CHEMISTRY

SECTION - A

Multiple Choice Questions: This section contains 20 multiple choice questions. Each question has 4 choices (1), (2), (3) and (4), out of which **ONLY ONE** is correct.

Choose the correct answer :

1. Given below are two statements : one is labelled as **Assertion (A)** and the other is labelled as **Reason (R).**

   Assertion (A) : At 10°C, the density of a 5 M solution of KCl [atomic masses of K & Cl are 39 & 35.5 g mol^{-1} respectively], is 'x' g ml^{-1}. The solution is cooled to –21°C. The molality of the solution will remain unchanged.

   Reason (R) : The molality of a solution does not change with temperature as mass remains unaffected with temperature.

   In the light of the above statements, choose the **correct** answer from the options given below.

   (A) Both **(A)** and **(R)** are true and **(R)** is the correct explanation of **(A)**.

   (B) Both **(A)** and **(R)** are true but **(R)** is not the correct explanation of **(A)**.

   (C) **(A)** is true but **(R)** is false.

   (D) **(A)** is false but **(R)** is true.

Answer (A)

Sol. Density = 'x' gm ml^{-1}

$$\therefore \text{ molality, } m = \frac{5 \times 1000}{[x(1000) - 372.5]} = 7.96$$

$\simeq 8$ m (Assuming x = 1)

$\therefore \Delta T_f = iK_f m$

Assuming complete dissociation of salt (100%)

(i = 2)

$\Delta T_f = 2 \times 1.86 \times 8 \simeq 29.76$

Hence, the solution does not freeze at –21°C. This means that molality of the solution won't change as $x \geq 1$.

Statement (II) is also correct as molality is mass dependent and hence, does not change with temperature. However, as solvents are not mentioned, statement (I) can also be incorrect.

2. Based upon VSEPR theory, match the shape (geometry) of the molecules in **List-I** with the molecules in **List-II** and select the **most appropriate** option.

List-I (Shape)	**List-II (Molecules)**
(A) T-shaped	(I) XeF_4
(B) Trigonal planar	(II) SF_4
(C) Square planar	(III) ClF_3
(D) See-saw	(IV) BF_3

(A) (A)-(I), (B)-(II), (C)-(III), (D)-(IV)

(B) (A)-(III), (B)-(IV), (C)-(I), (D)-(II)

(C) (A)-(III), (B)-(IV), (C)-(II), (D)-(I)

(D) (A)-(IV), (B)-(III), (C)-(I), (D)-(II)

Answer (B)

Sol.

(Shape)	**(Molecules)**
(A) T-shaped	(III) ClF_3
(B) Trigonal planar	(IV) BF_3
(C) Square planar	(I) XeF_4
(D) See-saw	(II) SF_4

Hence, (B) is the correct option.

3. Match **List-I** with **List-II**

List-I

(A) Spontaneous process

(B) Process with $\Delta P = 0$, $\Delta T = 0$

(C) $\Delta H_{reaction}$

(D) Exothermic Process

List-II

(I) $\Delta H < 0$

(II) $\Delta G_{T,P} < 0$

(III) Isothermal and isobaric process

(IV) [Bond energies of molecules in reactants] – [Bond energies of product molecules]

Choose the **correct** answer from the options given below :

(A) (A)-(III), (B)-(II), (C)-(IV), (D)-(I)

(B) (A)-(II), (B)-(III), (C)-(IV), (D)-(I)

(C) (A)-(II), (B)-(III), (C)-(I), (D)-(IV)

(D) (A)-(II), (B)-(I), (C)-(III), (D)-(IV)

Answer (B)

Sol. Correct match is

(A) Spontaneous process	(II) $\Delta G_{T,P} < 0$ (Constant temperature and pressure condition)
(B) Process with $\Delta P = 0, \Delta T = 0$	(III) Isothermal and isobaric process
(C) $\Delta H_{reaction}$	(IV) [Bond energies of molecules in reactants – bond energies of product molecules]
(D) Exothermic process	(I) $\Delta H < 0$

Hence, the correct option is (B).

4. Match **List-I** with **List-II**

List-I	**List-II**
(A) Lyophilic colloid	(I) Liquid-liquid colloid
(B) Emulsion	(II) Protective colloid
(C) Positively charged colloid	(III) $FeCl_3$ + NaOH
(D) Negatively charged colloid	(IV) $FeCl_3$ + hot water

Choose the **correct** answer from the options given below :

(A) (A)-(II), (B)-(I), (C)-(IV), (D)-(III)

(B) (A)-(III), (B)-(I), (C)-(IV), (D)-(II)

(C) (A)-(II), (B)-(I), (C)-(III), (D)-(IV)

(D) (A)-(III), (B)-(II), (C)-(I), (D)-(IV)

Answer (A)

Sol. Correct match of List-I and List-II is:

(A) Lyophilic colloid	(II) Protective colloid
(B) Emulsion	(I) Liquid-liquid colloid
(C) Positively charged colloid	(IV) $FeCl_3$ + hot water (It forms a positively charged sol of $Fe(OH)_3$)
(D) Negatively charged colloid	(III) $FeCl_3$ + NaOH (Negatively charged colloid is formed due to adsorption of OH^- ions on $Fe(OH)_3$)

Hence, the correct option is (A).

5. Given below are two statements : one is labelled as **Assertion (A)** and the other is labelled as **Reason (R).**

Assertion (A) : The ionic radii of O^{2-} and Mg^{2+} are same.

Reason (R) : Both O^{2-} and Mg^{2+} are isoelectronic species.

In the light of the above statements, choose the **correct** answer from the options given below.

(A) Both **(A)** and **(R)** are true and **(R)** is the correct explanation of **(A)**.

(B) Both **(A)** and **(R)** are true but **(R)** is not the correct explanation of **(A)**.

(C) **(A)** is true but **(R)** is false.

(D) **(A)** is false but **(R)** is true.

Answer (D)

Sol. Correct order of ionic radii:

$$O^{-2} > Mg^{+2}$$

This is because among isoelectronic species, the size of anions are greater than the size of cations. Statement (II) is correct as both O^{-2} and Mg^{+2} are isoelectronic.

6. Match **List-I** with **List-II.**

List-I	**List-II**
(A) Concentration of Gold ore	(I) Aniline
(B) Leaching of alumina	(II) NaOH
(C) Froth stabiliser	(III) SO_2
(D) Blister copper	(IV) NaCN

Choose the **correct** answer from the options given below.

(A) (A)-(IV), (B)-(III), (C)-(II), (D)-(I)

(B) (A)-(IV), (B)-(II), (C)-(I), (D)-(III)

(C) (A)-(III), (B)-(II), (C)-(I), (D)-(IV)

(D) (A)-(II), (B)-(IV), (C)-(III), (D)-(I)

Answer (B)

Sol.

	List-I		List-II
(A)	Concentration of Gold ore	(IV)	NaCN
(B)	Leaching of alumina	(II)	NaOH
(C)	Froth stabiliser	(I)	Aniline (Aniline and cresols are used as froth stabilisers in froth floatation process)
(D)	Blister copper	(III)	SO_2 (During self reduction process used in the formation of blister copper SO_2 gas is evolved)

Hence (B) is most appropriate option.

7. Addition of H_2SO_4 to BaO_2 produces:

(A) BaO, SO_2 and H_2O

(B) $BaHSO_4$ and O_2

(C) $BaSO_4$, H_2 and O_2

(D) $BaSO_4$ and H_2O_2

Answer (D)

Sol. $BaO_2 \cdot 8H_2O + H_2SO_4 \rightarrow BaSO_4 + H_2O_2 + H_2O$

Hence, the correct option is (D)

8. $BeCl_2$ reacts with $LiAlH_4$ to give:

(A) Be + $Li[AlCl_4]$ + H_2

(B) Be + AlH_3 + LiCl + HCl

(C) BeH_2 + LiCl + $AlCl_3$

(D) BeH_2 + $Li[AlCl_4]$

Answer (C)

Sol. $BeCl_2 + LiAlH_4 \rightarrow BeH_2 + LiCl + AlCl_3$

The above reaction using $LiAlH_4$ is an important preparation method for production of hydrides.

9. Match **List-I** with **List-II.**

List-I (Si-Compounds)	List-II (Si-Polymeric/other Products)
(A) $(CH_3)_4Si$	(I) Chain Silicone
(B) $(CH_3)Si(OH)_3$	(II) Dimeric Silicone
(C) $(CH_3)_2Si(OH)_2$	(III) Silane
(D) $(CH_3)_3Si(OH)$	(IV) 2D-Silicone

Choose the **correct** answer from the options given below:

(A) (A)-(III), (B)-(II), (C)-(I), (D)-(IV)

(B) (A)-(IV), (B)-(I), (C)-(II), (D)-(III)

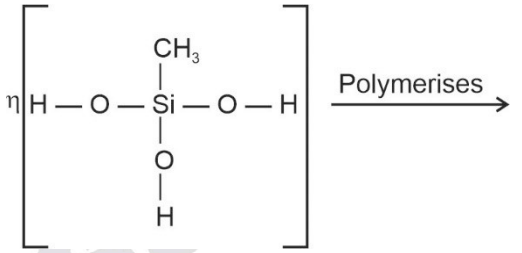
(C) (A)-(II), (B)-(I), (C)-(IV), (D)-(III)

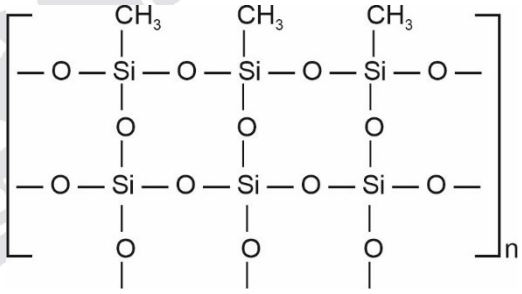
(D) (A)-(III), (B)-(IV), (C)-(I), (D)-(II)

Answer (D)

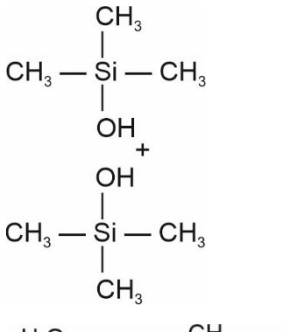
Sol.

List-I (Si-Compounds)	List-II (Si-Polymeric/other Products)
(A) $(CH_3)_4Si$	(III) Silane
(B) $(CH_3)Si(OH)_3$	(IV) 2D-Silicone
(C) $(CH_3)_2Si(OH)_2$	(I) Chain Silicone
(D) $(CH_3)_3Si(OH)$	(II) Dimeric Silicone

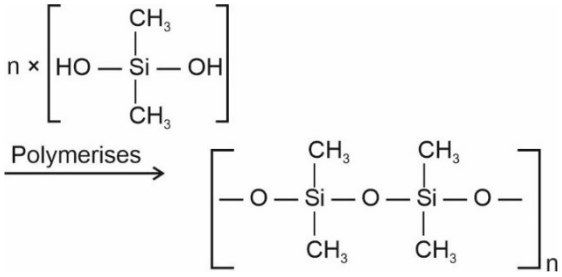




2D-Silicone



Dimeric Silicone



10. Heating white phosphorus with conc. NaOH solution gives mainly:

(A) Na_3P and H_2O

(B) H_3PO and NaH

(C) $P(OH)_3$ and NaH_2PO_4

(D) PH_3 and NaH_2PO_2

Answer (D)

Sol. P_4(white) + NaOH

$\rightarrow PH_3 + NaH_2PO_2 + H_2O$

11. Which of the following will have maximum stabilization due to crystal field?

(A) $[Ti(H_2O)_6]^{3+}$ (B) $[Co(H_2O)_6]^{2+}$

(C) $[Co(CN)_6]^{-3}$ (D) $[Cu(NH_3)_4]^{2+}$

Answer (C)

Sol. The given complexes are:

$[Ti(H_2O)_6]^{3+}$, $[Co(H_2O)_6]^{2+}$, $[Co(CN)_6]^{-3}$, $[Cu(NH_3)_4]^{2+}$

CN^- is the strongest ligand among the given complexes CFSE value for the $[Co(CN)_6]^{-3}$ complex will be highest as it has d^6 configuration with a CFSE value of $-2.40\ \Delta_0 + 2P$, where P represents pairing energy and Δ_0 represents splitting energy in octahedral field.

The value of Δ_0 is high for cyanide complexes.

12. Given below are two Statements:

Statement I: Classical smog occurs in cool humid climate. It is a reducing mixture of smoke, fog and sulphur dioxide.

Statement II: Photochemical smog has components, ozone, nitric oxide, acrolein, formaldehyde, PAN etc.

In the light of the above statements, choose the most appropriate answer from the options given below.

(A) Both **Statement I** and **Statement II** are correct.

(B) Both **Statement I** and **Statement II** are incorrect.

(C) **Statement I** is correct but **Statement II** is incorrect.

(D) **Statement I** is incorrect but **Statement II** is correct

Answer (A)

Sol. (I) Classical smog occurs in cool humid climate. It is a reducing mixture of smoke, fog and sulphur dioxide. This is a correct statement.

(II) This statement is also based on fact and is a correct statement.

13. Which of the following is structure of a separating funnel?

(A)  (B) 

(C)  (D) 

Answer (A)

Sol. The diagram is option (A) clearly represents separating funnel which is used to separate two immiscible liquids.

14. 'A' and 'B' respectively are:

$A \xrightarrow[(2)\ Zn-H_2O]{(1)\ O_3}$ Ethane-1, 2-dicarbaldehyde + Glyoxal/Oxaldehyde

$B \xrightarrow[(2)\ Zn-H_2O]{(1)\ O_3} 5-oxohexanal$

(A) 1-methylcyclohex-1, 3-diene & cyclopentene

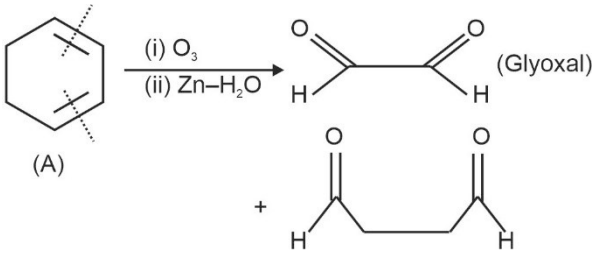
(B) Cyclohex-1, 3-diene & cyclopentene

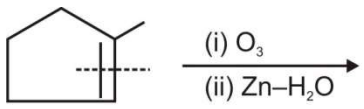
(C) 1-methylcyclohex-1, 4-diene & 1-methylcyclo-pent-ene

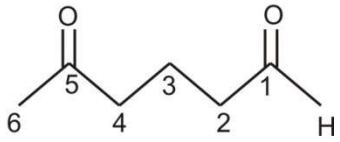
(D) Cyclohex-1, 3-diene & 1-methylcyclopent-1-ene

Answer (D)

Sol.

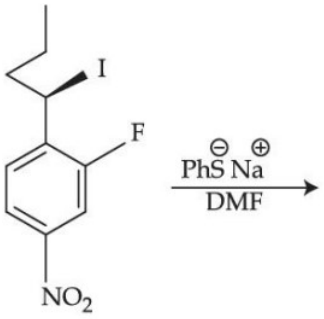


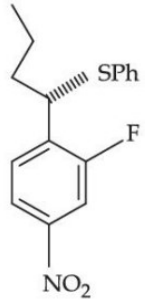


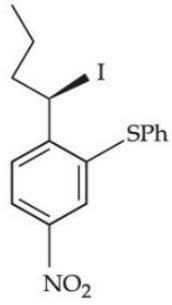


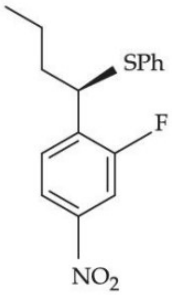
(B) should be 1-methylcyclopent-1-ene.

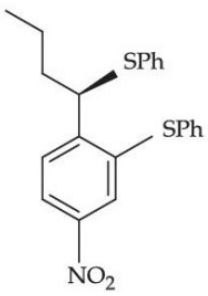
15. The major product of the following reaction is:



(A) 

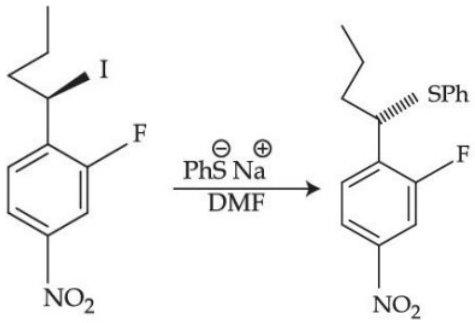
(B) 

(C) 

(D) 

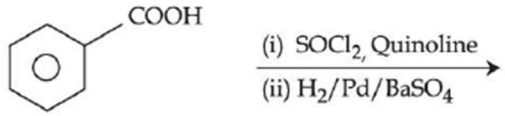
Answer (A)

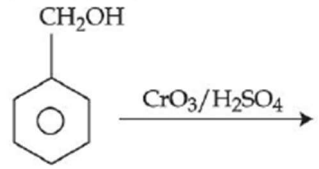
Sol.

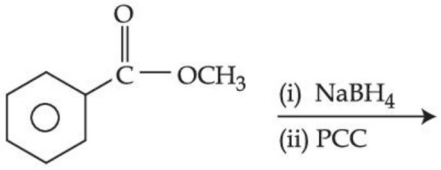


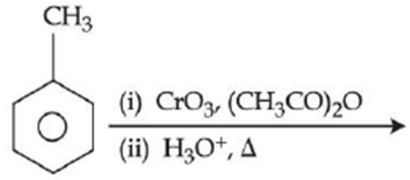
Rate of S_N2 >S_N2 (AR)

16. Which of the following reactions will yield benzaldehyde as a product?

(A) 

(B) 

(C) 

(D) 

(A) (B) and (C)

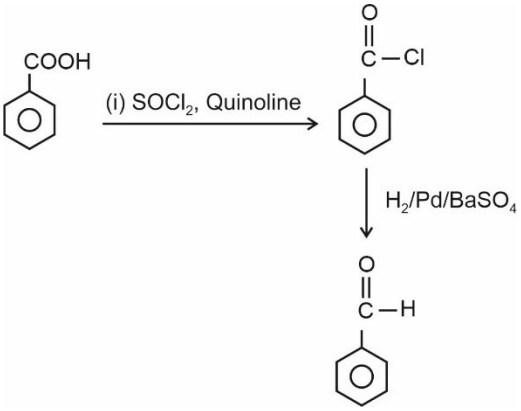
(B) (C) and (D)

(C) (A) and (D)

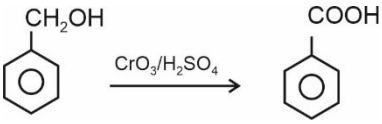
(D) (A) and (C)

Answer (C)

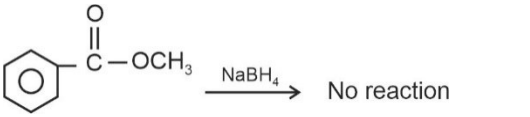
Sol. (A)



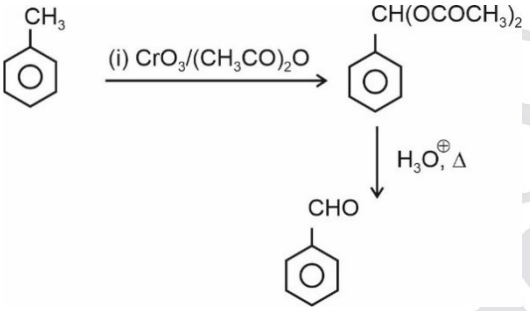
(B)



(C)



(D)



17. Given below are two statements:

Statement-I : In Hofmann degradation reaction, the migration of only an alkyl group takes place from carbonyl carbon of the amide to the nitrogen atom.

Statement-II : The group is migrated in Hofmann degradation reaction to electron deficient atom.

In the light of the above statements, choose the **most appropriate** answer from the options given below:

(A) Both **Statement I** and **Statement II** are correct

(B) Both **Statement I** and **Statement II** are incorrect

(C) **Statement I** is correct but **Statement II** is incorrect

(D) **Statement I** is incorrect but **Statement II** is correct

Answer (D)

Sol. Hofmann bromamide degradation

In this degradation, the migration of the alkyl/aryl group occurs to the electron deficient nitrogen (nitrene).

Statement (I) is not absolutely correct as it mentions only the alkyl group, whereas migration of aryl groups may also occur depending on migratory aptitude.

Statement (II) is correct as migration occurs to electron deficient atom.

18. Match List-I with List-II

List-I (Polymer)	**List-II (Used in)**
(A) Bakelite	(I) Radio and television cabinets
(B) Glyptal	(II) Electrical switches
(C) PVC	(III) Paints and Lacqures
(D) Polystyrene	(IV) Water pipes

Choose the **correct** answer from the options given below:

(A) (A) –(II) (B) – (III), (C) – (IV), (D) – (I)

(B) (A) –(I) (B) – (II), (C) – (III), (D) – (IV)

(C) (A) –(IV) (B) – (III), (C) – (II), (D) – (I)

(D) (A) –(II) (B) – (III), (C) – (I), (D) – (IV)

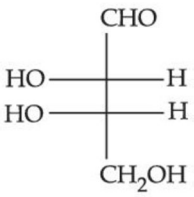
Answer (A)

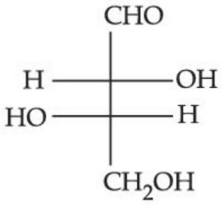
Sol.

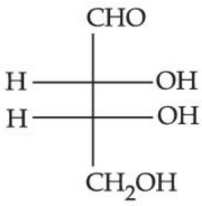
List-I (Polymer)	**List-II (Used in)**
(A) Bakelite	(II) Electrical switches
(B) Glyptal	(III) Paints and Lacqures
(C) PVC	(IV) Water pipes
(D) Polystyrene	(I) Radio and television Cabinets

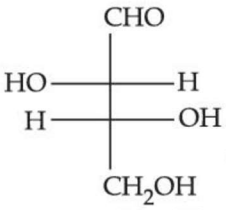
Therefore, the correct option is (A).

19. L-isomer of a compound 'A' ($C_4H_8O_4$) gives a positive test with $[Ag(NH_3)_2]^+$. Treatment of 'A' with acetic anhydride yields triacetate derivative. Compound 'A' produces an optically active compound (B) and an optically inactive compound (C) on treatment with bromine water and HNO_3 respectively. Compound (A) is:

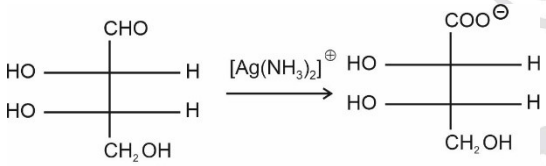
(A) 

(B) 

(C) 

(D) 

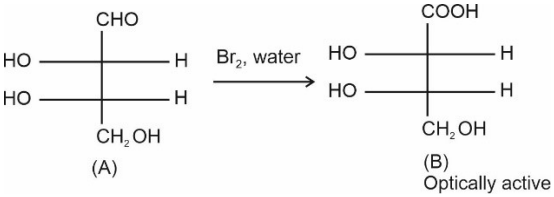
Answer (A)

Sol. 

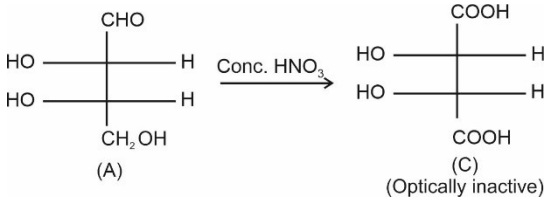
L-erythreose

(A)

When (A) is heated with acetic anhydride, acetylation occurs and –OH group is replaced by $-O-\overset{\overset{O}{\|}}{C}-CH_3$ and hence, triacetate is formed.



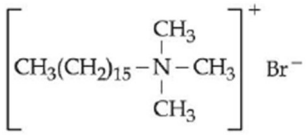
(A) (B) Optically active

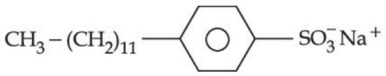


(A) (C) (Optically inactive)

20. Match List-I with List-II

List-I

(A) 

(B) 

(C) $C_{17}H_{35}COO^-Na^+ + Na_2CO_3 + Rosinate$

(D) $CH_3(CH_2)_{16}COO(CH_2CH_2O)CH_2CH_2OH$

List-II

(I) Dishwashing power

(II) Toothpaste

(III) Laundry soap

(IV) Hair conditional

Choose the correct answer from the options given below:

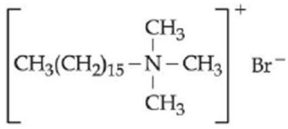
(A) (A) –(III) (B) – (II), (C) – (IV), (D) – (I)

(B) (A) –(IV) (B) – (II), (C) – (III), (D) – (I)

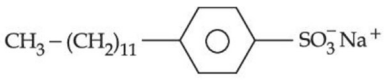
(C) (A) –(IV) (B) – (III), (C) – (II), (D) – (I)

(D) (A) –(III) (B) – (IV), (C) – (I), (D) – (II)

Answer (B)

Sol.  → Cationic detergent

(Hair conditioner)

(B) 

→ Toothpaste

(Anionic detergent)

(C) $C_{17}H_{35}COO^-Na^+ + Na_2CO_3 + Rosinate$

→ Laundry soap

(D) $CH_3(CH_2)_{16}COO(CH_2CH_2O)CH_2CH_2OH$

→ Dishwashing powder

SECTION - B

Numerical Value Type Questions: This section contains 10 questions. In Section B, attempt any five questions out of 10. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the second decimal place; e.g. 06.25, 07.00, –00.33, –00.30, 30.27, –27.30) using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer.

1. Metal deficiency defect is shown by $Fe_{0.93}O$. In the crystal, some Fe^{2+} cations are missing and loss of positive charge is compensated by the presence of Fe^{3+} ions. The percentage of Fe^{2+} ions in the $Fe_{0.93}O$ crystals is _____. (Nearest integer)

Answer (85)

Sol. $Fe_{0.93}O$

Let the number of O^{-2} ions be 100

and the number of Fe^{+2} ions be X

The number of Fe^{+3} ions be (93 – X)

$\therefore$ X(2) + (93 – X)3 = 200

279 – X = 200

X = 79

$\therefore$ % of Fe^{+2} ions = $\frac{79}{93} \times 100$

$\simeq$ 85%

2. If the uncertainty in velocity and position of a minute particle in space are, 2.4×10^{-26} (m s^{-1}) and 10^{-7} (m) respectively. The mass of the particle in g is _____. (Nearest integer)

(Given : h = 6.626×10^{-34} Js)

Answer (22)

Sol. $\Delta v = 2.4 \times 10^{-26} m\ s^{-1}$

$\Delta x = 10^{-7} m$

$\therefore\ m \geq \frac{h}{4\pi(\Delta x)(\Delta v)}$

$\geq \frac{6.626 \times 10^{-34}}{4 \times 3.14 \times (10^{-7})(2.4) \times 10^{-26}}$

$\geq \frac{6.626 \times 10^{-1}}{4 \times 2.4 \times 3.14}$

$\geq$ 0.02198 kg

$\therefore$ Mass of the particle $\simeq$ 22 g

3. 2 g of a non-volatile non-electrolyte solute is dissolved in 200 g of two different solvents A and B whose ebullioscopic constants are in the ratio of 1 : 8. The elevation in boiling points of A and B are in the ratio $\frac{x}{y}$(x : y). The value of y is _____.

(Nearest Integer)

Answer (8)

Sol. $\Delta Tb = k_b m$

$\frac{(\Delta T_b)_A}{(\Delta T_b)_B} = \frac{(k_b)_A}{(k_b)_B}$

$= \frac{1}{8} = \frac{x}{y}$

$\therefore\ y = 8$

4. $2NOCl(g) \rightleftharpoons 2NO(g) + Cl_2(g)$

In an experiment, 2.0 moles of NOCl was placed in a one-litre flask and the concentration of NO after equilibrium established, was found to be 0.4 mol/ L. The equilibrium constant at 30°C is _____ × 10^{-4}.

Answer (125)

Sol. $2NOCl(g) \rightleftharpoons 2NO(g) + Cl_2(g)$

t = 0 2

t = t_{eq} 2 – 0.4 0.4 0.2

$k_C = \frac{(0.2) \times (0.4)^2}{(1.6)^2}$

$= \frac{0.2}{16} = \frac{1}{8} \times 10^{-1}$

$= 0.125 \times 10^{-1}$

$= 125 \times 10^{-4}$

5. The limiting molar conductivities of NaI, $NaNO_3$ and $AgNO_3$ are 12.7, 12.0 and 13.3 mS m^2 mol–1, respectively (all at 25°C). The limiting molar conductivity of AgI at this temperature is ____ mS m^2 mol–1.

Answer (14)

Sol. $\Lambda_m^0(AgI) = \Lambda_m^0(NaI) + \Lambda_m^0(AgNO_3) - \Lambda_m^0(NaNO_3)$

= 12.7 + 13.3 – 12.0

= 26 – 12

= 14 mS m^2 mol^{-1}

6. The rate constant for a first order reaction is given by the following equation :

$$\ln k = 33.24 - \frac{2.0\times10^4\,K}{T}$$

The activation energy for the reaction is given by _____ kJ mol^{-1}. (In nearest integer)

(Given : R = 8.3 J K^{-1} mol^{-1})

Answer (166)

Sol. $\ln k = 33.24 - \frac{2\times10^4}{T}$

$\therefore \quad \frac{E_a}{R} = 2\times10^4$

$E_a = 2 \times 10^4 \times 8.3$

= 166 kJ/mol

7. The number of statement(s) **correct** from the following for Copper (at. no. 29) is/are _____.

(A) Cu(II) complexes are always paramagnetic

(B) Cu(I) complexes are generally colourless

(C) Cu(I) is easily oxidized

(D) In Fehling solution, the active reagent has Cu(I)

Answer (3)

Sol. (A) Cu(II) complexes are always paramagnetic as they have one unpaired electron due to d^9 configuration of Cu(II)

(B) Cu(I) complexes are generally colourless due to d^{10} configuration.

(C) Cu(I) is easily oxidised to Cu^{+2} in aqueous solution

$2Cu^+ \rightarrow Cu^{+2} + Cu$

Cu^{+1} disproportionates to Cu^{+2} and Cu

($E^\circ_{cell} > 0$ for this cell reaction in aqueous solution)

In Fehling's solution, active reagent has Cu(II) which is reduced to Cu(I) on reaction with aldehydes.

Hence (D) statement is incorrect

8. Acidified potassium permanganate solution oxidises oxalic acid. The spin-only magnetic moment of the manganese product formed from the above reaction is _____ B.M.

(Nearest Integer)

Answer (6)

Sol. $KMnO_4(\text{acidic medium}) + H_2C_2O_4 \rightarrow CO_2 + Mn^{+2}$

Mn^{+2} has 5 unpaired electrons

$\therefore$ Spin only magnetic moment = $\sqrt{5(5+2)}$

= $\sqrt{5\times7}$

= $\sqrt{35}$

$\simeq$ 5.92 B.M.

$\simeq$ 6 B.M.

9. Two elements A and B which form 0.15 moles of A_2B and AB_3 type compounds. If both A_2B and AB_3 weigh equally, then the atomic weight of A is _____ times of atomic weight of B.

Answer (2)

Sol. Mole of A_2B = moles of AB_3

$$\frac{W}{2A+B} = \frac{W}{A+3B}$$

A + 3B = 2A + B

2B = A

Atomic weight of A is 2 times that of B.

10. Total number of possible stereoisomers of dimethyl cyclopentane is _____.

Answer (Bonus)

Sol. Position of methyl groups not mentioned.