JEE MAIN 18th March Shift-1 2021 (Chemistry)

SECTION – A

1. The ionic radius of Na^+ ion is 1.02 Å. The ionic radii (in Å) of Mg^{2+} and Al^{3+}, respectively are:

a. 0.72 and 0.54 b. 0.68 and 0.72
c. 1.05 and 0.99 d. 0.85 and 0.99

Ans. (a)

Solution For iso-electronic system

$r \alpha \frac{1}{Z_{effective}}$

Na^+ Mg^{2+} Al^{3+}

Z=11 Z=12 Z=13 10 electron in each

Z=atomic No.

2. Match List-I with List-II:

List-I (Chemicals)	List-II (Use/Preparation/Constituent)
(a) Alcoholic potassium hydroxide	(i) electrodes in batteries
(b) $Pd/BaSO_4$	(ii) obtained by addition reaction
(c)BHC (Benzene hexachloride)	(iii) used for β-elimination reaction
(d) Polyacetylene	(iv) Lindlar's Catalyst

Choose the most appropriate match:

a. (a)-(ii), (b)-(i), (c)-(iv), (d)-(iii) b. (a)-(iii), (b)-(i), (c)-(iv), (d)-(ii)
c. (a)-(ii), (b)-(iv), (c)-(i), (d)-(iii) d. (a)-(iii), (b)-(iv), (c)-(ii), (d)-(i)

Ans. (d)

Solution

Alcoholic KOH ⇒ Used for beta - elimination reaction
$Pd/ BaSO_4$ ⇒ Lindlar's catalyst
BHC (Benzene hexachloride) ⇒ Addition product of benzene and chlorine.
Polyacetylene ⇒ Used in electrodes in batteries

3. The statements that are TRUE:
   (A) methane leads to both global warming and photochemical smog
   (B) methane is generated from paddy fields
   (C) methane is a stronger global warming gas than CO_2
   (D) methane is a part of reducing smog.
   Choose the most appropriate answer from the option given below:

   a. (B), (C), (D) only
   b. (A), (B), (C) only
   c. (A), (B), (D) only
   d. (A) and (B) only

Ans. (b)
Solution
Contribution of global warming gas
$CO_2 > CH_4 > CFC > O_3 > N_2O > H_2O$
But CH_4 is 40 times stronger green house gases than CO_2 its has more heating effect.

4. Compound with molecular formula C_3H_6O can show:
   (1) Both positional isomerism and metamerism
   (2) Metamerism
   (3) Positional isomerism
   (4) Functional group isomerism

Ans. (4)
Solution
C_3H_6O DOU = 1
$CH_3 - CH_2 - CH = O$ & $CH_3 - CO - CH_3$ are functional isomer. Therefore, functional group isomerism is the most appropriate.

5. Match List-I with List-II:

List-I	List-II
(a) $Ca(OCl)_2$	(i) Antacid
(b) $CaSO_4 \cdot 1/2H_2O$	(ii) Cement
(c) CaO	(iii) Bleach
(d) $CaCO_3$	(iv) Plaster of Paris

Choose the most appropriate answer from the option given below:

a. (a)-(iii), (b)-(iv), (c)-(ii), (d)-(i)
b. (a)-(iii), (b)-(ii), (c)-(iv), (d)-(i)
c. (a)-(iii), (b)-(ii), (c)-(i), (d)-(iv)
d. (a)-(i), (b)-(iv), (c)-(iii), (d)-(ii)

Ans. (a)
Solution
$Ca(OCl)_2$ → Bleaching power
$CaSO_4. 1/2H_2O$ → Plaster of Paris
CaO → cement
$CaCO_3$ → Antacid

6. In a binary compound, atoms of element A form a hcp structure and those of element M occupy 2/3 of the tetrahedral voids of the hcp structure. The formula of the binary compound is:

a. M_2A_3 b. MA_3
c. M_4A d. M_4A_3

Ans. (d)
Solution
A → hcp
M → 2/3rd of tetrahedral
$M_{2\times\frac{12}{3}}$ $A_6 = M_8A_6 = M_4A_3$

7. Match List-I with List-II:

List-I (Class of Drug)	**List-II (Example)**
(a) Antacid	(i) Novestrol
(b) Artificial Sweetner	(ii) Cimetidine
(c) Antifertility	(iii) Valium
(d) Tranquilizers	(iv) Alitame

Choose the most appropriate answer from the option given below:

a. (a)-(iv), (b)-(iii), (c)-(i), (d)-(ii) b. (a)-(ii), (b)-(iv), (c)-(i), (d)-(iii)
c. (a)-(ii), (b)-(iv), (c)-(iii), (d)-(i) d. (a)-(iv), (b)-(i), (c)-(ii), (d)-(iii)

Ans. (b)
Solution
Antacid — Cimetidine
Artificial sweetener — Alitame
Antifertility — Novestrol
Tranquilizers — Valium

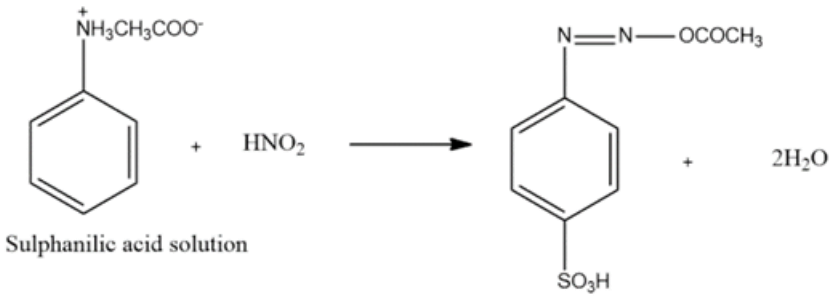
8. Reagent, 1-naphthylamine and sulphanilic acid in acetic acid is used for the detection of:

a. NO b. N_2O
c. NO_3^- d. NO_2^-

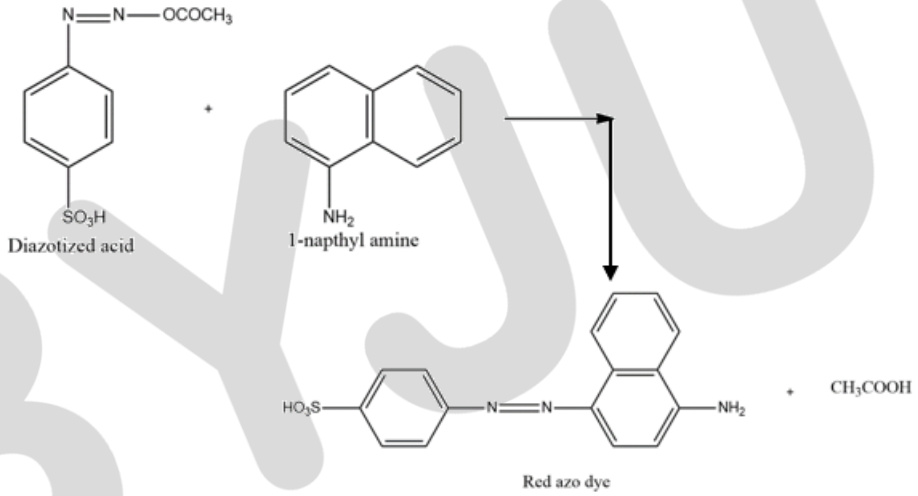
Ans. (d)

Solution

For detection of NO_2^-, the following test is used



Sulphanilic acid solution



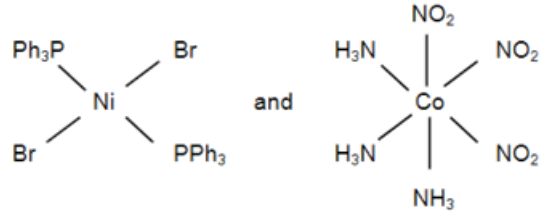
Diazotized acid

1-napthyl amine

Red azo dye

9. The correct structures of trans-$[NiBr_2(PPh_3)_2]$ and meridonial-$[Co(NH_3)_3(NO_2)_3]$ respectively are :

a.



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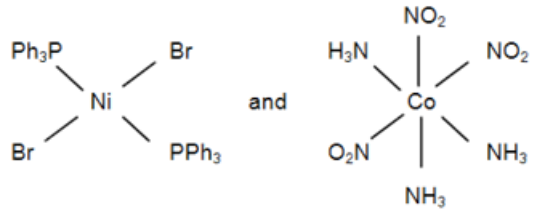
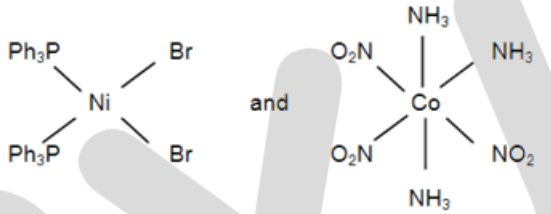


c.



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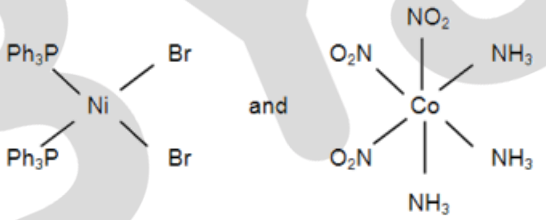
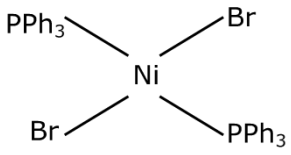
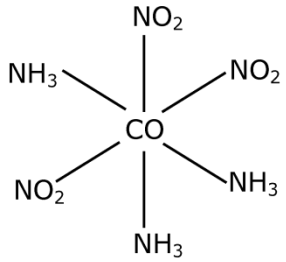


Ans. (b)

Solution Trans $[Ni\ Br_2(Pph_3)_2]$



Meridonial $[CO(NH_3)_3(NO_2)_3]$



10. Match List-I with List-II:

List-I	List-II
(a) Chlorophyll	(i) Ruthenium
(b) Vitamin – B_{12}	(ii) Platinum
(c) Anticancer drug	(iii) Cobalt
(d) Grubbs catalyst	(iv) Magnesium

Choose the most appropriate answer from the option given below:

a. (a)-(iv), (b)-(iii), (c)-(i), (d)-(ii) b. (a)-(iii), (b)-(ii), (c)-(iv), (d)-(i)
c. (a)-(iv), (b)-(iii), (c)-(ii), (d)-(i) d. (a)-(iv), (b)-(ii), (c)-(iii), (d)-(i)

Ans. (c)
Solution
⇒ Cis – Platin $[Pt(NH_3)_2Cl_2]$ used in treatment of cancer.
⇒ Chlorophyll is complex of Mg
⇒ Vitamin B_{12} is a complex of CO
⇒ Grubb's catalyst are a series of catalyst containing ruthenium

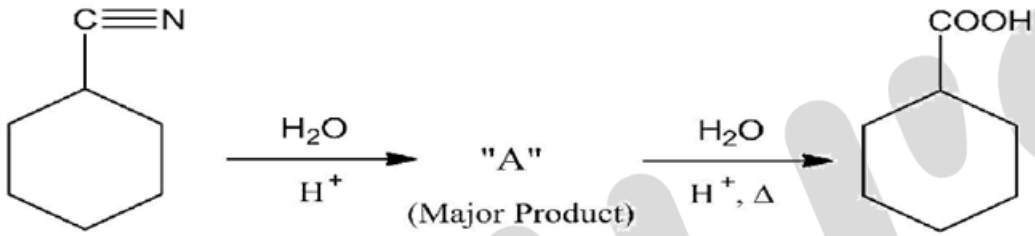
11. The number of ionisable hydrogens present in the product obtained from a reaction of phosphorus trichloride and phosphonic acid is:
a. 3 b. 1 c. 0 d. 2

Ans. (4)
Solution
$PCl_3 + H_3PO_3 + H_2O \rightarrow H_4P_2O_5 + HCl$
pyrophosphorous acid
Structure of pyrophosphorous acid shows that it has two acidic or ionisable hydrogen.

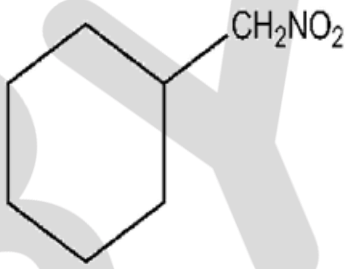
12. A certain orbital has no angular nodes and two radial nodes. The orbital is:
a. 2p b. 3p c. 2s d. 3s

Ans. (d)
Solution
No angular nodes $\Rightarrow \ell = 0$
Radial nodes $= n - \ell - 1 = n - 0 - 1 = 2$
$n = 3$
Ans. 3s

13.



Consider the above chemical reaction and identity product "A":

a.


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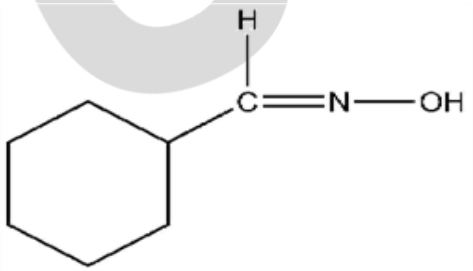
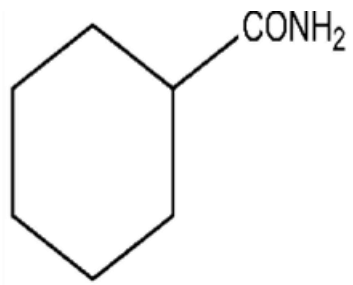
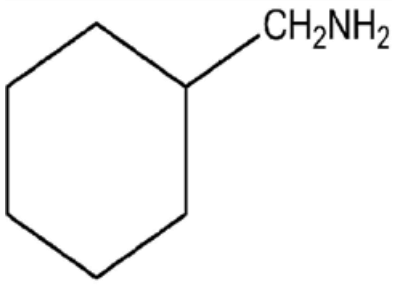
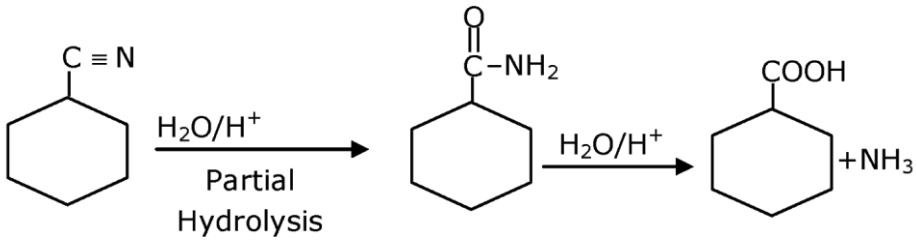


c.


d.


Ans. (c)

Solution



14. Given below are two statements: One is labeled as Assertion A and the other is labeled as Reason R:

Assertion A: During the boiling of water having temporary hardness, $Mg(HCO_3)_2$ is converted to $MgCO_3$.

Reason R: The solubility product of $Mg(OH)_2$ is greater than that of $MgCO_3$.

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

a. A is false but R is true
b. Both A and R are true and R is the correct explanation of A.
c. Both A and R are true but R is NOT the correct explanation of A
d. A is true but R is false.

Ans. (a)

Solution

$Mg(HCO_3)_2 \rightarrow Mg(OH)_2 \downarrow + CO_2$

Temporary Hardness

$Ca(HCO_3)_2 \rightarrow CaCO_3 \downarrow + CO_2 + H_2O$

$K_{sp}\ Mg(OH)_2 > K_{sp}\ MgCO_3$

and Hence $Mg(OH)_2$ precipitation first

15. The chemical is added to reduce the melting point of the reaction mixture during the extraction of aluminium is:

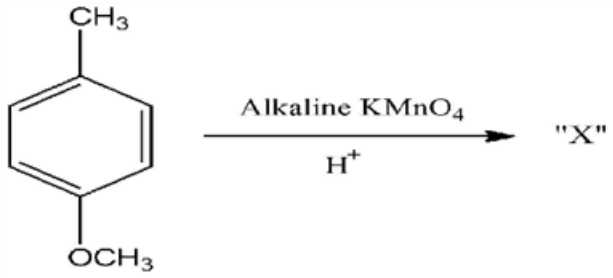
a. Cryolite b. Calamine c. Kaolite d. Bauxite

Ans. (a)

Solution

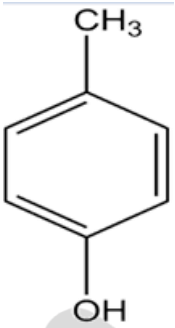
For reducing the melting point of Alumina, Cryolite i.e. Na_3AlF_6 is added.

16.

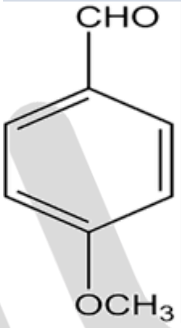


Considering the above chemical reaction, identity the product "X":

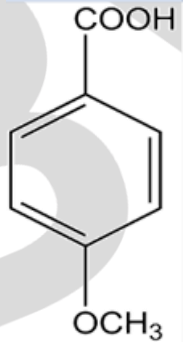
a.



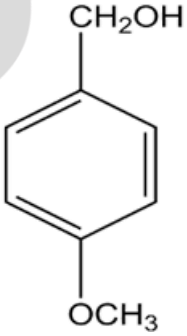
b.



c.

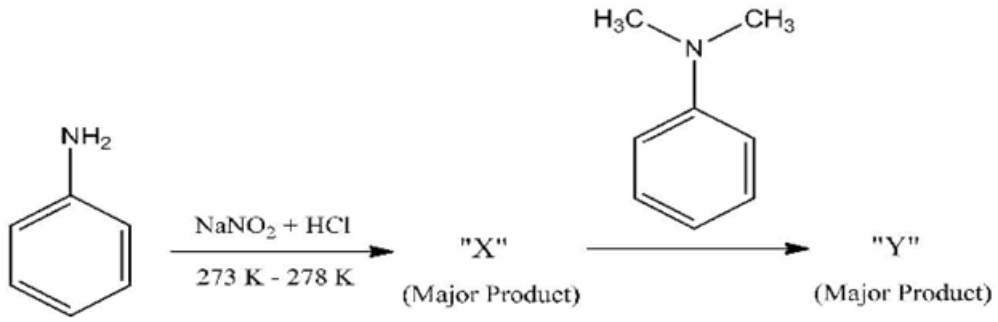


d.



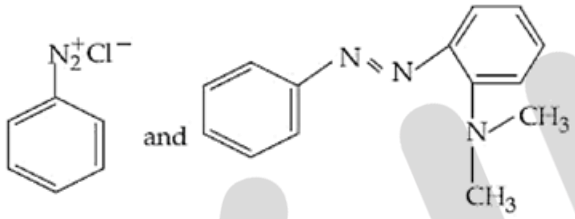
Ans. (c)
Solution:

17.

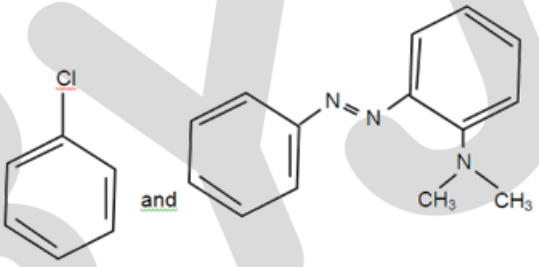


Considering the above reaction, X and Y respectively are:

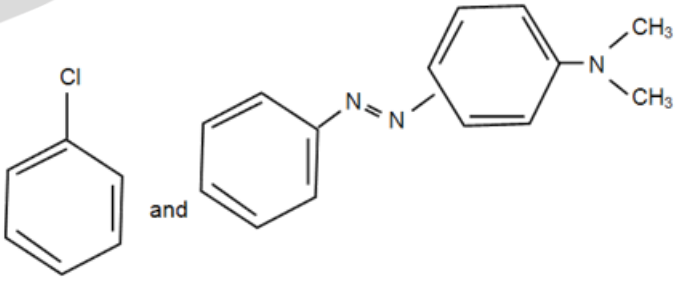
a.



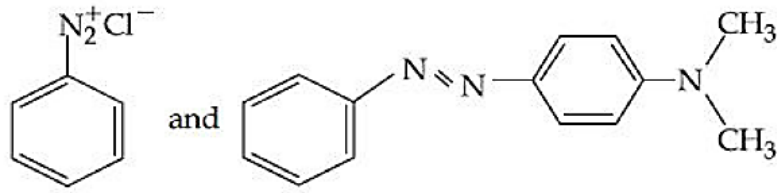
b.



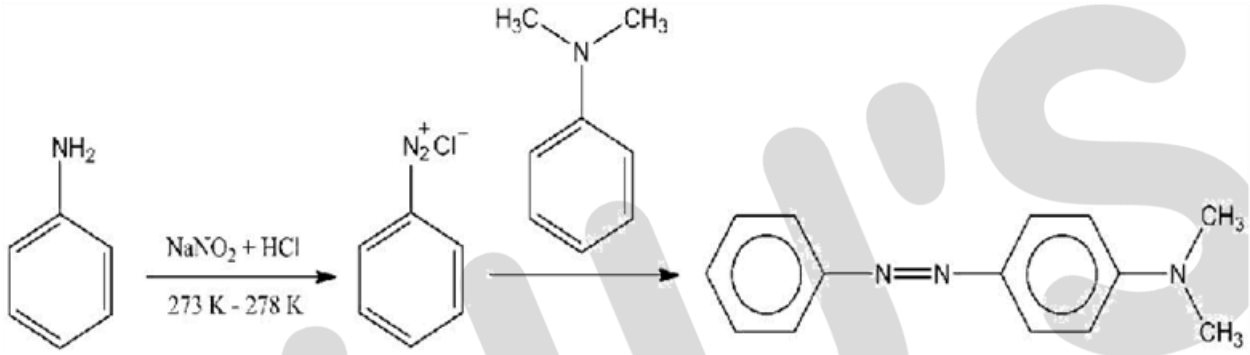
c.



d.

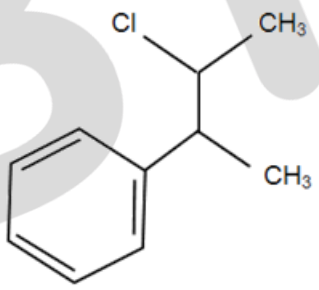


Ans. (d)
Solution

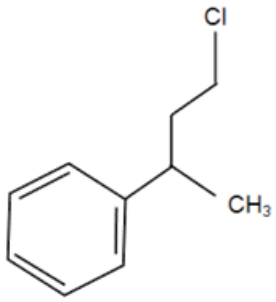


18. Reaction of Grignard reagent, C_2H_5MgBr with C_8H_8O followed by hydrolysis is gives compound "A" which reacts instantly with Lucas reagent to give compound B, $C_{10}H_{13}Cl$. The Compound B is:

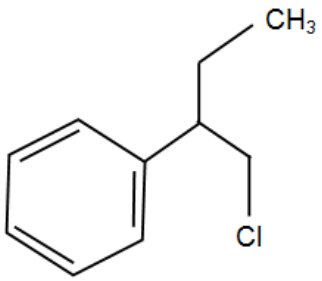
a.



b.



c.



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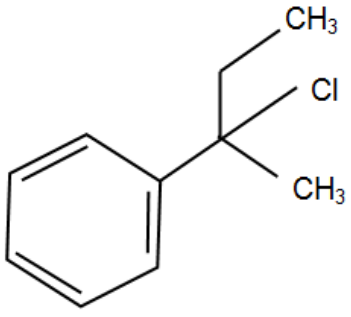
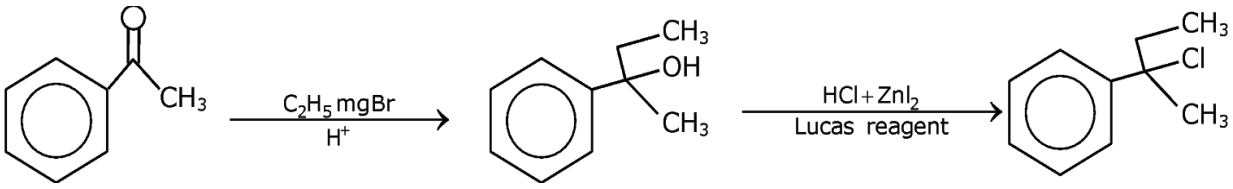


Ans. (d)

Solution $C_8H_8O \xrightarrow[H^+]{C_2H_5mgBr} (A) \xrightarrow{\text{Lucas reagent}} (B)\ C_{10}H_{13}Cl$



19. A non-reducing sugar "A" hydrolyses to give two reducing mono saccharides. Sugar A is:

a. Glucose b. Fructose c. Sucrose d. Galactose

Ans. (c)

Solution $C_{12}H_{22}O_{11} + H_2O \longrightarrow C_6H_{12}O_6 + C_6H_{12}O_6$

Sucrose D-glucose D-fructose

(Non-reducing sugar) (reducing sugar)

A non-reducing sugar is a carbohydrate that is not oxidized by a weak oxidizing agent (an oxidizing agent that oxidises aldehydes but not alcohols, such as the tollen's reagent) in basic aqueous solution

20. Match List-I with List-II:

List-I (Process)	**List-II (Catalyst)**
(a) Deacon's process	(i) ZSM-5
(b) Contact process	(ii) $CuCl_2$
(c) Cracking of hydrocarbons	(iii) Particles 'Ni'
(d) Hydrogenation of vegetables oils	(iv) V_2O_5

Choose the most appropriate answer from the option given below:

a. (a)-(i), (b)-(iii), (c)-(ii), (d)-(iv) b. (a)-(iv), (b)-(ii), (c)-(i), (d)-(iii)

c. (a)-(ii), (b)-(iv), (c)-(i), (d)-(iii) d. (a)-(iii), (b)-(i), (c)-(iv), (d)-(ii)

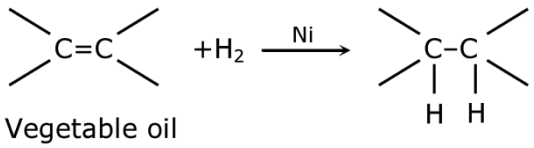
Ans. (c)

Solution

Deacon's process is used for industrial preparation of Chlorine gas

$HCl + O_2 \xrightarrow{CuCl_2} H_2O + Cl_2$

Contact process in used for industrial preparation of sulphuric acid & V_2O_5 in catalyst involved in the process.



$C_xH_4 \xrightarrow[Cracking]{ZSM-5}$ products

SECTION - B

1. 2 molal solution of a weak acid HA has a freezing point of 3.885 °C. The degree of dissociation of this acid is _____ $\times 10^{-3}$. (Round off to the Nearest Integer).
[Given: Molal depression constant of water = 1.85 K kg mol^{-1} Freezing point of pure water = 0^0C]

Ans. 50

Solution

$T_{f\,sol.} = -3.885°C$

$\Delta T_f = +3.885 = i \times k_f \times m$

$3.885 = i \times 1.85 \times 2$

$i = \frac{3.885}{1.85\ X\ 2} = [1 + \propto]$

$\propto = \frac{0.185}{3.7} = 0.05 = 50 \times 10^{-3}$

Ans. 50

2. The total number of unpaired electrons present in the complex $K_3[Cr(oxalate)_3]$ is _____.

Ans. (3)

Solution $K_3[Cr(ox)_3]$

Chromium & in + 3 oxidation state

$Cr \rightarrow 3d^5\ 4s^1$

$Cr^{3+} \rightarrow 3d^3$ 3 unpaired electron the hybridization of chromium in the complex is d^2sp^3

3. AX is a covalent diatomic molecule where A and X are second row elements of periodic table. Based on Molecular orbital theory, the bond order of AX is 2.5. The total number of electrons in AX is _____. (Round off to the Nearest Integer).

Ans. (15)

Solution

The compound AX is NO its bond order is 2.5 & it has total 15 electrons.

4. _____ grams of 3-Hydroxy propanal (MW = 74) must be dehydrated to produce 7.8 g of acrolein (MW = 56) (C_3H_4O) if the percentage yield is 64. (Round off to the Nearest Integer).
[Given: Atomic masses: C : 12.0 u, H : 1.0 u, O : 16.0 u]

Ans. 16
Solution

$HO - CH_2 - CH_2 - CHO$

xmol

$\downarrow$ $- H_2O$

C_3H_4O

7.8 gm

$\frac{7.8}{56} = 0.14$ mol

$\%\ \text{yield} = \frac{7.8/56}{x} \times 100 = 64$

$x = \frac{7.8 \times 100}{56 \times 64} = \frac{780}{56 \times 64}$ mol

$W_{\text{Reactant}} = \frac{780}{56 \times 64} \times 74 = 16.11$ g

5. A reaction of 0.1 mole of Benzyl amine with bromomethane gave 23 g of Benzyl trimethyl ammonium bromide. The number of moles of bromomethane consumed in this reaction are $n \times 10^{-1}$, when n = _____ . (Round off to the Nearest Integer).
[Given: Atomic masses: C: 12.0 u, H : 1.0 u, N : 14.0 u, Br : 80.0 u]]

Ans. (3)
Solution

$Ph - CH_2NH_2 + 3CH_3Br \longrightarrow PhCH_2N^+(Me)_3Br^-$

0.1 mol $\qquad\qquad \frac{23}{230} = 0.1$ mol

$\therefore$ moles of $CH_3Br = 0.3 = 3 \times 10^{-1}$ mol

6. $2NO\ (g) + Cl_2\ (g) \rightarrow 2\ NOCl\ (s)$
This reaction was studied at -10^0C and the following data was obtained.

Run	$[NO]_0$	$[Cl_2]_0$	r_0
1	0.10	0.10	0.18
2	0.10	0.20	0.35
3	0.20	0.20	1.40

$[NO]_0$ and $[Cl_2]_0$ are the initial concentrations and r_0 is the initial reaction rate.
The overall order of the reaction is _____. (Round off to the Nearest Integer).

Ans. (3)

Solution

Exp. (I) $0.18 = K\,(0.1)^{x}\,(0.1)^{+y}$ .... (1)

Exp. (II) $0.35 = K\,(0.1)^{x}\,(0.2)^{y}$ .... (2)

Exp. (III) $1.40 = K\,(0.2)^{x}(0.2)^{y}$ .... (3)

(2) ÷ (3)

$$\frac{0.35}{1.40} = \frac{K \times (0.1)^{x}(0.2)^{y}}{K(0.2)^{x}(0.2)^{y}}$$

$$\frac{1}{4} = \left(\frac{1}{2}\right)^{x} \Rightarrow x = 2$$

(1) ÷ (2)

$$\frac{1}{2} = \left(\frac{1}{2}\right)^{y} \Rightarrow y = 1$$

7. For the reaction

$2Fe^{3+}(aq) + 2I^{-}(aq) \rightarrow 2Fe^{2+}(aq) + I_2(s)$

The magnitude of the standard molar free energy change,

$\Delta_r G_m^0 = -$ _____ kJ (Round off the Nearest Integer).

$$\begin{bmatrix} E^{\circ}_{Fe^{2+}/Fe(s)} = -0.440\ V; E^{\circ}_{Fe^{3+}/Fe(s)} = -0.036V \\ E^{\circ}_{I_2/2I^-} = 0.539\ V; \quad F = 96500\ C \end{bmatrix}$$

Ans. 45 kJ

Solution

$2Fe^{3+}(aq) + 2I^{-}(aq) \longrightarrow 2Fe^{+2}(aq) + I_2(s)$

$$1 \times E^{\circ}_{Fe^{+3}/Fe^{+2}} + 2 \times E^{\circ}_{Fe^{+2}/Fe} = 3 \times E^{\circ}_{Fe^{+3}/Fe}$$

$$E^{\circ}_{Fe^{+3}/Fe^{+2}} = 3 \times (-0.036) - 2 \times (-0.44)$$
$$= -0.108 + 0.88$$
$$= 0.772\ V$$

$$E^{\circ}_{cell} = E^{\circ}_{Fe^{+3}/Fe^{+2}} + E^{\circ}_{I^-/I_2}$$
$$= 0.772 - 0.539 = 0.233\ V$$

$$\Delta G^{\circ} = nFE^0_{cell}$$
$$= +2 \times 96500 \times 0.233$$
$$= 44969\ J = 44.9\ KJ \simeq 45\ KJ$$

8. For the reaction

$C_2H_6 \rightarrow C_2H_4 + H_2$

The reaction enthalpy $\Delta_r H =$ _____ kJ mol^{-1}. (Round off to the Nearest Integer).

[Given: Bond enthalpies in kJ mol^{-1}; C – C: 347, C = C : 611; C – H : 414; H – H ; 436]

Ans. 131 kJ/mol

Solution

$C_2H_6 \longrightarrow C_2H_4 + H_2$

$\Delta H = ??$

$\Delta H = [(E\ c\text{-}c + 6\ E\ C\text{-}H) - (E\ C{=}C + 4E\ C\text{-}H + E\ H\text{-}H)$

$\Delta H = [347 + 6*414] - (611 + 4*414 + 433] = 2831 - 2700$

$= 131$ kJ/mol

9. In order to prepare a buffer solution of pH 5.74, sodium acetate is added to acetic acid. If the concentration of acetic acid in the buffer is 1.0 M, the concentration of sodium acetate in the buffer is _____ M. (Round off to the Nearest Integer).
[Given: pK_a (acetic acid) = 4.74]

Ans. 10

Solution

Buffer $p^H = 5.74 = P(K_a)$ (acetic acid) $+ \log \frac{\text{sodium acetate}}{\text{acetic acid}}$

So, on solving, $\frac{\text{sodium acetate}}{\text{acetic acid}} = 10$

Sodium acetate $= 10$ M

10. Complete combustion of 3 g of ethane gives $x \times 10^{22}$ molecules of water. The value of x is _____. [Round off to the Nearest Integer].
[Use: $N_A = 6.023 \times 10^{23}$; Atomic masses in u : C : 12.0; O : 16.0 : H : 1.0]

Given: 18

Ans. 18

Solution

$C_2H_6 + O_2 \longrightarrow 2CO_2 + 3H_2O$

3gm 0.3 mol

0.1 mol 0.3 N_A

$= 0.3 \times 6.023 \times 10^{23}$ molecules of H_2O

$= 1.8069 \times 10^{23}$

$= 18.069 \times 10^{22}$