015)

(a) NH_2CO (b) $N_2H_2CO_2$

(c) $N_2H_4CO_2$ (d) N_2H_4CO

19. During the manufacture of nitric acid, nitric oxide is oxidized to nitrogen dioxide. This reaction is given as: (2015)

$2NO_{(g)} + O_{2(g)} \rightleftharpoons 2NO_{2(g)} \Delta H = -114$ kJ/mol

According to Le Chatelier's Principle

(a) Reaction must not be temperature dependent

(b) Reaction must be carried out at room temperature

(c) Reaction must be carried out at low temperature

(d) Reaction must be carried out at high temperature

20. What is the percentage of nitrogen in NH_3NO_3? (2015)

(a) 65% (b) 35%

(c) 20% (d) 58%

21. The %age of nitrogen in ammonium nitrate is: (2016)

(a) 46% (b) 82%

(c) 33% (d) 13%

22. Which one of the following is anhydride of sulphuric acid? (2016)

(a) Sulphur (II) oxide

(b) Sulphur (IV) oxide

(c) Iron pyrite

(d) Sulphur (VI) oxide

23. During contact process of is,the following reaction occurs:

$2SO_{2(g)} + O_2 \rightleftharpoons SO_{3(g)} \quad \Delta H = -96\ kJmol^{-1}$

(a) Temperature is raised to very high degree

(b) SO_3 formed is removed very quickly

(c) Both temperature and pressure are kept very low

(d) An excess of air is used to drive the equilibrium to the right side

24. Synthesis of ammonia by Haber's process is a reversible reaction. What should be done to increase the yield of ammowing reaction? (2016)

$N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)} \quad \Delta H = -92\ kJmol^{-1}$

(a) Pressure should be decreased

(b) Ammonia should remain in reaction mixture

(c) Pressure should be increased

(d) Concentration of nitrogen should be decreased

Answers:

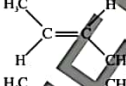
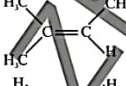
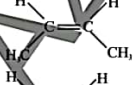
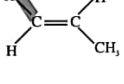
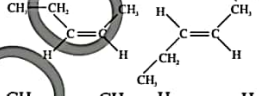
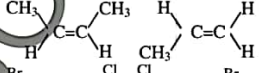
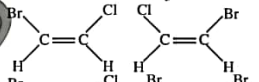
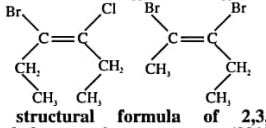
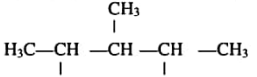
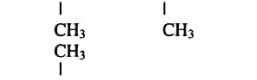
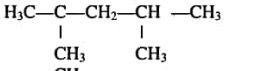
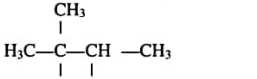
1.	d	2.	a	3.	c	4.	b
5.	a	6.	b	7.	a	8.	c
9.	d	10.	b	11.	d	12.	d
13.	b	14.	d	15.	c	16.	a
17.	b	18.	d	19.	c	20.	b
21.	c	22.	d	23.	d	24.	c

1C

FUNDAMENTAL PRINCIPLES

Multiple Choice Questions

Entry Test Questions:

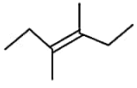
1. **The compound with an atom, which has unshared pair of electrons is called:(2011)**
   (a) Nucleophile (b) Electrophile
   (c) Protophile (d) None of the above
2. **1-chloropropane and 2-chlorpropane are isomers of each other, the type of isomerism in these two is called: (2011)**
   (a) Cis-trans isomerism
   (b) Chain isomerism
   (c) Position isomerism
   (d) Functional group isomerism
3. **Ethene on polymerization, gives the product polyethene. This reaction may be called as: (2012)**
   (a) Addition (b) Condensation
   (c) Substitution (d) Pyrolysis
4. **In the following, which one is free radical? (2012)**
   (a) Cl^- (b) Cl^+
   (c) Cl_2 (d) $Cl^\bullet$
5. **The cis-isomerism is shown by: (2013)**
   (a) 
   (b) 
   (c) 
   (d) 
6. **Select the nucleophile from the following examples: (2013)**
   (a) NO_2 (b) NH_3
   (c) NO_2^+ (d) N^+H_4
7. **Which one of the following compound is a ketone? (2014)**
   (a) $CH_3 - O - CH_2 - CH_3$
   (b) $CH_3 - CO - CH_2 - CH_3$
   (c) $CH_3COCOOH$
   (d) $CH_3 - CH_2CHO$
8. **Which one of the following pair of compounds is cis and trans isomers of each other? (2014)**
   (a) 
   (b) 
   (c) 
   (d) 
9. **The structural formula of 2,3,4 trimethylpentane is: (2015)**
   (a) 
   (b) 
   (c) 
   (d) 

10. Which one of the following is a powerful electrophile used to attack on the electrons of benzene ring? (2015)

(a) $FeCl_2$ (b) $FeCl^{4-}$

(c) Cl^+ (d) Cl_2

11. Skeletal formula of an organic compound is given below: (2016)



It is a hydrocarbon. IUPAC name of the compound is:

(a) 3, 3-dimethyl-3-hexene

(b) 3, 4-dimethyl-3-hexene

(c) 3-hexene

(d) 2,3-dimethyl-1-hexene

12. Which one of the following pairs can be cis-trans isomer to each other? (2016)

(a) $CHCl{=}CCl_2$ and $CH_2{=}CH_2$

(b) $CHCl{=}CH_2$ and $CH_2{=}CHCl$

(c) $CH_3CH{=}CHCH_3$ and $H_3CCH{=}CHCH_3$

(d) CH_3CH_3 and $CH_2{=}CH_2$

Answers:

1.	a	2.	C	3.	a	4.	d
5.	c	6.	B	7.	b	8.	a
9.	a	10.	c	11.	b	12.	c

★ ★ ★

2C

HYDROCARBONS

Multiple Choice Questions

Entry Test Questions:

1. Benzene in the presence of $AlCl_3$ produces acetophenone when reacts with: (2011)

(a) Acetyl chloride (b) Acetic acid

(c) Ethyl benzene (d) Ethanoic acid

2. The substitution of a '-H' by '$-NO_2$' group in benzene is called: (2011)

(a) Nitration (b) Ammonolusis

(c) Sulphonation

(b) Reduction of benzene

3. The introduction of $-\overset{O}{\overset{\|}{C}}-^+$ group in benzene is called: (2012)

(a) Acylation

(b) Carbonyl reduction

(c) Alkylation

(d) Formylation

4. In the reaction of ethane with bromine the intermediate formed is: (2012)

(a) H_3C-CH_2 with $Br^\bullet$

(b) $H_3C-CH_2^+$ with Br

(c) $H_3C-CH_2^+$ with Br

(d) $H_2C{=}CHBr$

5. The introduction of an alkyl group in benzene takes place in the presence of $AlCl_3$ and: (2013)

(a) $R-\overset{O}{\overset{\|}{C}}-OH$ (b) $R-Cl$

(c) $R-\overset{O}{\overset{\|}{C}}-Cl$ (d) $R-\overset{O}{\overset{\|}{C}}-O^-$

6. What is the product formed when propene reacts with HBr? (2013)

(a) $H_3C-CH_2-CH_2Br$

(b) $BrH_2C-CH{=}CH_2Br$

(c) $H_2C(Br)-CH(Br)-CH_3$

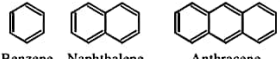
(d) $H_3C-CH(Br)-CH_3$

7. Addition of unsymmetrical reagent to an unsymmetrical alkene is governed by: (2014)
(a) Cannizzaro's Reaction
(b) Kirchhoff Rule
(c) Aldol Condensation
(d) Markownikov's Rule

8. Ethylene glycols are used as: (2014)
(a) Anesthetic
(b) Knocking agent
(c) Freezing agent
(d) Anti-freezing agent

9. Order of reactivity of alkenes with hydrogen halide is: (2015)
(a) HBr > HI > HCl
(b) HI > HBr > HF
(c) HF > HI > HCl
(d) HI > HBr > HCl

10. The given three hydrocarbons are: (2015)



Benzene Naphthalene Anthracene
(a) Alicyclic hydrocarbons
(b) Aromatic hydrocarbons
(c) Acyclic Hydrocarbons
(d) Heterocyclic hydrocarbons

11. Which one of the following reactions shows combustion of a saturated hydrocarbon? (2015)
(a) $C_2H_4 + 3O_2 \longrightarrow 2CO_2 + 2H_2O$
(b) $CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$
(c) $CH_4 + \frac{1}{2}O_2 \xrightarrow[400>C,\ 200\ atm]{Cu} CH_3OH$
(d) $C_2H_2 + \frac{5}{2} \longrightarrow 2CO_2 + H_2O$

12. The average bond energy of C-Br is:(2016)
(a) 228 $kJmol^{-1}$ (b) 200 $kJmol^{-1}$
(c) 250 $kJmol^{-1}$ (d) 290 $kJmol^{-1}$

Answers:

1.	**a**	**2.**	**a**	**3.**	**a**	**4.**	**a**
5.	**b**	**6.**	**d**	**7.**	**d**	**8.**	**d**
9.	**d**	**10.**	**b**	**11.**	**b**	**12.**	**d**

——★——★——★——

3C

ALKYL HALIDES

Multiple Choice Questions

Entry Test Questions:

1. When purely alcoholic solution of sodium/potassium hydroxide and halogenoalkanes are reacted an alkene is formed, what is the mechanism of reaction? (2011)
(a) Elimination (b) Dehydration
(c) Debromination
(d) Reduction of benzene

2. The organic compound carbon tetrachloride is used as: (2011)
(a) Lubricant (b) Solvent
(c) Oxidant (d) Plastic

3. The alkaline hydrolysis of bromoethane shown below gives alcohol as the product: (2012)

$H_3C—CH_2—Br \longrightarrow H_3C—CH_2—OH$

The reagent and the condition used in this reaction may be:
(a) H_2O at room temperature
(b) Ethanol, heat
(c) KOH in alcohol
(d) Dilute $NaOH_{(aq)}$ warm

4. In substitution reactions, dihaloalkane or secondary halogenoalkane give / show: (2012)
(a) S_N1 Mechanism
(b) S_N2 Mechanism
(c) Both E_1 and E_2
(d) Both S_N1 and S_N2

5. The order of reactivity of alkyl halides towards nucleophile is: (2013)
(a) RI > RBr > RF > RCl
(b) RI > RBr > RCl > RF
(c) RF > RCl > RBr > RI
(d) RF > RBr > RCl > RI

6. Consider the reaction given below:(2013)

Which statement is true?

(a) Reagent for I is KOH in alcohol
(b) Reagent for II is KOH in aqueous medium
(c) Reaction I is Debromination
(d) Reaction II is elimination

7. The halothane used in hospitals as an anesthetic is chemically: (2014)

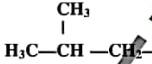
(a) 1-Bromo-1-chloro-2, 2, 2-trifluroethane
(b) 2-Bromo-2-chloro-1, 1, 1-trifluroethane
(c) 1, 1, 1-Triflouro-2-bromo-2-chloroethane
(d) 2-Chloro-2-bromo-1, 1, 1-triflouromoethane

8. If halogenoalkanes are mixed with an excess of ethanoic ammonia and heated under pressure, amine are formed. Which amine is formed in the following reaction? (2014)

$CH_2CH_3Br + NH_3 \longrightarrow$ Amine

(a) $CH_3—CH_2—NH—CH_2—CH_3$
(b) $CH_3—CH_2—NH_2$
(c) $CH_3—CH_2—CH_2—NH_2$
(d) $H_2N—CH_2—CH_2—NH_2$

9. The IUPAC name of the given compound is: (2015)



(a) 1-Chloro-2-methylpropane
(b) 1-Chloro-2-methylbutane
(c) Isobutyl chloride
(d) 2-Methyl-3-chloropropane

10. In the below reaction, the configuration of product is: (2015)

(a) 100% same of the configuration of reactant
(b) 50% retained
(c) 50% inverted
(d) 100% opposite from configuration of reactant

11. Consider the reaction given below:(2016)

$CH_3CH_2Br \xrightarrow[\text{alcohol}]{KOH} H_2C=CH_2+HBr$

Mechanism followed by the reaction is:

(a) E_2 (b) E_1
(c) S_N1 (d) S_N2

12. Which one of the following is NOT a nucleophile: (2016)

(a) NH_2^- (b) H_2O
(c) BF_3 (d) CH_3^-

Answers:

1.	a	2.	b	3.	d	4.	d
5.	b	6.	d	7.	b	8.	b
9.	a	10.	d	11.	a	12.	c

—★—★—★—

4C

ALCOHOLS AND PHENOLS

Multiple Choice Questions

Entry Test Questions:

1. An alcohol is converted to an aldehyde with same number of carbon atoms as that of alcohol in the presence of $K_2Cr_2O_7/H_2SO_4$ the alcohol is: (2011)

(a) $CH_3Cl(CH)_2OH$
(b) $CH_3CH_2CH_2OH$
(c) $(CH_3)_3COH$
(d) $(CH_3)_3CHOH$

2. Which of the following is a secondary alcohol? (2011)

(a) $H_3C—\underset{\displaystyle CH_3}{\underset{|}{CH}}—OH$
(b) $H_3C—CH_2—CH_2—OH$
(c) $H_3C—\underset{\displaystyle CH_3}{\underset{|}{CH}}—CH_2—OH$
(d) $H_3C—\underset{\displaystyle CH_3}{\underset{|}{CH}}—\underset{\displaystyle OH}{\underset{|}{\overset{\displaystyle CH_3}{\overset{|}{C}}}}—CH_3$

3. Which enzyme is involved in the fermentation of glucose: (2011)

(a) Zymase (b) Invertase

(c) Urease (d) Diastase

4. Relative acidic strength of alcohol, phenol, water and carboxylic acid is: (2011)

(a) Carboxylic acid > Alcohol > Phenol > Water

(b) Carboxylic acid > Phenol > Water > Alcohol

(c) Phenol > Carboxylic acid > Alcohol > Water

(d) Water > Alcohol > Phenol > Carboxylic acid

5. The dehydration of ethyl alcohol with concentrated H_2SO_4 at 140°C gives: (2012)

(a) Ethene (b) Diethyl ether

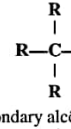
(c) Alcohol (d) Carboxylic acid

6. Ethanol can be converted in to ethanoic acid by: (2012)

(a) Oxidation (b) Fermentation

(c) Hydration (d) Hydrogenation

7. The following structure is of: (2012)



(a) Secondary alcohol

(b) Primary alcohol

(c) Tertiary alcohol

(d) Carboxylic acid

8. When ethanol is warmed with ethanoic acid in the presence of strong acid catalyst, an ester ethyl ethanoate is formed. (2012)

$CH_3CH_2OH + CH_3CO_2H \longrightarrow CH_3CO_2CH_2CH_3$

(a) Alcohol is reduced

(b) O-H bond in ethanoic acid is broken

(c) O-H bond in ethanol is broken

(d) Acid is oxidized

9. Consider the following reaction: (2013)

$C_2H_5OH + PCl_5 \longrightarrow ?$

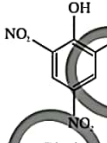
What product(s) may be formed?

(a) C_2H_5Cl only

(b) C_2H_5Cl and HCl

(c) C_2H_5Cl, $POCl_3$ and HCl

(d) C_2H_5Cl and $POCl_3$

10.  **is named as: (2013)**

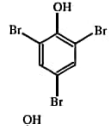
(a) Picric acid

(b) Nitro phenol

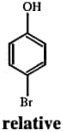
(c) Benzoic acid

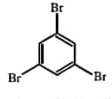
(d) Malonic acid

11. Aqueous phenol decolorizes bromine water to form a white precipitate. What is the structure of the white precipitate formed? (2013)

(a) 

(b) 

(c) 

(d) 

12. The relative strength of carboxylic acid, water, ethanol and phenol has the following order of increasing acid strength: (2013)

(a) Carboxylic Acid > Phenol > Ethanol > Water

(b) Carboxylic Acid > Phenol > Water > Ethanol

(c) Phenol > Carboxylic Acid > Ethanol > Water

(d) Water > Ethanol > Phenol > Carboxylic Acid

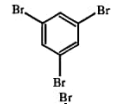
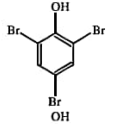
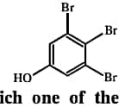
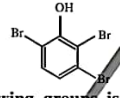
13. Primary, secondary and tertiary alcohols can be identified and distinguished by (2014)

(a) Lucas test
(b) Iodoform test
(c) Baeyer's test
(d) Silver mirror test

14. Which one of the following alcohol is indicated by formation of yellow crystals in Iodoform test? (2014)

(a) Methanol (b) Ethanol
(c) Butanol (d) Propanol

15. The formula of 2, 4, 6-tribromo phenol is: (2014)

(a) 
(b) 
(c) 
(d) 

16. Which one of the following groups is indicated when HCl is formed by reaction of ethanol with phosphorous pentachloride? (2014)

(a) Amino group
(b) Hydroxyl group
(c) Halide group
(d) Hydride group

17. Which one of the following was used as one of the earliest antiseptic and disinfectant? (2015)

(a) Phenol (b) Ether
(c) Ethanol (d) Methanol

18. Which one of the following is NOT able to denature the ethanol? (2015)

(a) Methanol (b) Lactic acid
(c) Pyridine (d) Acetone

19. How will you distinguish between methanol and ethanol? (2015)

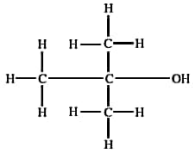
(a) By Lucas test
(b) By silver mirror test
(c) By oxidation
(d) By Iodoform test

20. To produce absolute alcohol (100%) from rectified spirit (95.6% alcohol), the remaining 4.4% water must be removed by a drying agent such as: (2015)

(a) Calcium oxide
(b) Calcium chloride
(c) Calcium carbonate
(d) Carbon monoxide

21. Which one of the following is an appropriate indication of positive iodoform test? (2016)

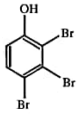
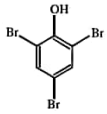
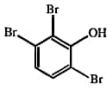
(a) Formation of H_2O
(b) Release of H_2 gas
(c) Brick red precipitate
(d) Yellow crystal

22. 

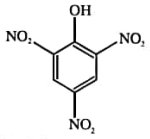
Which one of the following is the proper classification of above formula:

(a) Primary (b) Secondary
(c) Tertiary (d) Polyhydride

23. Which one of the following is an appropriate structure of product of bromination of phenol? (2016)

(a) 
(b) 
(c) 
(d) 

24.



Which one of the following is an appropriate name of above compound? (2016)

(a) 1,3,6-Trinitrophenol
(b) m-Nitrophenol
(c) Tartaric acid
(d) Picric acid

Answers:

1.	b	2.	a	3.	a	4.	b
5.	b	6.	a	7.	c	8.	c
9.	c	10.	a	11.	a	12.	b
13.	a	14.	b	15.	b	16.	b
17.	a	18.	b	19.	d	20.	a
21.	d	22.	c	23.	c	24.	d

★ ★ ★

5C

ALDEHYDES AND KETONES

Multiple Choice Questions

Entry Test Questions:

1. Consider the following reaction: (2011)

$$R\text{-}CHO + 2[Ag(NH_3)_2]OH \rightarrow R\text{-}COONH_4 + 2Ag + 2NH_3 + H_2O$$

This reaction represents one of the following tests.

(a) Fehling test (b) Benedict test
(c) Ninhydrin test (d) Tollens test

2. In the below reaction, the nucleophile is: (2011)

$$HCHO + HCN \longrightarrow H_2C(OH)\text{—}CN$$

(a) CN^- (b) HCl
(c) Cl (d) OH

3. Which one of the following compound belongs to the homologous series of aldehydes? (2011)

(a) $H\text{—}C(=O)\text{—}Cl$ (b) $H\text{—}C(=O)\text{—}NH_2$
(c) $H\text{—}C(=O)\text{—}H$ (d) $H\text{—}C(=O)\text{—}C_2H_5$

4. Formaldehyde reacts with HCN (NaCN+HCl) to give a compound: (2012)

(a) 
(b)
(c) 
(d) $H_3C\text{—}C(=O)\text{—}CN$

5. Iodoform test will not be positive with: (2012)

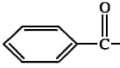
(a) $H_3C\text{—}CH_2\text{—}C(=O)\text{—}CH_2\text{—}CH_3$
(b) $H_3C\text{—}CH_2\text{—}C(=O)\text{—}CH_3$
(c) C_2H_5OH
(d) $H_3C\text{—}C(=O)\text{—}H$

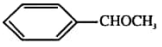
6. When CH_3CH_2OH is oxidized in the presence of $K_2Cr_2O_7$ and H_2SO_4, the product formed is: (2012)

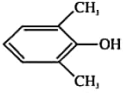
(a) $H_3C\text{—}C(=O)\text{—}OH$ (b) $H\text{—}C(=O)\text{—}OH$
(c) $H_3C\text{—}C(=O)\text{—}CH_3$ (d) $H_3C\text{—}C(=O)\text{—}OCH_3$

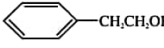
7. Which group gives a yellow precipitate of triiodo methane when warmed with alkaline aqueous iodine? (2013)

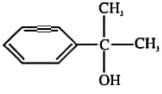
(a) An amide group, $H_3C\text{—}C(=O)\text{—}NH_2$
(b) Entyl Ketone group, $C_2H_5\text{—}C(=O)\text{—}R$
(c) A primary Alcohol group as in Propanol $CH_3\text{-}CH_2\text{-}CH_2\text{-}OH$
(d) Methyl Ketone group, $CH_3\text{—}C(=O)\text{—}R$

8. What is the structure of alcohol which on oxidation with acidified $Na_2Cr_2O_7$ gives  **:**

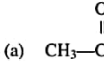
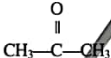
(a) 

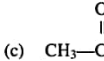
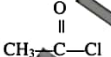
(b) 

(c) 

(d) 

9. Which of the following is the structure of ketone? (2013)

(a)  (b) 

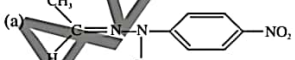
(c)  (d) 

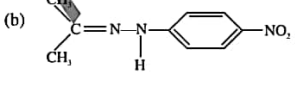
10. A student mixed ethyl alcohol with small amount of sodium dichromate and added it to the hot solution of dilute sulphuric acid. A vigorous reaction took place. He distilled the product formed immediately. What was the product? (2014)

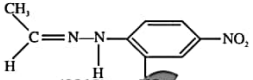
(a) Acetone (b) Acetic acid

(c) Dimethyl ether (d) Acetaldehyde

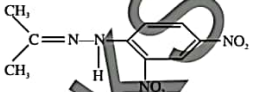
11. The structural formula of the product of reaction of acetone with 2, 4-dinitrophenyl hydrazine is: (2014)

(a) 

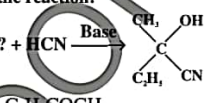
(b) 

(c) 

(2013)

(d) 

12. For the reaction: (2014)



(a) $C_2H_5COCH_3$

(b) $C_2H_5CH(CH_3)OH$

(c) CH_3COCH_3

(d) $C_2H_5CH_2CHO$

13. Which one of the following is also called silver mirror test? (2015)

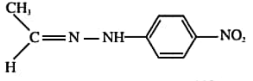
(a) Fehling's solution test

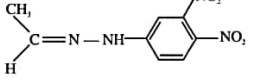
(b) Iodoform test

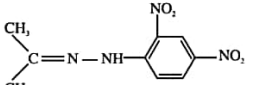
(c) Tollen's reagent

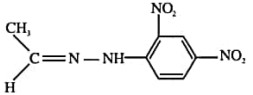
(d) Benedict's solution tests

14. When acetaldehyde reacts with 2,4-dinitrophenylhydrazine (2,4-DNPH), which one of the following products is formed? (2015)

(a) 

(b) 

(c) 

(d) 

15. Both aldehydes and ketones are planer to the neighborhoods of carbonyl (C=O) group. Which one of the following bonds is distorted towards the oxygen atoms? (2015)

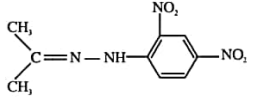
(a) π-bond of C and O

(b) Sigma bond of C and H

(c) Sigma bond of C and O

(d) Sigma bond of C and C

16. (2016)



It is the general formula of:

(a) 2, 4-Dinitrophenyl hydrazine

(b) 1, 3-Dinitrophenyl hydrazone

(c) Phenyl hydrazone

(d) 2, 4-Dinitrophenyl hydrazone

17.  **(2016)**

Which one of the following is the IUPAC name of above given structure:

(a) Propionaldehyde

(b) Methanone

(c) Acetaldehyde

(d) Methanal

18. Which one of the following test is given by both aldehyde and ketone? (2016)

(a) Silver mirror test

(b) Fehling's solution test

(c) 2, 4 DNPH test

(d) Benedict's solution test

Answers:

1.	d	2.	a	3.	c	4.	b
5.	a	6.	a	7.	d	8.	a
9.	b	10.	d	11.	d	12.	a
13.	c	14.	d	15.	a	16.	d
17.	d	18.	c				

★ ★ ★

6C

CARBOXYLIC ACIDS

Multiple Choice Questions

Entry Test Questions:

1. $CH_3COOH + PCl_5 \longrightarrow$? (2011)

The products of the above reaction are:

(a) $CH_3COI + POCl_3 + HCl$

(b) $CH_3COI + POCl_2 + HCl$

(c) $CH_3Cl + POCl_3 + HCl$

(d) $CH_3COCl + POCl_3 + H_2$

2. $CH_3CN + HCl \longrightarrow A + B$ (in the presence of water) (2011)

In the above reaction, A and B are:

(a) Acetic acid and acid amide

(b) Acetic acid and ammonia

(c) Acetic acid and methyl chloride

(d) Acetic acid and ammonium chloride

3. Consider the following reaction: (2011)

$CH_3COOH + Mg$ (metal) $\longrightarrow$?

What product will form?

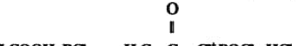
(a) Magnesium formate

(b) Magnesium acetate

(c) Magnesium ion

(d) Carboxylate ion

4. In the below reaction the nucleophile which attacks on the carbon atom of acid is: (2012)



(a) OH– (b) P

(c) Cl– (d) H–

5. When ethanol chloride reacts with methylamine, an amide is formed. What is the structure of the amide formed? (2012)

(a) $H_3C—CH_2—\overset{\overset{O}{\|}}{C}—NH_2$

(b) $H_3C—CH_2—\overset{\overset{O}{\|}}{C}—NHCH_3$

(c) $H_3C—\overset{\overset{O}{\|}}{C}—NH_2$

(d) $H_3C—\overset{\overset{O}{\|}}{C}—NHCH_3$

6. Primary alcohols normally give us aldehydes when oxidized in the presence of $Na_2Cr_2O_7$, what the product will be, when the secondary alcohols are oxidized in same conditions? (2012)

(a) Alkenes (b) Alkynes
(c) Alkyl halides (d) Ketones

7. The formation of ester from acetic acid in presence of acid and ethanol is a:(2013)

(a) Nucleophilic substitution reaction
(b) Nucleophilic addition reaction
(c) Electrophilic substitution reaction
(d) Electrophilic addition reaction

8. Methyl cyanides, on boiling with mineral acids or alkalis yield: (2013)

(a) Acetic acid (b) Formic acid
(c) Propanoic acid (d) Butanoic acid

9. $CH_3—\overset{\overset{O}{\|}}{C}—OH + NH_3 \xrightarrow{\text{heat}} ?$ **(2013)**

The final products formed are:

(a) $CH_3—\overset{\overset{O}{\|}}{C}—NH_2 + CO_2$

(b) $CH_3—\overset{\overset{O}{\|}}{C}—NH_2 + H_2O$

(c) $CH_3—\overset{\overset{O}{\|}}{C}—NH_2 + H_2$

(d) $CH_3—\overset{\overset{O}{\|}}{C}—NH_2 + HCl$

10. Ethyl butyrate and butyl butanoate are esters with the flavor of : (2014)

(a) Pear (b) Banana
(c) Pineapple (d) Apple

11. Acetamide is formed by dehydration of: (2014)

(a) Oxalic acid
(b) Ethanoic acid
(c) Butanoic acid
(d) Propanoic acid

12. Organic compounds 'X' and 'Y' both can react with Na-Metal to evolve hydrogen gas. If 'X' and 'Y' react with each other form an organic compound 'Z' which gives fruity smell. What type of compound 'X', 'Y' and 'Z' are?(2014)

	X	Y	Z
a)	Alcohol	Ester	Acetic
b)	Alcohol	Ester	Mineral
c)	Alcohol	Acetic	Ester
d)	Alcohol	Mineral	Ester

13. Ka' values of few organic acids are given: (2015)

Acid	Ka Value
CH_3COOH	1.85×10^{-5}
CCl_3COOH	2.3×10^{-2}
$CHCl_2COO$	5.0×10^{-3}
CH_2ClCOO	1.3×10^{-3}

The order of acid strength is:

(a) $CCl_3COOH > CHCl_2COOH > CH_2ClCOOH > CH_3COOH$

(b) $CH_3COOH > CHCl_2COOH > CCl_3COOH > CH_2ClCOOH$

(c) $CHCl_2COOH > CH_3COOH > CCl_3COOH > CH_2ClCOOH$

(d) $CCl_3COOH > CH_3COOH > CHCl_2COOH > CH_2ClCOOH$

14. An organic acid 'z' reacts separately with sodium bicarbonate, sodium hydroxide and sodium carbonate. Which one of the following represent the structure of 'z'? (2015)

(a) $HCOOC_2H_5$

(b) $CH_3—CH=CH_2$

(c) CH_3CH_2OH

(d) $H_3C—CH_2—COOH$

15. **Carboxylic acids are rather hard to reduce, which powerful reducing agent can be used to convert them to the corresponding primary alcohol: (2015)**

(a) $H_2SO_4/HgSO_4$

(b) V_2O_5

(c) $LiAlH_4$

(d) $K_2Cr_2O_7/H_2SO_4$

16. $CH_3COOH + CH_3CH_2OH \rightleftharpoons$

$CH_3COOC_2H_5 + H_2O$ **(2016)**

Which one of the following will act as a catalyst in above reaction?

(a) HNO_3 (b) H_2SO_4

(c) Acidified potassium dichromate

(d) $SOCl_2$

17. $CH_3COOH + PCl_5 \longrightarrow ?$ **(2016)**

Which one of the following options shows the products of above reaction?

(a) $POCl_2 + CH_3COCl_2 + HCl$

(b) $CH_3COCl + POCl_2 + HCl$

(c) $POCl_3 + CH_3COCl_2 + H_2$

(d) $POCl_3 + CH_3COCl + HCl$

18. **Which one of the following reaction of carboxylic acid is reversible? (2016)**

(a) Esterification

(b) Salt formation

(c) Reaction with PCl_5

(d) Reaction with $SOCl_2$

Answers:

1.	a	2.	d	3.	b	4.	c
5.	d	6.	d	7.	a	8.	a
9.	b	10.	c	11.	b	12.	c
13.	a	14.	d	15.	c	16.	b
17.	d	18.	a				

——★——★——★——

7C

AMINO ACIDS

Multiple Choice Questions

Entry Test Questions:

1. **The —NH—CO is called: (2011)**

(a) Amide group (b) Amino group

(c) Protein linkage (d) Peptide linkage

2. **Which one of the following is an alpha amino acid? (2011)**

(a) $H_3C—\underset{\underset{NH_2}{|}}{\underset{\underset{H}{|}}{CH}}—COOH$

(b) $H_3C—\underset{\underset{H_3C—NH_2}{|}}{C}—COOH$

(c) $H_3C—\underset{\underset{NH_2}{|}}{\underset{\underset{H}{|}}{CH}}—CH_2—COOH$

(d) $H_3C—\underset{\underset{HOOC}{|}}{C}—\underset{\underset{NH_2}{|}}{CH}—CH_3$

3. **Which of the following has an amino R-group? (2011)**

(a) Lysine (b) Proline

(c) Valine (d) Alanine

4. **At intermediate value of pH, amino acids form Zwitter ions containing: (2011)**

(a) $—N^+H_3$ and $COO—$

(b) $—NH_3$ and $COO—$

(c) $—N^+H_3$ and $COOH$

(d) $—NH_3$ and $COOH$

5. **A polymer in which the number of amino acid residue is greater than 100 or molecular mass is greater than 1000, is known as: (2011)**

(a) Protein (b) Polypeptide

(c) Dipeptide (d) Tripeptide

6. Aspartic acid is an acidic amino acid, which has chemical formula: (2011)

(a) $H_3C-\underset{NH_2}{\underset{|}{CH}}-COOH$

(b) $H_2N-\overset{H}{\overset{|}{\underset{H_2C-COOH}{\underset{|}{C}}}}-COOH$

(c) $H_3C-\underset{NH_2}{\underset{|}{CH}}-CH_2-COOH$

(d) $H_3C-\overset{H}{\overset{|}{\underset{H}{\underset{|}{C}}}}-\underset{NH_2}{\underset{|}{CH}}-COOH$

7. Organic compound containing both amine and carboxyl group is known as (2012)

(a) Amino acid (b) Fatty acid
(c) Saccharide (d) Amide

8. Alanine is an amino acid which shows neutral effect on litmus paper, the formula of alanine may be: (2012)

(a) $H_2N-\overset{H}{\overset{|}{\underset{CH_3}{\underset{|}{C}}}}-COOH$

(b) $H_2N-\overset{H}{\overset{|}{\underset{H}{\underset{|}{C}}}}-\underset{NH_2}{\underset{|}{CH}}-COOH$

(c) $HOOC-CH_2-\underset{NH_2}{\underset{|}{CH}}-COOH$

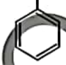
(d) $\underset{NH_2}{\underset{|}{H_2C}}-(CH_2)_3-\underset{NH_2}{\underset{|}{CH}}-COOH$

9. Which of the following structures is not an alpha amino acid? (2012)

(a) $H_3C-\underset{NH_2}{\underset{|}{CH}}-COOH$

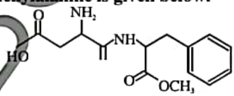
(b) $H_2N-CH_2-CH_2-CH_2-CH_2-COOH$

(c) $H_2N-\underset{CH_2}{\underset{|}{CH}}-COOH$



(d) $H_2N-\underset{CH_2OH}{\underset{|}{CH}}-COOH$

10. The skeletal formula of dipeptide formed between aspartic acid and phenylalanine is given below: (2012)



How many functional groups are present in its formula?

(a) 1 (b) 2
(c) 4 (d) 3

11. In basic conditions, amino acid exists in which of the following forms? (2012)

(a) $H_3N^+-CH_2-COOH$
(b) H_2N-CH_2-COOH
(c) $H_3N^+-CH_2-COO^-$
(d) $H_2N-CH_2-COO^-$

12. In basic conditions, amino acid exists in which of the following forms? (2012)

$$H_2N-CH_2-\overset{O}{\overset{||}{C}}-NH-\underset{CH_3}{\underset{|}{CH}}-COOH$$

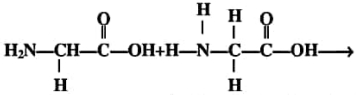
This is called:

(a) Glycyl glycine (b) Glycyl alanine
(b) Alaninyl alanine (c) Alaninyl glycine

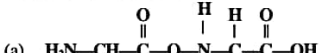
13. The amino acids which largely exist in dipolar ionic form are: (2013)

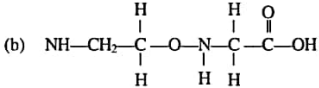
(a) Acidic amino acids
(b) Basic amino acids
(c) Beta amino acids
(d) Alpha amino acids

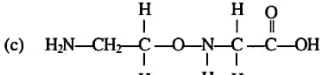
14. The reaction: (2013)

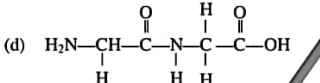


Gives a product called dipeptide molecule represented by:

(a) 

(b) 

(c) 

(d) 

15. Two or more amino acids condensed to form protein by a peptide linkage which is resent between two atoms: (2013)

(a) C and C (b) O and C

(c) C and N (d) C and H

16. α-amino acids are compounds having carboxylic acid as well as amino functional groups attached to: (2013)

(a) Any H-atom in the molecule

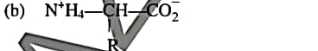
(b) Same carbon atom

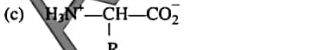
(c) Alternate carbon atoms

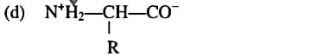
(d) Neighboring carbon atoms

17. The formula of 'Zwitter ion' is represented by: (2013)

(a) 

(b) 

(c) 

(d) 

18. What is the name of amino acid, 'R' is CH_3 group?

(a) Glycine (b) Lysine

(c) Aspartic acid (d) Alanine

19. The amino acids which are not prepared in human body are called : (2014)

(a) Essential amino acids

(b) Non-essential amino acids

(c) Alpha amino acids

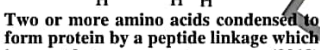
(d) Beta amino acids

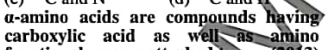
20. Indicate the cyclic amino acid from the following: (2014)

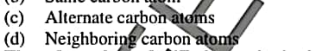
(a) Cysteine (b) Serine

(c) Haloamine (d) Proline

21. Which one of the following is Glutamic Acid? (2014)

(a) 

(b) 

(c) 

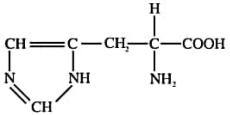
(d)

22. At low pH or in acidic condition amino acid exists as (2014)

(a) Anion (b) Cation

(c) Zwitter ion (d) Neutral specie

23. The structure shown below represents: (2014)

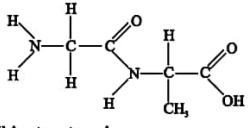


(a) Proline (b) Histidine
(c) Glycine (d) Lysine

24. Which one of the following reagent is used for identification of amino acids? (2014)

(a) Fehling's solution
(b) Benedict's solution
(c) Ninhydrin
(d) Copper (II) Sulphate

25. (2015)



This structure is

(a) Gly-Ala (dipeptide)
(b) Asp-Gly (dipeptide)
(c) Gly-Val (dipeptide)
(d) Asp-Val (dipeptide)

26. Which one of the following amino acids is basic in nature? (2015)

(a) Glycine (b) Alanine
(c) Lysine (d) Glutamic acid

27. Which one of the following structures shows the correct formula of glutamic acid? (2015)

(a) $H_2N-CH(COOH)-(CH_2)_2-COOH$

(b) $H_2N-CH(COOH)-COOH$

(c) $H_2N-CH(CH_3)-COOH$

(d) $H_2N-CH(COOH)-COOH$

28. Select the correct Zwitter ionic structures of an amino acid. (2015)

(a) $R^+-CH(NH_2)-COOH$

(b) $H_2N^+-CH(R)-COO^-$

(c) $H_2N^+-CH_2-COO^-$

(d) $H_3N^+-CH(R^+)-COO^-$

29. The structural formula for alanine is: (2015)

(a) $H_3C-CH(NH_2)-COOH$

(b) $H-CH(NH_2)-COOH$

(c) $HO-CH_2-CH(NH_2)-COOH$

(d) $H_3C-CH(NH_2)-COOH$

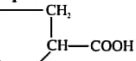
30. In $\overset{4}{C}H_3-\overset{3}{C}(CH_3CH_3)-\overset{2}{C}H_2-\overset{1}{C}OOH$ which one is α-carbon atom? (2015)

(a) 1 (b) 3
(c) 2 (d) 4

31. In the formation of Zwitter ion which one of the following donates the proton? (2016)

(a) COOH (b) NH_2
(c) CH_2COO^- (d) OH^-

32. Which one of the following is structural formula of proline? (2016)

(a) 

(b) $H_3C-HC(CH_3)-CH(NH_2)-COOH$

(c) $H_3C-CH(NH_2)-CH_2-COOH$

(d) NH_2

33. $HOOC-CH_2-CH_2-CH(NH_2)-COOH$

(2016)

What is the name of above given structural formula?

(a) Aspartic Acid (b) Asparagine
(c) Adipic Acid (d) Glutamic Acid

34. Which one of the following is simplest amino acid? (2016)

(a) Lysine (b) Leucine
(c) Alanine (d) Glycine

35. $R-CH(NH_3^+)-COO^-$ **(2016)**

Select the best option indicating the name of the above structure:

(a) Cation
(b) Neutral amino acid
(c) Internal salt (d) Anion

36. When acid is added to an amino acid, which one of the following will act as a base? (2016)

(a) NH_3^+ (b) COO^-
(c) H^+ (d) R group

Answers:

1.	d	2.	a	3.	a	4.	a
5.	a	6.	b	7.	a	8.	a
9.	b	10.	c	11.	d	12.	b
13.	d	14.	b	15.	c	16.	b
17.	a	18.	d	19.	a	20.	d
21.	a	22.	b	23.	b	24.	c
25.	a	26.	c	27.	b	28.	b
29.	d	30.	c	31.	a	32.	a
33.	a	34.	d	35.	c	36.	b

★ ★ ★

8C

MACROMOLECULES

Multiple Choice Questions

Entry Test Questions:

1. When hexane dioic acid is heated with hexamethylene diamine, the compound formed is: (2011)

(a) Polypeptide
(b) Addition polymer
(c) Ester
(d) Nylon 6,6

2. Glucose and fructose are common examples of: (2011)

(a) Pentoses (b) Hexoses
(c) Heptoses (d) Butoses

3. The reaction between fats and caustic soda is called: (2011)

(a) Hydrogenolysis
(b) Fermentation
(c) Carboxylation
(d) Saponification

4. Macromolecules are described as large molecules built up from small repeating units known as: (2011)

(a) Monomers (b) Isomers
(c) Metameres (d) Tautomer

5. Polyvinyl chloride is an example of:(2011)

(a) Addition polymer
(b) Condensation polymer
(c) Biopolymer
(d) Thermosetting polymer

6. Terylene, a polyester is an example of: (2011)

(a) Biopolymer (b) Lipids
(c) Condensation polymer
(d) Addition polymer

7. The principle energy storage carbohydrate in animal's is (2012)
(a) Glucose (b) Starch
(c) Protein (d) Glycogen

8. Starch is a polymer of (2012)
(a) β–D–glucose
(b) α– –glucose
(c) γ–D–glucose
(d) α–L–glucose

9. The reaction between fats and caustic soda is called: (2012)
(a) Hydrogenolysis
(b) Fermentation
(c) Esterification
(d) Saponification

10. Adipic acid and hexamethylene diamine both of which have _____ carbon atoms: (2012)
(a) Seven (b) Eight
(c) Six (d) Four

11. Lactose is a sugar present in milk. It is an example of: (2012)
(a) Disaccharides
(b) Monosaccharides
(c) Polysaccharides
(d) Starch

12. Macromolecules are described as large molecules built up from small repeating units called: (2012)
(a) Monomers (b) Isomers
(c) Metamers (d) Tautomers

13. Polyvinyl acetate (PVA) is colourless and non-toxic resin used as an adhesive and as a binder for making: (2013)
(a) Toys
(b) Gramophone recorders
(c) Compact discs
(d) Emulsion pains

14. Both ribose and deoxyribose are monosaccharides containing____carbon atoms. (2013)
(a) Four (b) Six
(c) Five (d) Seven

15. The increased quantities of cholesterol in blood make plaque like deposits in the arteries causing: (2013)
(a) Cholera
(b) Down's syndrome
(c) Heart attack
(d) Phenylketonuria

16. Polyvinyl chloride is an example of: (2013)
(a) Condensation polymer
(b) Addition polymer
(c) Biopolymer
(d) Thermosetting polymer

17. Collagen is a fibrous protein present most abundantly in: (2013)
(a) Hair (b) Nail
(c) Tendons (d) Arteries

18. Animals store glucose in the form of glycogen in: (2013)
(a) Stomach (b) Mouth
(c) Liver and muscles
(d) Small intestine

19. Which one of the following is an example of condensation polymer?(2014)
(a) Polyvinylchloride
(b) Polystyrene
(c) Polyethene
(d) Polyamide

20. Among the most common disaccharides, which one of the followings is present in the milk? (2014)
(a) Sucrose (b) Maltose
(c) Fructose (d) Lactose

21. Fats are a type of lipid called glycerides. They are esters of long chain carboxylic acids: (2014)
(a) Propene-1, 2, 3-triol
(b) Propane-1, 2, 3-triol
(c) Propene-1, 2, 3-diol
(d) Propane-1, 2, 3-diol

22. Which one of the following base is NOT present in RNA? (2014)
(a) Cytosine (b) Adenine
(c) Thymine (d) Guanine

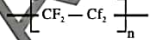
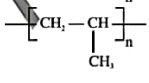
23. Collagen proteins are present in _____ throughout the body: (2014)
(a) Muscle
(b) Red blood cells
(c) Tendons
(d) Blood plasma

24. Polystyrene is an addition polymer. Which one of the following structures represents the monomer of polystyrene? (2014)
(a) $CH_2 = CH_2$
(b) $CH_2 \equiv CH - CH_3$
(c) $CH_2 = CH - Cl$
(d) $CH_2 = CH - C_6H_5$

25. The specific substances (metabolite) that fits on the enzyme surface and is converted to products is called (2015)
(a) Co-factor
(b) Prosthetic group
(c) Isoenzyme
(d) Substrate

26. Polymide is formed due to the condensation od hexane-dioic acid with : (2015)
(a) Hexane-1,5-diamine
(b) Hexane-1,6-diamine
(c) Hexane-1,4-diamine
(d) Hexane-2,5-diamine

27. Haemoglobin is a: (2015)
(a) Genetic protein
(b) Building protein
(c) Transport protein
(d) Structural protein

28. Which one of the following polymer is polystyrene? (2015)
(a) 
(b) 
(c) 
(d) 

29. Out of these which nitrogen base is NOT present in DNA? (2015)
(a) Adenine (b) Guanine
(c) Uracil (d) Thymine

30. Which one of the following is an example of co-polymer? (2015)
(a) Polyamide
(b) Polystyrene
(c) Polyvinyl acetate
(d) Polyvinyl chloride

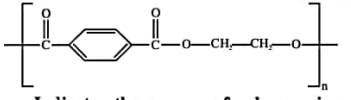
31. Which one of the following polymer is called as Nylon 6,6? (2016)
(a) Polyester
(b) Polyvinyl chloride
(c) Polyamide
(d) Polyvinyl acetate

32. Which one of the following is an exact composition of a carbohydrates? (2016)
(a) Carbon and Hydrogen
(b) Carbon and Oxygen
(c) Carbon, Hydrogen and Oxygen
(d) Hydrogen and Oxygen

33. Which one of the following nitrogen base is NOT present in DNA? (2016)
(a) Adenine (b) Guanine
(c) Uracil (d) Cytosine

34. In the woody parts of trees, the % age of cellulose is: (2016)
(a) 50% (b) 10%
(c) 30% (d) 100%

35. In laboratory experiment an unknown compound was added in test tube containing iodine, the colour became intense blue. What could be the unknown compound? (2016)
(a) Cellulose (b) Raffinose
(c) Ribose (d) Starch

36. (2016)


Indicate the name of above given structure.
(a) Nylon 6,6 (b) Adipic Acid
(c) PVA (d) Polyester

Answers:

1.	d	2.	b	3.	d	4.	a
5.	a	6.	c	7.	d	8.	b
9.	d	10.	c	11.	a	12.	a
13.	d	14.	c	15.	c	16.	b
17.	c	18.	c	19.	d	20.	d
21.	b	22.	c	23.	c	24.	d
25.	d	26.	b	27.	c	28.	a
29.	c	30.	a	31.	c	32.	c
33.	c	34.	d	35.	d	36.	d

★ ★ ★

9C

ENVIRONMENTAL CHEMISTRY

Multiple Choice Questions

Entry Test Questions:

1. **The suspected liver carcinogen which also has negative reproduction and developmental effect on humans is: (2011)**
   (a) Iodoform
   (b) Bromoform
   (c) Tropoform
   (e) Chloroform
2. **Peroxyacetyl nitrate is an irritant to human beings and it effects: (2011)**
   (a) Nose (b) Stomach
   (c) Ears (d) Eyes
3. **The increase in concentration of oxidizing agents in smog like H_2O_2, HNO_3, PAN and ozone in the air is called (2012)**
   (a) Carbonated smog
   (b) Nitrated smog
   (c) Photochemical smog
   (d) Sulphonated smog
4. **Which is the metal, whose elevated concentration is harmful for fish as it clogs the gills thus causing suffocation? (2012)**
   (a) Sodium (b) Lead
   (c) Zinc (d) Aluminium
5. **Aerobic decomposition of organic matter i.e. glucose by bacteria in water sediments produces: (2013)**
   (a) Propene (b) Ethane
   (c) Methane (d) Butane
6. **The yellowish-brown color in photochemical smog is due to the presence of: (2013)**
   (a) Sulphur dioxide
   (b) Carbon monoxide
   (c) Carbon dioxide
   (d) Nitrogen dioxide
7. **_____ is an eye irritant. (2014)**
   (a) Peroxyacetyl nitrate
   (b) Peroxyacetyl nitrite
   (c) Peroxymethoxy aniline
   (d) Peroxyacetyl aniline
8. **Which one of the following pollutants can cause death of a person by binding with haemoglobin of red blood cells? (2014)**
   (a) Chlorofluorocarbons
   (b) Oxides of Sulphur
   (c) Carbon monoxide
   (d) Oxides of nitrogen
9. **The biggest source of acid rain is the oxide of: (2015)**
   (a) N (b) S
   (c) O (d) C
10. **Burning of which one of the following waste is considered as useful industrial fuel or to produce electricity (2015)**
    (a) Metals (b) Grass
    (c) Paper (d) Plastic
11. **Ozone concentration is measured in: (2016)**
    (a) Debye units (b) Dupont units
    (c) Debacle units (d) Dobson units
12. **The gas which is mainly produced in landfills from the waste is: (2015)**
    (a) CH_4 (b) CO_2
    (c) SO_2 (d) Cl_2

Answers:

1.	d	2.	d	3.	c	4.	d
5.	c	6.	d	7.	a	8.	c
9.	b	10.	d	11.	d	12.	a

★ ★ ★