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)

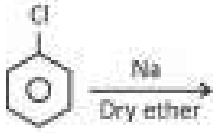
Sol. $2Na + S \longrightarrow Na_2S$

(from organic compound)

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

Violet colour

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	Frittig 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

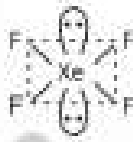
(2) XeF_2

(3) SF_4

(4) PF_5

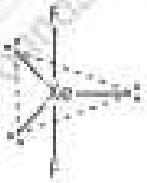
Answer (3)

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



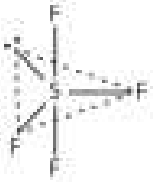
All the Xe – F bond lengths are same but Xe has two lone pairs.

XeF_2 : Hybridisation of Xe : sp^3d



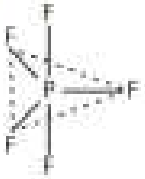
All the Xe – F bond lengths are same but Xe has three lone pairs.

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 & ∞ steps follows order :

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

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

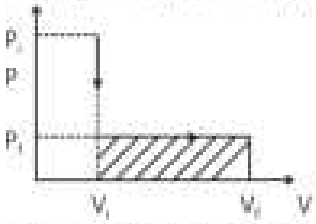
(3) $|W_{rev}|_{expansion} = |W_{irrev}|_{expansion}$

(4) Can't be predicted

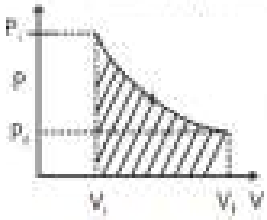
Answer (1)

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 α at pressure P_T, then

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

(2) If P_T increases, then α decreases

(3) If P_T increases, then α increases

(4) If $K_P >> P_T$, then α tend to 0

Answer (2)

Sol.

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

$P_T = P_0 + P_0\alpha$

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

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

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

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

α tends to zero if $P_T >> K_P$

If P_T increases, then α 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

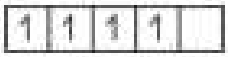
(2) 4 and sp^3d^2

(3) 2 and d^2sp^3

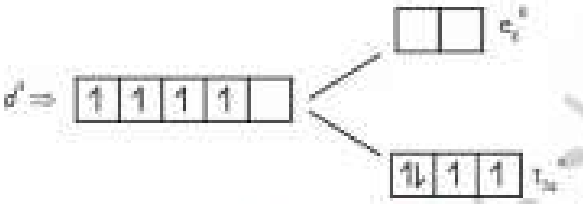
(4) 2 and sp^3d^2

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) ψ 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)

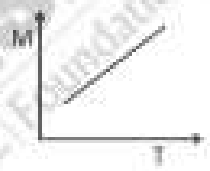
Answer (3)

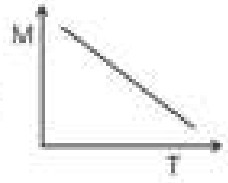
Sol. $2p_x$ orbital is 

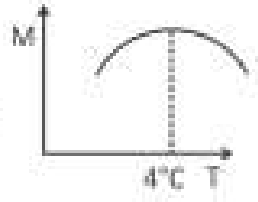
For $2p_x$ orbital, yz is the nodal plane.

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) 

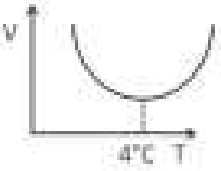
(2) 

(3) 

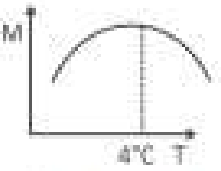
(4) 

Answer (4)

Sol. Volume of water vs temperature



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



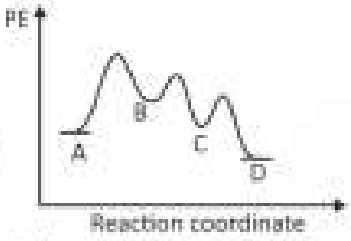
Volume is minimum at 4°C, so molarity will be maximum at 4°C.

18. Consider the following reaction:

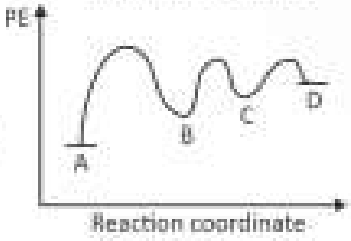
$$A \xrightarrow[\text{slow}]{\Delta H > 0} B \xrightarrow[\text{fast}]{\Delta H < 0} C \xrightarrow[\text{fast}]{\Delta H < 0} D$$

Then correct graph will be

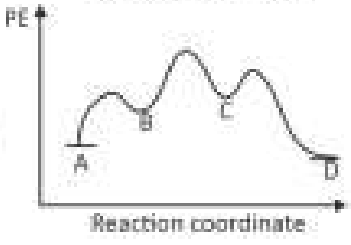
(1)



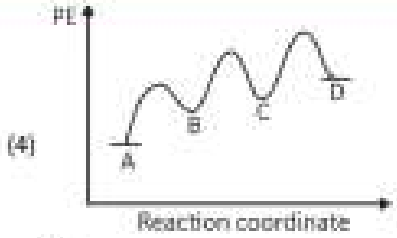
(2)



(3)



(4)



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

$= 0.06272$ g

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

$= 12.544\% \approx 13\%$

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

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

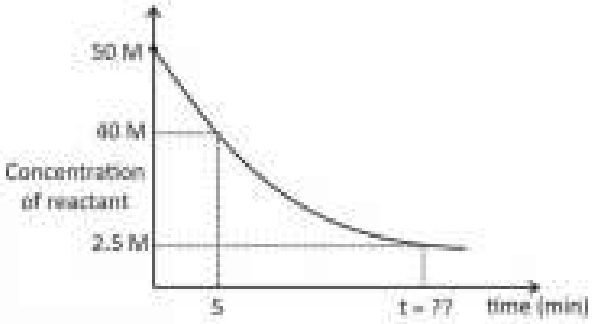
= 0.05 M

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

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

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

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.