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.

1. Which of the following is animal starch?
   (1) Glycogen
   (2) Lactose
   (3) Amylopectin
   (4) Amylose

Answer (1)

Sol. Lactose is present in milk.
Amylopectin and amylose are part of starch.
Glycogen is animal starch.

2. **Statement 1 :** Correct order of ionic radius for Mg^{2+}, Na^+, O^{2-}, & F^- is $F^- > O^{2-} > Na^+ > Mg^{2+}$

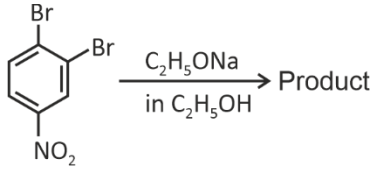
   Statement 2 : Correct order of electron gain enthalpy for 17th group elements follows order Cl > F > Br > I (Magnitude only)

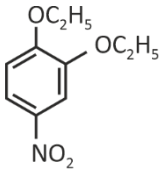
   (1) Statement-1 & Statement-2 are correct
   (2) Statement-1 is correct Statement-2 is incorrect
   (3) Statement-1 & Statement-2 are incorrect
   (4) Statement-1 is incorrect Statement-2 is correct

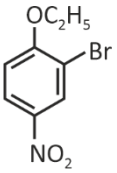
Answer (4)

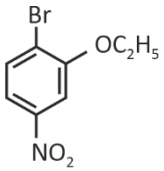
Sol.: Correct order of ionic radius $O^{2-} > F^- > Na^+ > Mg^{2+}$
Correct order for electron gain enthalpy (Magnitude) Cl > F > Br > I

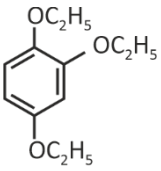
3. Identify the product formed in the following reaction



(1) 

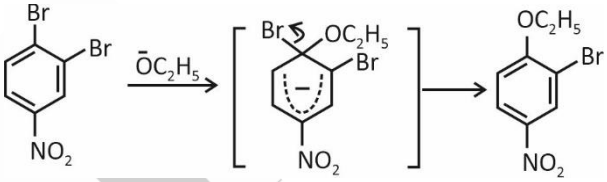
(2) 

(3) 

(4) 

Answer (2)

Sol. Aryl halides having strong electron withdrawing group like NO_2 either at the ortho or para position undergo SNAR reaction easily involving carbanion intermediate



4. Which of the following is steam volatile
   (1) Ortho nitrophenol (2) Para nitrophenol
   (3) Para aminophenol (4) Para nitroaniline

Answer (1)

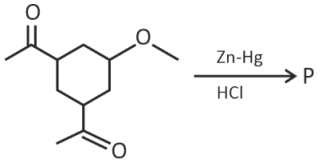
Sol. Ortho nitrophenol is steam volatile due to intramolecular H-bonding It's B.P is less. p-nitrophenol, p-amino phenol, paranitro aniline show intermolecular H-bonding

5. Consider the following complexes
   $[Mn(CN)_6]^{4-}$ $[Fe(CN)_6]^{4-}$ $[Fe(CN)_6]^{3-}$ $[Co(CN)_6]^{3-}$
   (1) (2) (3) (4)
   Correct order of CFSE (Δ) will be
   (1) 3 > 4 > 2 > 1 (2) 4 > 3 > 2 > 1
   (3) 4 > 3 > 1 > 2 (4) 3 > 4 > 1 > 2

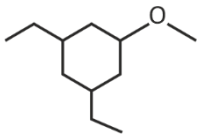
Answer (2)

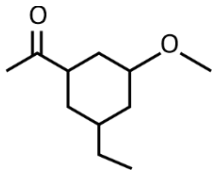
Sol. (1) $[Mn(CN)_6]^{4-}$, Mn^{2+}
(2) $[Fe(CN)_6]^{4-}$, Fe^{2+}
(3) $[Fe(CN)_6]^{3+}$, Fe^{3+}
(4) $[Co(CN)_6]^{3+}$, Co^{3+}
order of CFSE will be 4 > 3 > 2 > 1

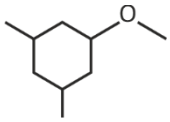
6. Consider the following reaction

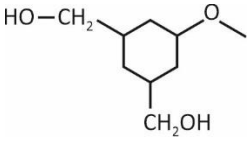


Identify the final product P.

(1) 

(2) 

(3) 

(4) 

Answer (1)

Sol. Clemmensen's reduction reagent reduces aldehyde and ketone to alkane.

7. What is the value of van't Hoff Factor for A_2B, if 30% of A_2B is dissociated?

(1) 1.60 (2) 1.30

(3) 1.50 (4) 1.20

Answer (1)

Sol. $\underset{1-\alpha}{A_2B} \rightleftharpoons \underset{2\alpha}{2A^+} + \underset{\alpha}{B^{2-}}$

$i = 1 - \alpha + 2\alpha + \alpha = 1 + 2\alpha$

$\alpha = 0.30$

$i = 1 + 2 \times 0.30 = 1.60$

8. Find the order of the reaction

$A + B \rightarrow F$

if the mechanism of the reaction is as follows:

Step 1 : $A + B \rightarrow D$ (slow)

Step 2 : $D \rightarrow C + E$ (fast)

Step 3 : $C + E \rightarrow F$ (fast)

(1) 1 (2) 3

(3) 2 (4) 4

Answer (3)

Sol. Since the slowest step is considered as rate determining step.

So, here $r = k[A][B]$

Order = 2

9. Match the following **List-I** with **List-II** and choose the correct option

List-I (Complexes)	List-II (Hybridisation)
(A) $[Co(OX)_3]^{3-}$	(i) sp^3d^2
(B) $[FeF_6]^{3-}$	(ii) d^2sp^3
(C) $[Ni(CO)_4]$	(iii) dsp^2
(D) $[PtCl_4]^{2-}$	(iv) sp^3

(1) A-(i), B-(ii), C-(iii), D-(iv)

(2) A-(ii), B-(i), C-(iii), D-(iv)

(3) A-(i), B-(ii), C-(iv), D-(iii)

(4) A-(ii), B-(i), C-(iv), D-(iii)

Answer (4)

Sol. : $\left[Co(OX)_3\right]^{3-} \Rightarrow Co^{3+}, (OX)$ act as SFL for Co^{3+}

$\Rightarrow d^6 \Rightarrow t_{2g}^6\, eg^0 \Rightarrow d^2sp^3$ hybridisation

$[FeF_6]^{3-} \Rightarrow Fe^{3+}, F^-$ act as WFL,

$Fe^{3+} \Rightarrow d^5 \Rightarrow t_{2g}^3\, eg^2 \Rightarrow sp^3d^2$ hybridisation.

$\left[Ni(CO)_4\right] \Rightarrow$ Ni(0), CO act as SFL

$Ni(0) \Rightarrow s^2d^8 \Rightarrow d^{10} \Rightarrow sp^3$ hybridisation

$[PtCl_4]^{2-} \Rightarrow Pt^{2+} \Rightarrow Cl^-$ act as SFL.

$Pt^{2+} \Rightarrow d^8 \Rightarrow dsp^2$ hybridisation.

10. What is the correct Nernst equation representation for the following cell reaction

$Mg \rightarrow Mg^{2+} + 2e^-$

$Ag^+ + e^- \rightarrow Ag$

(1) $E_{cell} = E^\circ_{cell} - \frac{RT}{2F}\ln\frac{[Mg^{2+}]}{[Ag^+]^2}$

(2) $E_{cell} = E^\circ_{cell} - \frac{RT}{2F}\ln\frac{[Ag^+]^2}{[Mg^{2+}]}$

(3) $E_{cell} = E^{\circ}_{cell} + \frac{RT}{F}\ln\frac{[Mg^{2+}]}{[Ag^{+}]^2}$

(4) $E_{cell} = E^{\circ}_{cell} + \frac{RT}{2F}\ln\frac{[Ag^{+}]^2}{[Mg^{2+}]}$

Answer (1)

Sol. $Mg(s) \rightarrow Mg^{2+}(2q) + 2e^{-}$

$2Ag^{+}(aq) + 2e^{-} \rightarrow 2Ag(s)$

$Mg(s) + 2Ag^{+}(aq) \rightarrow 2Ag(s) + Mg^{2+}(aq)$

$E_{cell} = E^{\circ}_{cell} - \frac{RT}{2F}\ln\frac{[Mg^{2+}]}{[Ag^{+}]^2}$

11. The correct order of melting point of d-block elements is :

(1) Fe > Mn (2) Tc > Ru

(3) Os > Re (4) Ta > W

Answer (1)

Sol. Melting point order is Fe > Mn, Ru > Tc, Re > Os, W > Ta

12. Consider the following reaction

$A_2B(g) \rightleftharpoons A_2(g) + \frac{1}{2}B_2(g)$

If P is total pressure at equilibrium & K_P is equilibrium constant. Then α in terms of K_P & P is (Assume $\alpha << 1$)

(1) $\sqrt{\frac{K_P}{P}}$ (2) $\sqrt[4]{\frac{K_P}{P}}$

(3) $\sqrt{\frac{2K_P}{P}}$ (4) $\sqrt[3]{\frac{2K_P^2}{P}}$

Answer (4)

Sol. $A_2B(g) \rightleftharpoons A_2(g) + \frac{1}{2}B_2(g)$

t = 0 p_0

$t = t_{eq}$ $p_0(1-\alpha)$ $p_0\alpha$ $p_0\frac{\alpha}{2}$

$P = p_0 + p_0\frac{\alpha}{2}$

$P = p_0\left(1+\frac{\alpha}{2}\right)$ $(P \approx p_0)$

At equilibrium $K_P = \frac{\left(p_{A_2}\right)\left(\frac{p_{B_2}}{}\right)}{\left(p_{A_2B}\right)} = (\alpha << 1)$

$k_p = \frac{(p_0\alpha)\left(p_0\frac{\alpha}{2}\right)^{\frac{1}{2}}}{p_0(1-\alpha)} = k_p = \alpha\left(p\frac{\alpha}{2}\right)^{\frac{1}{2}}$

$\frac{K_P}{P^{\frac{1}{2}}} = \frac{\alpha^{3/2}}{2^{1/2}}$

$\frac{2K_P^2}{P} = \alpha^3$

$\boxed{\sqrt[3]{\frac{2K_P^2}{P}} = \alpha}$

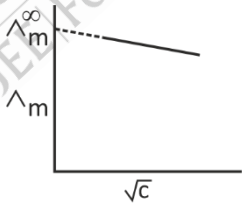
13. $\wedge_m$ is linearly dependent to $\sqrt{c}$ for an electrolyte, then molar conductance for the same electrolyte at infinite dilution shows

(1) Small increase (2) Small decrease

(3) Sharp increase (4) Sharp decrease

Answer (1)

Sol. $\wedge_m$ decreases linearly with $\sqrt{c}$ for strong electrolytes having small –ve slope. It can be extrapolated to $\wedge_m^{\infty}$ as $c \rightarrow 0$.



The molar conductance of the same electrolyte at infinite dilution or as $c \rightarrow 0$ shows small increase.

14. Given ionisation enthalpy of element E(g) is 300 kJ/mol and electron gain enthalpy of A, B, C and D gaseous atoms are –320 kJ/mol, –340 kJ/mol, –200 kJ/mol and –250 kJ/mol, then what will be the correct order of ionic nature of compounds?

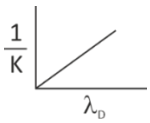
(1) EB > EA > ED > EC (2) EB > EA > EC > ED

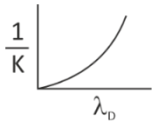
(3) EC > ED > EA > EB (4) EC > ED > EB > EA

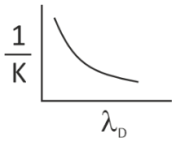
Answer (1)

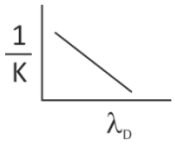
Sol. Since ionic strength depends on IE of electropositive atom; E.G.E. of electronegative element and lattice energy, more the negative value of electron gain enthalpy, more will be ionic nature.

15. Graph between de Broglie wavelength (λ_D) and kinetic energy (K) of an electron is

(1) 

(2) 

(3) 

(4) 

Answer (2)

Sol. de Broglie wavelength (λ_D) of an electron of mass (m), moving with velocity (v) is given by

$$\lambda_D = \frac{h}{mv}$$

Where h is planck's constant.

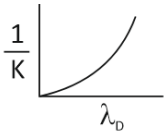
Kinetic energy (K) = $\frac{1}{2}mv^2$

$mv = \sqrt{2mK}$

$$\lambda_D = \frac{h}{\sqrt{2mK}}$$

$$\frac{1}{K} = \frac{2m\lambda_D^2}{h^2}$$

Plot of $\frac{1}{K}$ vs λ_D is



16. Which of the following ions is strongest oxidising agent

Given : $E^\circ_{Al^{3+}/Al} = -2.7V$

$E^\circ_{Cu^{2+}/Cu} = 0.34V$

$E^\circ_{Pb^{4+}/Pb^{2+}} = 1.8V$

$E^\circ_{Ti^{3+}/Ti^{2+}} = -0.37\,V$

(1) Al^{3+} (2) Cu^{2+}

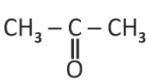
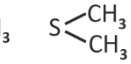
(3) Pb^{4+} (4) Ti^{3+}

Answer (3)

Sol. Reduction potential of $Pb^{4+} \rightarrow Pb^{2+}$ is most positive, Hence Pb^{4+} is strongest oxidising agent.

17. Total number of nucleophiles among the following are

Ph–SH, OH^-, $CH_2 = CH_2$, , H_3O^+,

 , 

(1) 5 (2) 6

(3) 7 (4) 4

Answer (2)

Sol. Species having atom containing lone pair available for donation can act as nucleophile

18. Radius of 1st orbit of hydrogen atom is a_0 Å, then find de-Broglie wavelength of 2nd orbit of hydrogen atom.

(1) $4\pi a_0$ (2) $\frac{4}{\pi a_0}$

(3) $8\pi a_0$ (4) $2\pi a_0$

Answer (1)

Sol. $r_n = a_0 \frac{n^2}{Z}$

for n = 1, Z = 1

$r_1 = a_0$

$r_2 = a_0 \frac{4}{1} = 4a_0$

$2\pi r_n = n\lambda$

$$\lambda = \frac{2\pi r_2}{2} = \frac{2\pi \times 4a_0}{2} = 4\pi a_0$$

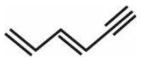
19.

20.

SECTION - B

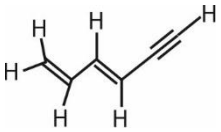
Numerical Value Type Questions: This section contains 5 Numerical based questions. The answer to each question should be rounded-off to the nearest integer.

21. Calculate the total number of sigma and π-bonds in the given molecule?



Answer (15)

Sol.



Number of sigma bonds = 11 σ

Number of π-bonds = 4 π

Total = 15

22. Chromite ore + $Na_2CO_3 + O_2 \longrightarrow$ Insoluble product

Calculate the molar mass of insoluble product formed. (Given : Molar mass of Cr = 52 g/mol, Na = 23 g/mol, Fe = 56 g/mol, 0 = 16 g/mol)

Answer (160)

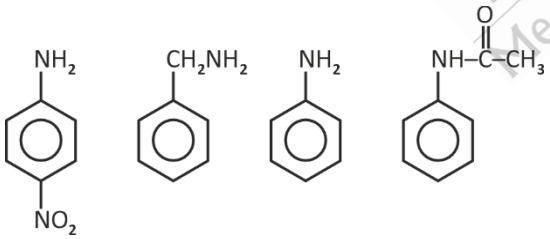
Sol. $\underset{\text{(Chromite ore)}}{4FeCr_2O_4} + 8Na_2CO_3 + 7O_2 \longrightarrow 8Na_2CrO_4 + \underbrace{2Fe_2O_3}_{\text{Insoluble product}} + 8CO_2$

Molar mass of Fe_2O_3

$\Rightarrow 2(56) + 3(16)$

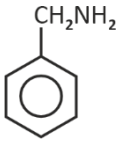
$\Rightarrow 160$

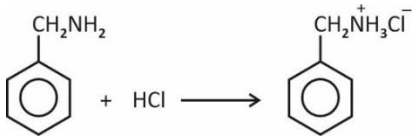
23. Consider the following amines



1 gram of most basic compound reacts with x mg of HCl, calculate value of x.

Answer (341)

Sol. Most basic compound is 



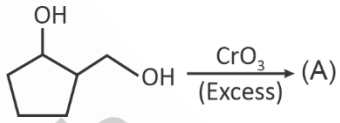
$\frac{1}{107}$mol $\quad \frac{1}{107}$mol

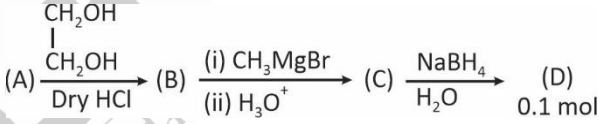
mass of HCl required to react with Benzyl amine

$= \frac{1}{107} \times 36.5\,g$

= 0.341 g = 341 mg

24. Consider the following reaction

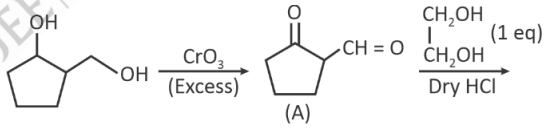


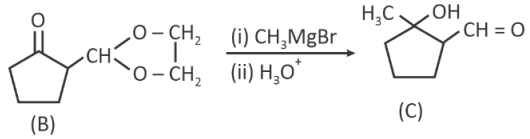


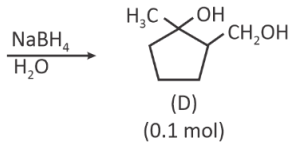
Find the mass of final product(D) formed in g

Answer (13)

Sol.







Molar mass of D = 130 g mol^{-1}

Mass of 0.1 mol of (D) formed = 13g

25.