# 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 the electronic configurations

   (a) $1s^2 2s^2 2p^3$ (b) $1s^2 2s^2 2p^4$

   (c) $1s^2 2s^2 2p^5$ (d) $1s^2 2s^2 2p^6$

   The correct order of electronegativity is

   (1) a > b > c > d

   (2) c > b > a > d

   (3) d > c > b > a

   (4) c > b > d > a

**Answer (2)**

**Sol.** $1s^2 2s^2 2p^3$ = N

$1s^2 2s^2 2p^4$ = O

$1s^2 2s^2 2p^5$ = F

$1s^2 2s^2 2p^6$ = Ne

Electronegativity order : F > O > N > Ne

2. In 3,3-dimethylhex-1-en-4-yne, the number of *sp*, $sp^2$ and $sp^3$ carbon atoms, respectively are

   (1) 2, 2, 4

   (2) 2, 2, 2

   (3) 4, 2, 2

   (4) 2, 4, 2

**Answer (1)**

**Sol.**  ⇒ 3,3-dimethylhex-1-en-4-yne, $2sp^2$ hybridised, 2-*sp* hybridised and $4sp^3$ hybridised carbon atoms are present.

3. Nature of compounds $TeO_2$ and $TeH_2$ is ____ and ____ respectively

   (1) Oxidising and reducing

   (2) Highly acidic and highly basic

   (3) Reducing and basic

   (4) Basic and oxidising

**Answer (1)**

**Sol.** $TeO_2$ is oxidising in nature

$TeH_2$ is reducing in nature

4. **Statement-I :** Melting point of neopentane is greater than that of n-pentane.

   **Statement-II :** Neopentane gives only one monosubstituted product.

   (1) Both **Statement-I** and **Statement-II** are correct

   (2) Both **Statement-I** and **Statement-II** are incorrect

   (3) **Statement-I** is incorrect but **Statement-II** is correct

   (4) **Statement-I** is correct but **Statement-II** is incorrect

**Answer (1)**

**Sol.**
- Melting point of neopentane (256.4 K) > n-pentane (143.3 K) because of symmetry
- All H-atoms of Neopentane are equivalent. Hence only 1 monosubstituted product is formed.

5. Sodium nitroprusside test is used for detection of which of the following species in organic compounds?

   (1) $SO_4^{2-}$

   (2) $S^{2-}$

   (3) $Na^+$

   (4) $PO_4^{3-}$

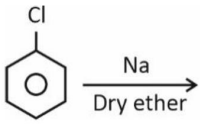
**Answer (2)**

**Sol.** $2\,Na + S \longrightarrow Na_2S$

(from organic compound)

$$Na_2S + Na_2\left[Fe^{II}(CN)_5NO\right] \longrightarrow \underset{\text{Violet colour}}{Na_4\left[Fe(CN)_5NOS\right]}$$

6. Match the reactions given in List-I with the name of the reaction given in List-II and select the correct option.

| | List-I | | List-I |
|---|---|---|---|
| A | $RX + Na \xrightarrow[\text{ether}]{\text{Dry}}$ | I | Fittig reaction |
| B | $RCOOH \xrightarrow[\Delta]{NaOH + CaO}$ | II | Lucas test |
| C | $ROH \xrightarrow[\text{conc.HCl}]{\text{anhy. } ZnCl_2}$ | III | Wurtz reaction |
| D |  | IV | Soda lime Decarboxylation reaction |

(1) A-I, B-IV, C-II, D-III (2) A-III, B-IV, C-II, D-I

(3) A-III, B-II, C-IV, D-I (4) A-I, B-II, C-III, D-IV

**Answer (2)**

**Sol.** A-III, B-IV, C-II, D-I

7. Which of the following is the correct order of enthalpy of atomisation of 3d-series?

(1) Ni > Cu > Mn > Zn

(2) Zn > Cu > Mn > Ni

(3) Cu > Mn > Ni > Zn

(4) Mn > Ni > Cu > Zn

**Answer (1)**

**Sol.** The enthalpy of atomisation of

Ni = 430 kJ/mol

Cu = 339 kJ/mol

Mn = 281 kJ/mol

Zn = 186 kJ/mol

8. Which one of the following has at least one lone pair at the central atom and different bond lengths?

(1) $XeF_4$

(2) $XeF_2$

(3) $SF_4$

(4) $PF_5$

**Answer (3)**

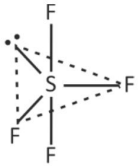
**Sol.** $XeF_4$ : Hybridisation of Xe : $sp^3d^2$

All the Xe – F bond lengths are same but Xe has two lone pairs.

$XeF_2$ : Hybridisation of Xe : $sp^3d$

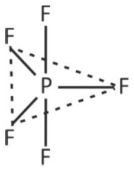
All the Xe – F bond lengths are same but Xe has three lone pairs.

$SF_4$ :Hybridisation of S : $sp^3d$



Axial S – F bond length is different from equatorial S – F bond length and S has one lone pair.

$PF_5$ :Hybridisation of P : $sp^3d$




P has no lone pair.

9. In adiabatic process, the magnitude of work done in case of one step & $\infty$ steps follows order :-

(1) $|W_{rev}|_{expansion} > |W_{irr}|_{expansion}$

(2) $|W_{rev}|_{expansion} < |W_{irrev}|_{expansion}$

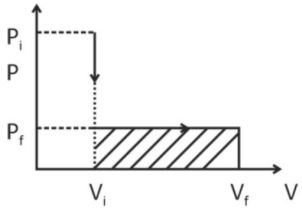
(3) $|W_{rev}|_{expansion} = |W_{irrev}|_{expansion}$

(4) Can't be predicted

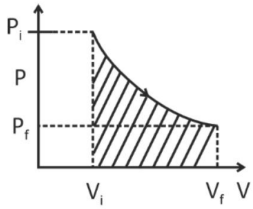
**Answer (1)**

**Sol.** $|W|$ = Area under PV curve

For single step (Expansion) process




For infinite steps process (Expansion)



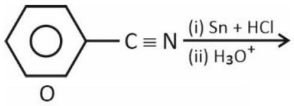

From above graph

$|W_{rev}|_{expansion} > |W_{irr}|_{expansion}$

10. Which of the following reactions gives carboxylic acid?

(1) $RCN \xrightarrow{H^+/H_2O}$

(2) $RCH_2OH \xrightarrow{PCC}$

(3) 


(4) $R-\underset{\underset{O}{\|}}{C}-Cl \xrightarrow{Pd\text{-}BaSO_4,\ H_2}$

**Answer (1)**

**Sol.** $R-CN \xrightarrow{H^+/H_2O} R-COOH$

$RCH_2-OH \xrightarrow{PCC} R-CHO$

$Ph-CN \xrightarrow[(ii)\ H_3O^+]{(i)\ Sn+HCl} Ph-CHO$

$R-\underset{\underset{O}{\|}}{C}-Cl \xrightarrow[H_2]{Pd+BaSO_4} R-\underset{\underset{O}{\|}}{C}-H$

11. Which of the following complexes has the highest CFSE value neglecting pairing energy (Magnitude)

(1) $[CoF_6]^{3-}$ (2) $[Mn(H_2O)_6]^{2+}$

(3) $[Zn(H_2O)_6]^{2+}$ (4) $[Co(en)_3]^{3+}$

**Answer (4)**

**Sol.** $CFSE = (-0.4 \times t_{2g}e^- + 0.6 \times e_g e^-)\Delta_o$

$[CoF_6]^{3-} \Rightarrow Co^{3+}$ WFL $\Rightarrow t_{2g}^4 e_g^2$

$CFSE = [4 \times -0.4 + 0.6 \times 2]\Delta_o$

$= -0.4\Delta_o$

$[Mn(H_2O)_6]^{2+} \Rightarrow Mn^{2+} \Rightarrow 3d^5$

$H_2O \Rightarrow$ WFL $\Rightarrow t_{2g}^3 e_g^2$

$CFSE = [3 \times (-0.4) + 2 \times (0.6)]\Delta_o$

$= 0$

$[Zn(H_2O)_6]^{2+}$

$Zn^{2+} \Rightarrow 3d^{10}$

$H_2O \Rightarrow$ WFL $\Rightarrow t_{2g}^6 e_g^4$

$CFSE = [6 \times (-0.4) + 4 \times (0.6)]\Delta_o$

$= 0$

$[Co(en)_3]^{3+} \Rightarrow Co^{3+} \Rightarrow 3d^6$

en $\Rightarrow$ SFL

$\Rightarrow t_{2g}^6 e_g^0$

$CFSE = 6 \times (-0.4)\Delta_o$

$= -2.4\Delta_o$

12. Match List-I with List-II and select the correct option.

| | List-I (Pair of molecules) | | List-I (Purification method) |
|---|---|---|---|
| A | Glycerol and spent-lye | I | Steam distillation |
| B | Water and Aniline | II | Fractional distillation |
| C | Petrol and Diesel | III | Distillation under reduced pressure |
| D | Aniline and $CHCl_3$ | IV | Distillation |

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

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

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

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

**Answer (04)**

**Sol.** Boiling point of aniline is 547 K and B.P of $CHCl_3$ is 334 K So they are separated by simple distillation.

$\therefore$ A-III, B-I, C-II, D-IV

13. The four different amino acids are given, A, B, C and D. Calculate the number of tetrapeptides formed including all the four amino acids.

(1) 8

(2) 16

(3) 24

(4) 32

**Answer (3)**

**Sol.** Total 24 tetrapeptides are formed. The 24 tetrapeptides formed including all the four amino acids are

ABCD BACD CABD DABC
ABDC BADC CADB DACB
ACBD BDAC CBAD DBAC
ACDB BDCA CBDA DBCA
ADBC BCAD CDAB DCAB
ADCB BCDA CDBA DCBA

Total 24

14. For the reversible reaction $A(g) \rightleftharpoons B(g) + C(g)$. The degree of dissociation is $\alpha$ at pressure $P_T$, then

(1) If $P_T >> K_P$, then $\alpha \approx 1$

(2) If $P_T$ increases, then $\alpha$ decreases

(3) If $P_T$ increases, then $\alpha$ increases

(4) If $K_P >> P_T$, then $\alpha$ tend to 0

**Answer (2)**

**Sol.**

| | $A(g)$ | $\rightleftharpoons$ | $B(g)$ | $+$ | $C(g)$ |
|---|---|---|---|---|---|
| $t=0$ | $P_0$ | | 0 | | 0 |
| $t=t_{eq}$ | $P_0(1-\alpha)$ | | $P_0\alpha$ | | $P_0\alpha$ |

$P_T = P_0 + P_0\alpha$

$$\frac{P_T}{1+\alpha} = P_0$$

$$K_p = \frac{(p_B)(p_C)}{(p_A)} = \frac{P_0\alpha \cdot P_0\alpha}{P_0(1-\alpha)}$$

$$K_P = \frac{P_0\alpha^2}{1-\alpha}$$

$$K_P = \frac{P_T\alpha^2}{1-\alpha^2}$$

$\alpha$ tends to zero if $P_T >> K_P$

If $P_T$ increases, then $\alpha$ decreases (According To Le-Chatelier Principle).

15. The number of unpaired electrons and hybridisation of $[Mn(CN)_6]^{3-}$, respectively are :-

(1) 4 and $d^2sp^3$

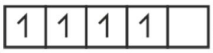
(2) 4 and $sp^3d^2$

(3) 2 and $d^2sp^3$

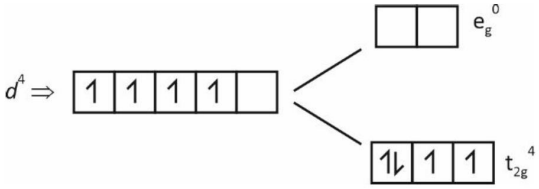
(4) 2 and $sp^3d^2$

**Answer (3)**

**Sol.** $[Mn(CN)_6]^{3-} \Rightarrow$ Mn in +3 oxidation state

$Mn^{3+} \Rightarrow 3d^4 \Rightarrow$  $\Rightarrow$ pairing will take place.

$CN^-$ ion in presence of $Mn^{3+}$ ion, acts as strong field ligand.




Inner orbital complex is formed, with 2 unpaired $e^-$

Total 2 unpaired $e^-$ are present in $[Mn(CN)_6]^{3-}$.

Its hybridisation will be $d^2sp^3$.

16. Consider the following statements

(A) Value of l gives shape of orbital

(B) $\psi$ represent wave function of an electron

(C) Electron density of $p_x$ orbital in xy plane is zero

(D) $2p_x$ orbital is 


The correct statement(s) are

(1) (A) and (D) only

(2) (A), (C) and (D) only

(3) (A), (B) and (D) only

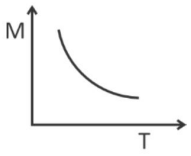
(4) (A), (B), (C) and (D)

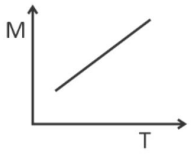
**Answer (3)**

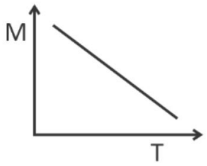
**Sol.** $2p_x$ orbital is 

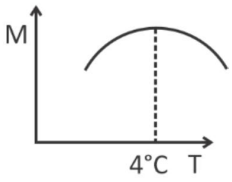

For $2p_x$ orbital, yz is the nodal plane.

17. 1 M NaCl solution is prepared at 0°C in $H_2O$. Now it is heated. Then find correct graph between molarity and temperature.

(1) 

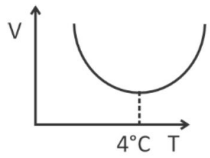

(2) 


(3) 

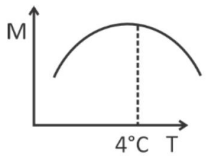

(4) 


**Answer (4)**

**Sol.** Volume of water vs temperature




$$\text{Molarity} = \frac{\text{Moles of solute}}{\text{Volume of solution}}$$



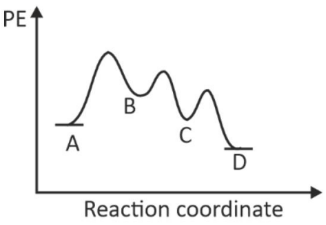

Volume is minimum at 4°C, so molarity will be maximum at 4°C.

18. Consider the following reaction:

$$A \xrightarrow[\text{slow}]{\Delta H > 0} B \xrightarrow[\text{fast}]{\Delta H < 0} C \xrightarrow[\text{fast}]{\Delta H < 0} D$$

Then correct graph will be

(1)

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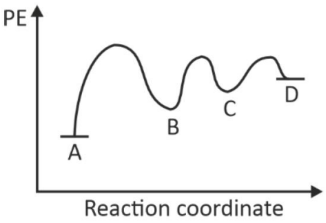


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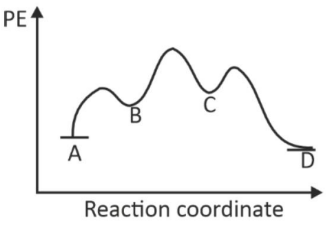


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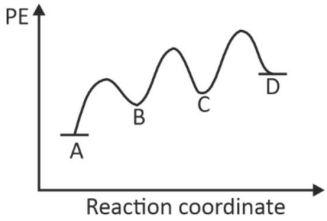



**Answer (1)**

**Sol.** First step is slowest and endothermic

19.

20.

**SECTION - B**

**Numerical Value Type Questions:** This section contains 5 Numerical based questions. The answer to each question should be rounded-off to the nearest integer.

21. 0.5 g of organic compound is heated with CuO in a $CO_2$ atmosphere at 300 K. The volume of $N_2$ gas collected over $H_2O$ is 60 mL. If aqueous tension is 15 mm Hg at 300 K and pressure recorded is 715 mm Hg, then calculate percentage of nitrogen in organic compound

**Answer (13)**

**Sol.** Pressure of $N_2$ gas = (715 – 15) = 700 mmHg

$$n_{N_2} = \frac{PV}{RT}$$

$$n_{N_2} = \frac{700 \times 60 \times 10^{-3}}{760 \times 0.0821 \times 300}$$

$$= 2.24 \times 10^{-3} \text{ mol}$$

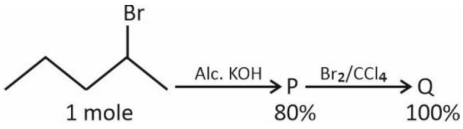
Mass of $N_2 = 2.24 \times 10^{-3} \times 28$ g

$$= 0.06272 \text{ g}$$

$$\%\ N_2 = \frac{0.06272}{0.5} \times 100$$

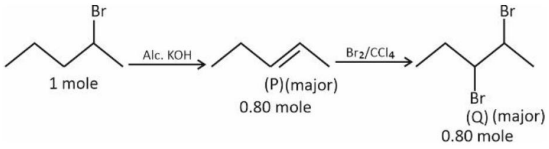
$$= 12.544\% \simeq 13\%$$

22. Consider the following reaction sequence with percentage yield of each product formed. Calculate mass(in g) of major product Q




**Answer (184)**

**Sol.**




Molecular mass of Q = 230 g $mol^{-1}$

Mass of Q = 0.8 × 230

= 184 g

23. If the percentage w/v for NaOH is 0.2 and resistivity is 870 milliohm metre. Then, calculate $\wedge_m$ (in S $cm^2$ $mol^{-1}$)

**Answer (230)**

**Sol.** $\kappa = \frac{1}{R}\frac{l}{A} = \frac{1}{\rho}$

$= \frac{1}{0.87}\ ohm^{-1}m^{-1}$

$= 1.15\ ohm^{-1}m^{-1}$

$= 0.0115\ ohm^{-1}cm^{-1}$

We have % w/v of NaOH = 0.2

Means 0.2 g of NaOH present in 100 mL of solution

$M = \frac{0.2}{40 \times 0.1}$

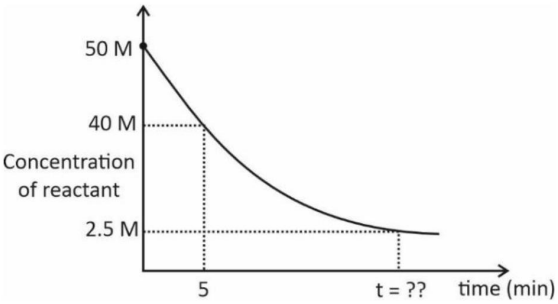
= 0.05 M

$\wedge_m = \frac{\kappa \times 1000}{M}$

$= \frac{1.15 \times 10^{-2} \times 1000}{0.05}$

= 230 S $cm^2mol^{-1}$

24. Concentration of reactant vs time graph for first order reaction is given below




Find out time required for concentration to become 2.5 M (in min) (Given: log 5 = 0.7 and log 4 = 0.6)

**Answer (65)**

**Sol.** $k = \frac{2.303}{5}\log\frac{50}{40}$

$k = \frac{2.303}{5}\log\frac{5}{4}$

$t = \frac{2.303}{k}\log\frac{50}{2.5}$

$= \frac{2.303 \times 5}{2.303\ \log\frac{5}{4}} \times \log 20$

$= \frac{5 \times 1.30}{0.1}$

= 65 min

25.