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MAIN
July
2021**

CHEMISTRY
25th July 2021 [SHIFT – 1]
QUESTION WITH SOLUTION

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SECTION –A

1. The ionic radii of K^+ , Na^+ , Al^{3+} and Mg^{2+} are in the order:

- (1) $Al^{3+} < Mg^{2+} < K^+ < Na^+$ (2) $K^+ < Al^{3+} < Mg^{2+} < Na^+$
 (3) $Na^+ < K^+ < Mg^{2+} < Al^{3+}$ (4) $Al^{3+} < Mg^{2+} < Na^+ < K^+$

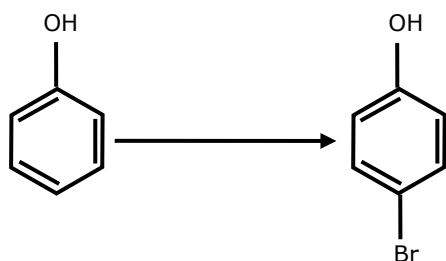
Sol. (4)

Al^{3+} , Mg^{2+} and Na^+ are isoelectronic ionic species. For monoatomic ionic isoelectronic species as positive charge increases ionic size decrease.

The order of size of Na^+ & K^+ is $Na^+ < K^+$,

∴ order of ionic radii is : $Al^{3+} < Mg^{2+} < Na^+ < K^+$

2. The given reaction can occur in the presence of:



(Major Product)

- (1) Bromine water (2) Br_2 in CS_2 , 273 K
 (3) $Br_2/FeBr_3$ (4) Br_2 in $CHCl_3$, 273 K

Choose the correct answer from the options given below:

- (1) (a) and (c) only (2) (b), (c) and (d) only
 (3) (a), (b) and (d) only (4) (b) and (d) only

Sol. (2)

Bromine water gives tribromo products, other gives monbromo products in which para is major product.

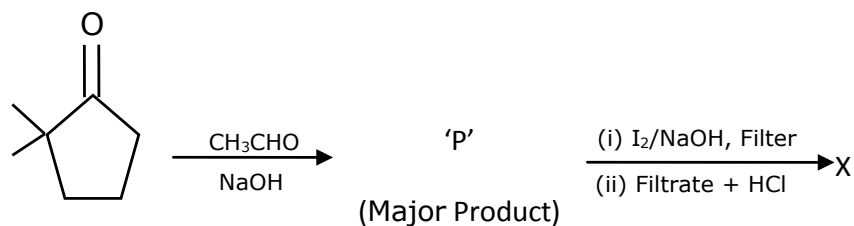
3. Which one of the following compounds of Group-14 elements is not known?

- (1) $[GeCl_6]^{2-}$ (2) $[SiCl_6]^{2-}$
 (3) $[Sn(OH)_6]^{2-}$ (4) $[SiF_6]^{2-}$

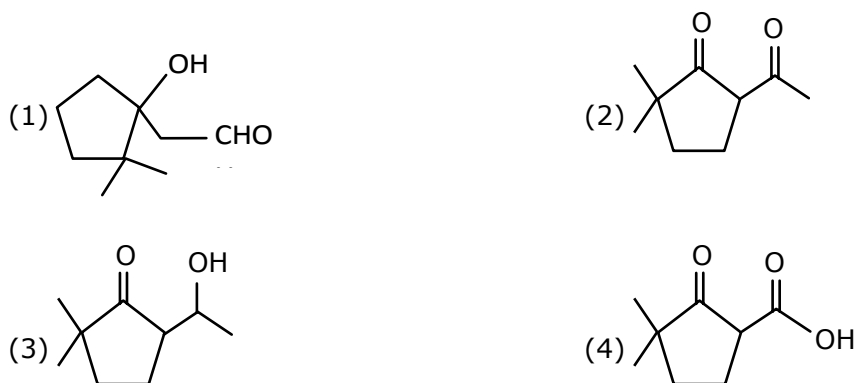
Sol. (2)

$[SiCl_6]^{2-}$ does not exist due to steric crowding of surrounding atoms.

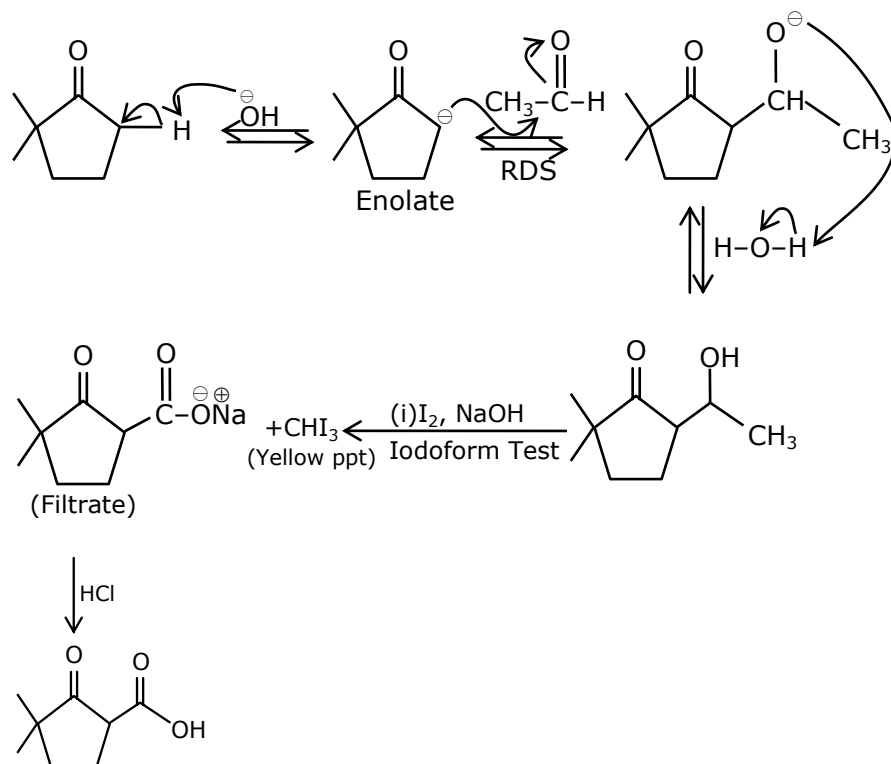
4.

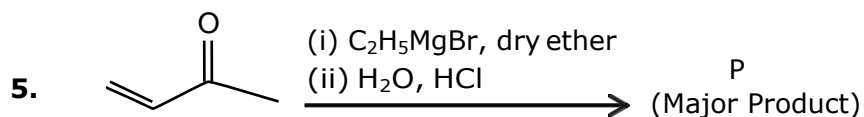


Consider the given reaction, the product 'X' is:

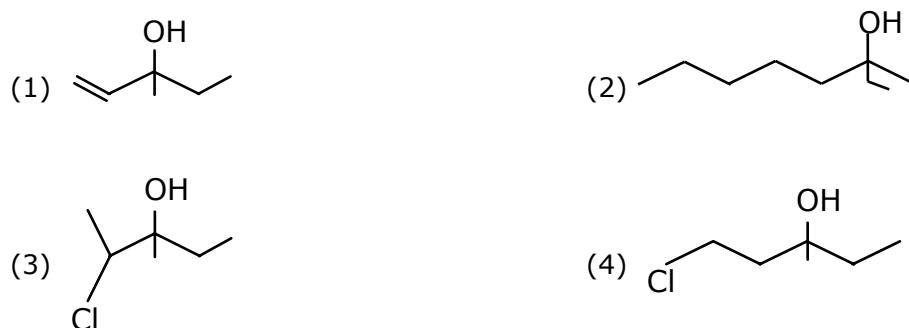


Sol. (4) Aldol reaction and then iodo form reaction.

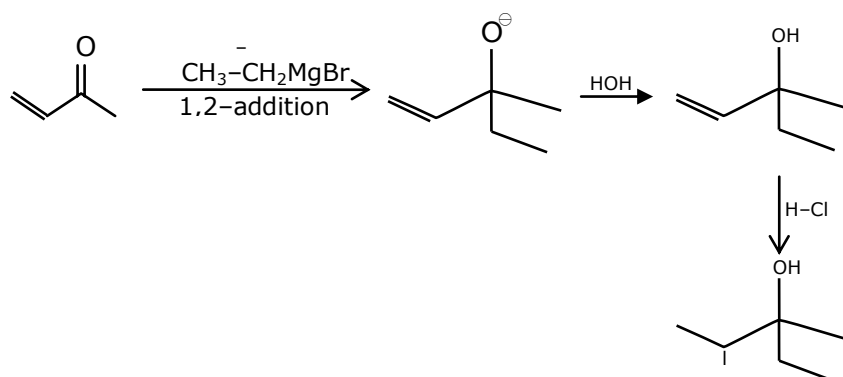




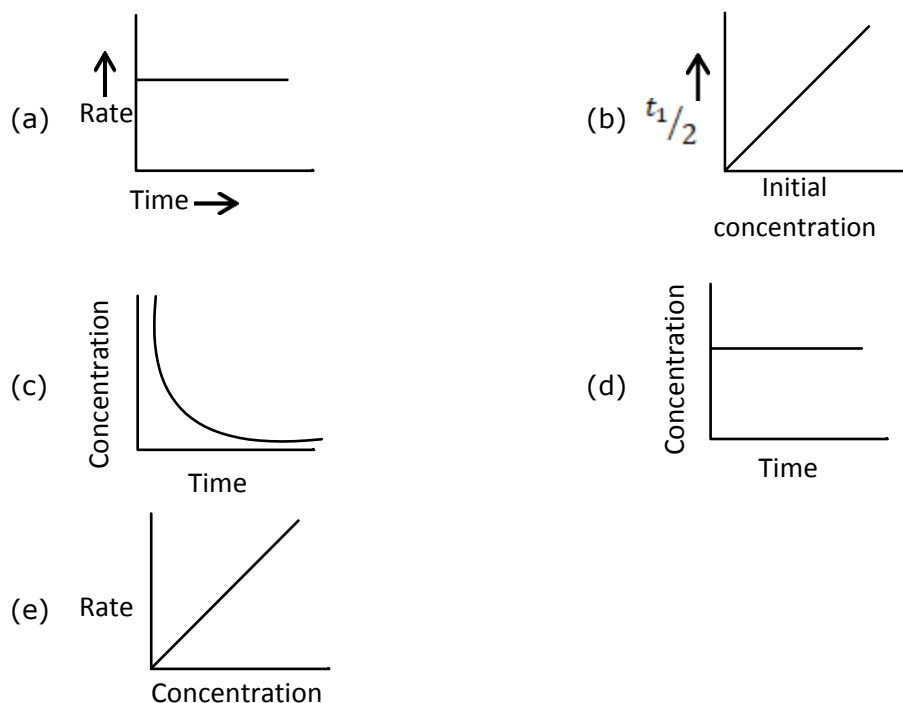
Consider the above reaction, the major product 'P' is:-



Sol. (3)



6. For the following graphs,



Choose from the options given below, the correct one regarding order of reaction is:

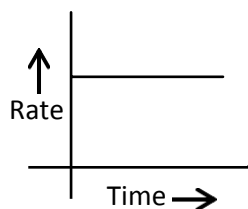
- (1)(b) and (d) Zero order (e) First order
- (2)(a) and (b) Zero order (c) and (e) First order
- (3)(a) and (b) Zero order (e) First order
- (4)(b) Zero order (c) and (e) First order

Sol. (3)

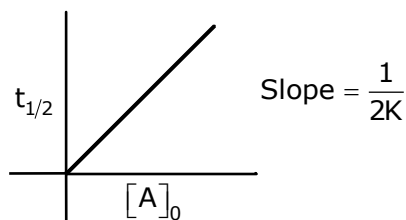
For zero order reactions'

$$\text{Rate} = K [\text{Reactant}]^0$$

$$\Rightarrow r = k$$

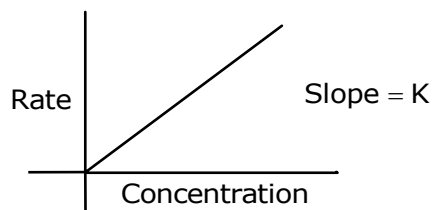


$$t_{1/2} = \frac{[A]_0}{2K} \text{ for zero order}$$



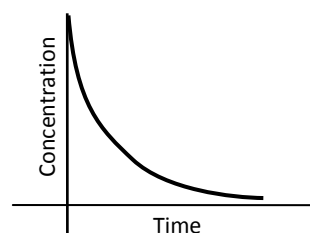
For first order reaction →

$$r = K [\text{Concentration}]$$



Reactant concentration after time t →

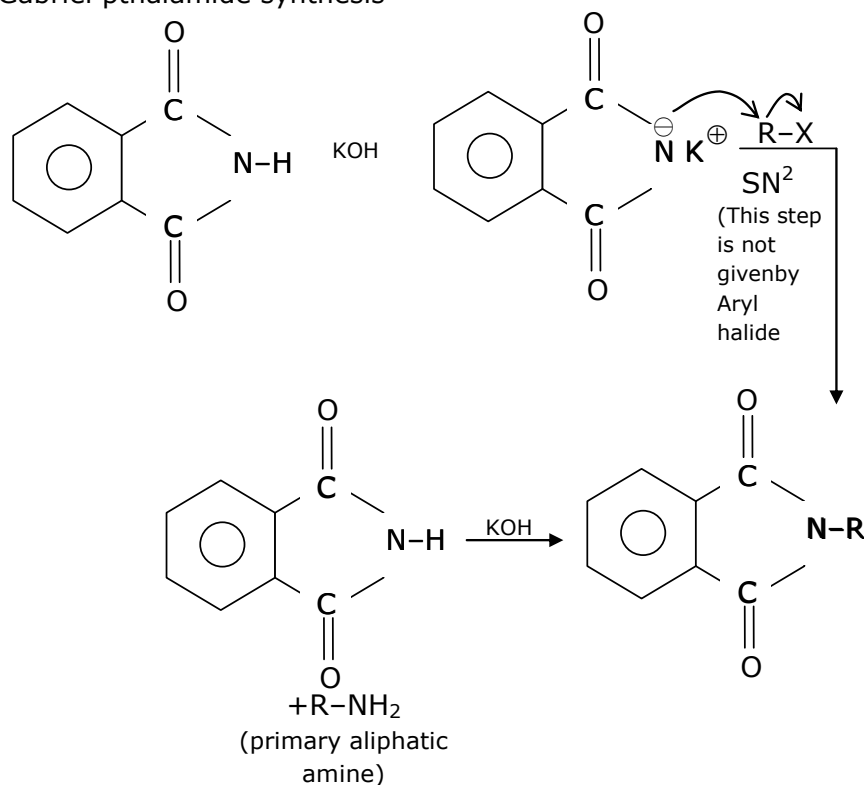
$$C_1 = C_0 e^{-kt}$$



7. Given below are two statements, one is labeled as Assertion (A) and other is labeled as:-
Reason (R).
Assertion (A): Gabriel phthalimide synthesis cannot be used to prepare aromatic primary amines.
Reason (R) : Aryl halides do not undergo nucleophilic substitution reaction.
 In the light of the above statements, choose the correct answer form the options given below.
 (1) (A) is true but (R) is flase
 (2) (A) is false but (R) is true
 (3) Both (A) and (R) are true but (R) is not the correct explanation of (A).
 (4) Both (A) and (R) are true and (R) is correct explanation of (A).

Sol. (4)

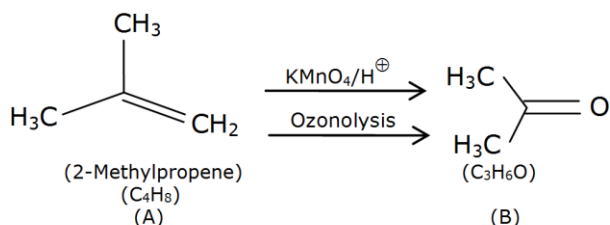
Gabriel pthalamide synthesis



Aromatic halide does not gives SN_2 reaction

8. An Organic compound 'A' C_4H_8 on treatment with KMnO_4/H^+ yields compound 'B' $\text{C}_3\text{H}_6\text{O}$. Compound 'A' also yields compound 'B' an ozonolysis. Compound 'A' is :
 (1) But-2-ene
 (2) 2-Methylpropene
 (3) Cyclobutane
 (4) 1-Methylcyclopropane

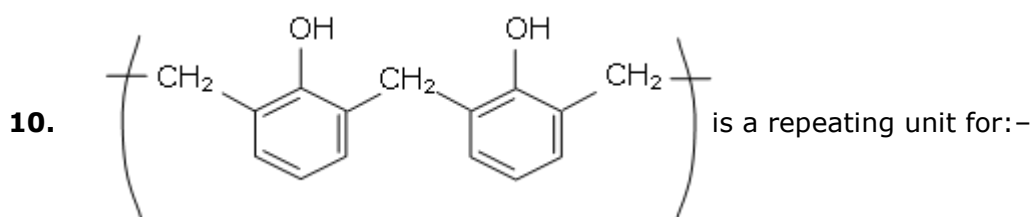
Sol. (2)



9. Sodium stearate $\text{CH}_3(\text{CH}_2)_{16}\text{COO}^-\text{Na}^+$ is an anionic surfactant which forms micelles in oil. Choose the correct statement for it from the following:
- (1) It forms spherical micelles with $\text{CH}_3(\text{CH}_2)_{16}$ group pointing towards the center of sphere.
 - (2) It forms non-spherical micelles with $\text{CH}_3(\text{CH}_2)_{16}$ group pointing towards the center.
 - (3) It forms spherical micelles with $\text{CH}_3(\text{CH}_2)_{16}$ group pointing towards the surface of sphere.
 - (4) It forms non-spherical micelles with $-\text{COO}^-$ group pointing outwards on the surface.

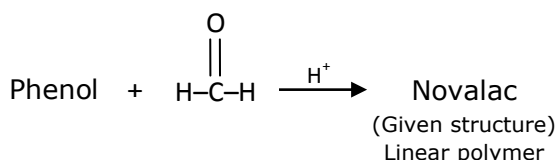
Sol. (1)

Forms spherical micelles with $\text{CH}_3(\text{CH}_2)_{16}$ group pointing towards the center of sphere



- (1) Novolac
- (2) Acrilan
- (3) Buna-N
- (4) Neoprene

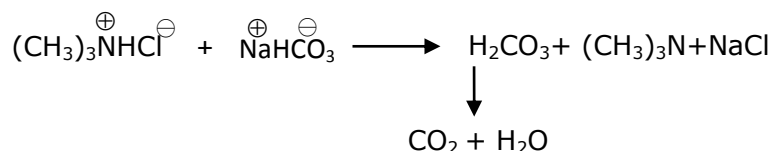
Sol. (1)



11. Which one of the following compounds will liberate CO_2 , when treated with NaHCO_3 ?

- (1) $(\text{CH}_3)_4\text{N}^+\text{OH}^-$
- (2) $(\text{CH}_3)_3\text{N}^+\text{HCl}^-$
- (3) CH_3NH_2
- (4) $\text{CH}_3-\overset{\text{O}}{\parallel}{\text{C}}-\text{NH}_2$

Sol. (2)

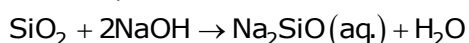


12. In the leaching of alumina from bauxite, the ore expected to leach out in the process by reacting with NaOH is:

- (1) TiO_2
- (2) SiO_2
- (3) Fe_2O_3
- (4) ZnO

Sol. (2)

In bauxite impurities of Fe_2O_3 , TiO_2 and SiO_2 are present, Fe_2O_3 and TiO_2 are basic oxides therefore does not reacts with or dissolve in NaOH whereas SiO_2 is acidic oxide it gets dissolve in NaOH , hence leach out



13. At 298.2 K the relationship between enthalpy of bond dissociation (in kJ mol^{-1}) for hydrogen (E_H) and its isotope, deuterium (E_D), is best described by:

(1) $E_H = \frac{1}{2} E_D$ (2) $E_H = E_D$ (3) $E_H = 2E_D$ (4) $E_H \approx E_D - 7.5$

Sol. (4)

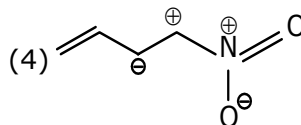
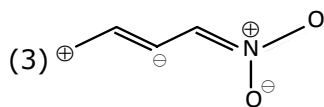
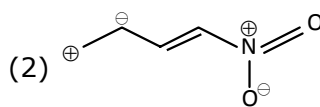
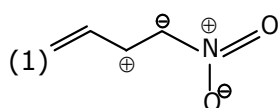
Enthalpy of bond dissociation (kJ/mole) at 298.2K

For, hydrogen = 4.35.88

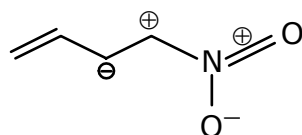
For, Deuterium = 443.35

$\therefore E_H \approx E_D - 7.5$

14. Which one among the following resonating structures is not correct?



Sol. (4)



15. Which one of the following chemical agent is not being used for dry-cleaning of clothes?

(1) H_2O_2 (2) $\text{Cl}_2\text{C} = \text{CCl}_2$ (3) CCl_4 (4) Liquid CO_2

Sol. (3)

CO_2 , CCl_4 and $\text{Cl}_2\text{C} = \text{CCl}_2$ are used as dry cleaning agents for clothes.

H_2O_2 is used as bleaching agent in laundry.

16. Given below are two statements:

Statement I : None of the alkaline earth metal hydroxides dissolve in alkali.

Statement II : Solubility of alkaline earth metal hydroxides in water increases down the group.

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

- (1) **Statement I** is correct but **Statement II** is incorrect.
 (2) **Statement I** and **Statement II** both are incorrect.
 (3) **Statement I** is incorrect but **Statement II** is correct.
 (4) **Statement I** and **Statement II** both are correct.

Sol. (3)

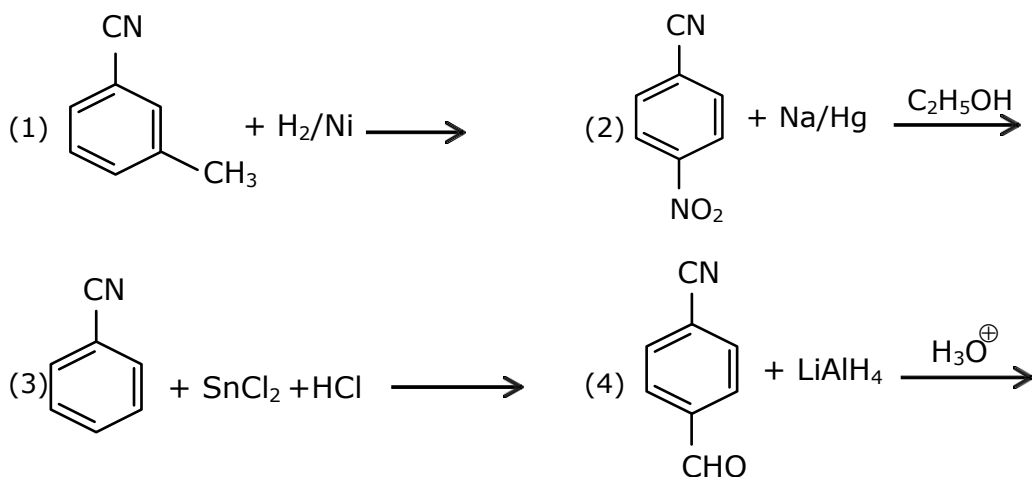
Statement-I is incorrect

$\text{Be}(\text{OH})_2$ dissolve in alkali due to its amphoteric nature.

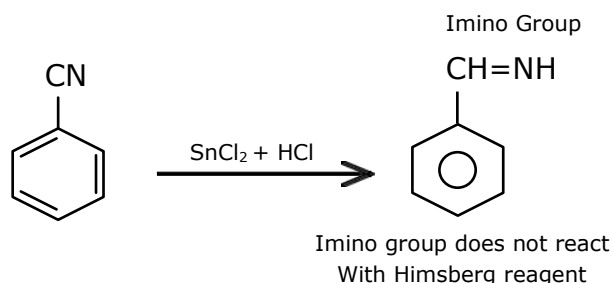
Statement-II is correct

Solubility of alkaline earth metal hydroxide in water increases down the group due to rapid decreases in lattice energy as compared to hydration energy.

17. Which one of the products of the following reactions does not react with Hinsburg reagent to form sulphonamide?



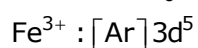
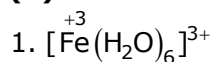
Sol. (3)



18. Which one of the following species responds to an external magnetic field?

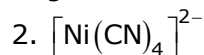


Sol. (1)



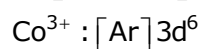
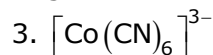
Hybridisation : sp^3d^2

Magnetic nature : Paramagnetic (so this complex response to external magnetic field)



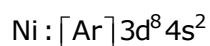
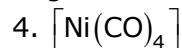
Hybridisation : dsp^2

Magnetic nature : diamagnetic



Hybridisation : d^2sp^3

Magnetic nature: diamagnetic



Hybridisation : sp^3

Magnetic nature : diamagnetic

19. The correct order of following 3d metal oxides, according to their oxidation numbers is :

- (a) CrO_3 (b) Fe_2O_3 (c) MnO_2 (d) V_2O_5 (e) Cu_2O

- (1) (a) > (c) > (d) > (b) > (e)
 (2) (d) > (a) > (b) > (c) > (e)
 (3) (a) > (d) > (c) > (b) > (e)
 (4) (c) > (a) > (d) > (e) > (b)

Sol. (3)

- (a) $\overset{+6}{\text{CrO}_3}$ (d) $\overset{+5}{\text{V}_2\text{O}_5}$
 (b) $\overset{+3}{\text{Fe}_2\text{O}_3}$ (e) $\overset{+1}{\text{Cu}_2\text{O}}$
 (c) $\overset{+4}{\text{MnO}_2}$

So order of oxidation state

$$a > d > c > b > e$$

20. The water soluble protein is :

- (1) Fibrin (2) Albumin (3) Collagen (4) Myosin

Sol. (2)

Albumin is water soluble.

SECTION –B

1. A source of monochromatic radiation of wavelength 400 nm provides 1000 J of energy in 10 seconds. When this radiation falls on the surface of sodium, $x \times 10^{20}$ electrons are ejected per second. Assume that wavelength 400 nm is sufficient for ejection of electron from the surface of sodium metal. The value of x is _____. (Nearest integer)

$$(h = 6.626 \times 10^{-34} \text{ Js})$$

Sol. (2)

Total energy provided by

$$\text{Source per second} = \frac{1000}{10} = 100 \text{ J}$$

$$\text{Energy required to eject electron} = \frac{hc}{\lambda}$$

$$= \frac{6.626 \times 10^{-34}}{400 \times 10^{-9}} \times 3 \times 10^8$$

Number of electrons ejected

$$= \frac{100}{\frac{6.626 \times 10^{-34} \times 3 \times 10^8}{400 \times 10^{-9}}}$$

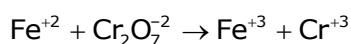
$$= \frac{400 \times 10^{-7} \times 10^{26}}{6.626 \times 3}$$

$$= \frac{40 \times 10^{-20}}{6.626 \times 3}$$

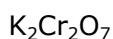
$$= 2.01 \times 10^{20}$$

2. When 10 mL of an aqueous solution of Fe^{2+} ions was titrated in the presence of dil H_2SO_4 using diphenylamine indicator, 15 mL of 0.02 M solution of $\text{K}_2\text{Cr}_2\text{O}_7$ was required to get the end point. The molarity of the solution containing Fe^{2+} ions is $X \times 10^{-2}$ M. The value of x is _____. (Nearest integer)

Sol. (18)



Milli-equivalents of Fe^{2+} = milli-equivalents of

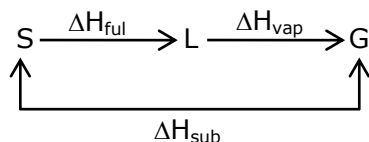


$$M \times 10 \times 1 = 0.02 \times 15 \times 6$$

$$M = 0.18 = 18 \times 10^{-2} \text{M}$$

3. At 298 K, the enthalpy of fusion of a solid (X) is 2.8 kJ mol^{-1} and the enthalpy of vaporisation of the liquid (X) is 98.2 kJ mol^{-1} . The enthalpy of sublimation of the substance (X) in kJ mol^{-1} is _____. (in nearest integer)

Sol. (101)



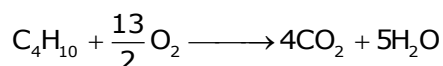
$$\Delta H_{\text{sub}} = \Delta H_{\text{fus.}} + \Delta H_{\text{vap.}}$$

$$= 2.8 + 98.2$$

$$= 101 \text{ KJ/mol}$$

4. Consider the complete combustion of butane, the amount of butane utilized to produce 72.0 g of water is _____ $\times 10^{-1}$ g. (in nearest integer)

Sol. (464)



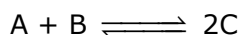
$$\text{Moles of H}_2\text{O} = \frac{72}{18} = 4$$

$$\text{Moles of C}_4\text{H}_{10} \text{ used} = \frac{1}{5} \times 4$$

$$\text{Weight of C}_4\text{H}_{10} \text{ used} = \frac{4}{5} \times 58$$

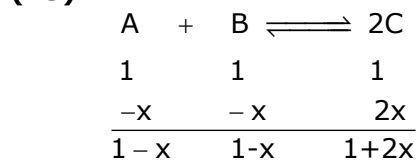
$$= 46.4 \text{ gm} \Rightarrow 464 \times 10^{-1} \text{ gm}$$

5. For the reaction



the value of equilibrium constant is 100 at 298 K. If the initial concentration of all the three species is 1 M each, then the equilibrium concentration of C is $X \times 10^{-1}$ M. The value of x is _____. (Nearest integer)

Sol. (25)



$$K = \frac{[C]_{eq}^2}{[A]_{eq}[B]_{eq}} = \frac{(1+2x)^2}{(1-x)(1-x)}$$

$$100 = \left(\frac{1+2x}{1-x} \right)^2$$

$$\left(\frac{1+2x}{1-x} \right) = 10$$

$$x = \frac{3}{4}$$

$$[C]_{eq} = 1 + 2x$$

$$= 1 + 2\left(\frac{3}{4}\right)$$

$$= 2.5 \text{ M}$$

$$25 \times 10^{-1} \text{ M}$$

6. CO_2 gas is bubbled through water during a soft drink manufacturing process at 298 K. If CO_2 exerts a partial pressure of 0.835 bar then x mmol of CO_2 would dissolve in 0.9 L of water. The value of x is _____. (Nearest integer)

(Henry's law constant for CO_2 at 298 K is 1.67×10^3 bar)

Sol. (25)

From Henry's Law

$$0.835 = 1.67 \times 10^3 \times \frac{n(\text{CO}_2)}{\frac{0.9 \times 1000}{18}}$$

$$n(\text{CO}_2) = 0.025$$

$$\text{Millimoles of } \text{CO}_2 = 0.025 \times 1000 = 25$$

7. A home owner uses $4.00 \times 10^3 \text{ m}^3$ of methane (CH_4) gas, (assume CH_4 is an ideal gas) in a year to heat his home. Under the pressure of 1.0 atm and 300 K, mass of gas used is $X \times 10^5$ g. The value of x is _____. (Nearest integer)

(Given $R = 0.083 \text{ L atm K}^{-1} \text{ mol}^{-1}$)

Sol. (26)

$$n(\text{CH}_4) = \frac{PV}{RT}$$

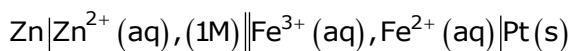
$$= \frac{1 \times 4 \times 10^3 \times 1000}{0.083 \times 300}$$

Weight of CH_4

$$= \frac{40 \times 16 \times 10^5}{0.083 \times 300} \text{ gm}$$

$$= 25.7 \times 10^5 \text{ gm}$$

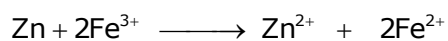
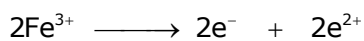
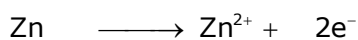
8. Consider the cell at 25°C



The fraction of total iron present as Fe^{3+} ion at the cell potential of 1.500 V is $X \times 10^{-2}$. The value of x is _____. (Nearest integer).

(Given $E_{\text{Fe}^{3+}/\text{Fe}^{2+}}^0 = 0.77 \text{ V}$, $E_{\text{Zn}^{2+}/\text{Zn}}^0 = -0.76 \text{ V}$)

Sol. (24)



$$E_{\text{cell}}^0 = 0.77 - (0.76)$$

$$= 1.53 \text{ V}$$

$$1.50 = 1.53 - \frac{0.06}{2} \log \left(\frac{\text{Fe}^{2+}}{\text{Fe}^{3+}} \right)^2$$

$$\log \left(\frac{\text{Fe}^{2+}}{\text{Fe}^{3+}} \right) = \frac{0.03}{0.06} = \frac{1}{2}$$

$$\frac{[\text{Fe}^{2+}]}{[\text{Fe}^{3+}]} = 10^{1/2} = \sqrt{10}$$

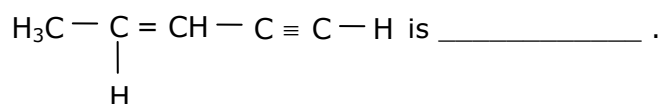
$$\frac{[\text{Fe}^{3+}]}{[\text{Fe}^{2+}]} = \frac{1}{\sqrt{10}}$$

$$\frac{[\text{Fe}^{3+}]}{[\text{Fe}^{2+}] + [\text{Fe}^{3+}]} = \frac{1}{1 + \sqrt{10}} = \frac{1}{4.16}$$

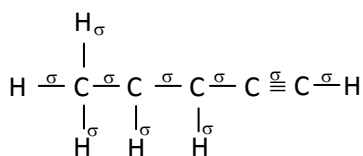
$$= 0.2402$$

$$= 24 \times 10^{-2}$$

9. The number of sigma bonds in



Sol. (10)

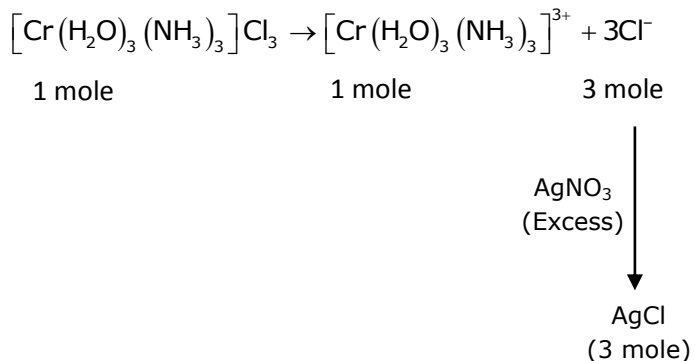


Numbers of σ bonds = 10

- 10.** Three moles of AgCl get precipitated when one mole of an octahedral co-ordination compound with empirical formula $\text{CrCl}_3 \cdot 3\text{NH}_3 \cdot 3\text{H}_2\text{O}$ reacts with excess of silver nitrate. The number of chloride ions satisfying the secondary valency of the metal ion is _____.

Sol. (0)

Mole of AgCl precipitated is equal the mole of Cl^- present in ionization sphere.



Since none of Cl^- is present in the co-ordination sphere. Therefore answer is zero.

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