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. Match **List-I** with **List-II.**

List-I (Compound)	**List-II (Shape)**
(A) BrF_5	(I) bent
(B) $[CrF_6]^{3-}$	(II) square pyramidal
(C) O_3	(III) trigonal bipyramidal
(D) PCl_5	(IV) octahedral

Choose the **correct** answer from the options given below :

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

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

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

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

Answer (C)

Sol. (A) BrF_5 – square pyramidal

(B) $[CrF_6]^{3-}$ – octahedral

(C) O_3 – bent

(D) PCl_5 – trigonal bipyramidal

2. Match **List-I** with **List-II.**

List-I (Processes/ Reactions)	**List-II (Catalyst)**
(A) $2SO_2(g) + O_2(g) \rightarrow 2SO_3(g)$	(I) Fe(s)
(B) $4NH_3(g) + 5O_2(g) \rightarrow 4NO(g) + 6H_2O(g)$	(II) Pt(s) – Rh(s)
(C) $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$	(III) V_2O_5
(D) Vegetable oil(l) + H_2 $\rightarrow$ Vegetable ghee(s)	(IV) Ni(s)

Choose the **correct** answer from the options given below :

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

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

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

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

Answer (B)

Sol. (A) $2SO_2(g) + O_2(g) \xrightarrow{V_2O_5} 2SO_3$

(B) $4NH_3(g) + 5O_2(g) \xrightarrow{Pt(s)-Rh(s)} 4NO(g) + 6H_2O(g)$

(C) $N_2(g) + 3H_2(g) \xrightarrow{Fe(s)} 2NH_3(g)$

(D) Vegetable oil(l) + H_2 $\xrightarrow{Ni(s)}$ Vegetable ghee(s)

3. Given two statements below:

Statement I : In Cl_2 molecule the covalent radius is double of the atomic radius of chlorine.

Statement II : Radius of anionic species is always greater than their parent atomic radius.

Choose the **most appropriate** answer from options given below:

(A) Both **Statement I** and **Statement II** are correct.

(B) Both **Statement I** and **Statement II** are incorrect.

(C) **Statement I** is correct but **Statement II** is incorrect.

(D) **Statement I** is incorrect but **Statement II** is correct.

Answer (D)

Sol.
- Covalent radius is not double of atomic radius.
- Radius of anionic species is always greater than their parent atomic radius as nuclear charge decreases in anionic counterpart.

4. Refining using liquation method is the most suitable for metals with:

(A) Low melting point

(B) High boiling point

(C) High electrical conductivity

(D) Less tendency to be soluble in melts than impurities

Answer (A)

Sol. Refining using liquation method is the most suitable for metals with low melting point.

5. Which of the following can be used to prevent the decomposition of H_2O_2?

(A) Urea (B) Formaldehyde

(C) Formic acid (D) Ethanol

Answer (A)

Sol. Urea is used as a stabilizer for the storage of H_2O_2.

6. Reaction of $BeCl_2$ with $LiAlH_4$ gives :

(A) $AlCl_3$

(B) BeH_2

(C) LiH

(D) LiCl

(E) $BeAlH_4$

Choose the **correct** answer from options given below :

(A) (A), (D) and (E) (B) (A), (B) and (D)

(C) (D) and (E) (D) (B), (C) and (D)

Answer (B)

Sol. $2BeCl_2 + LiAlH_4 \rightarrow 2BeH_2 + LiCl + AlCl_3$

7. Borazine, also known as inorganic benzene, can be prepared by the reaction of 3-equivalents of "X" with 6-equivalents of "Y". "X" and "Y", respectively are:

(A) $B(OH)_3$ and NH_3

(B) B_2H_6 and NH_3

(C) B_2H_6 and HN_3

(D) NH_3 and B_2O_3

Answer (B)

Sol. $3B_2H_6 + 6NH_3 \rightarrow \underset{\text{(Borazine)}}{2B_3N_3H_6}$

8. Which of the given reactions is not an example of disproportionation reaction?

(A) $2H_2O_2 \rightarrow 2H_2O + O_2$

(B) $2NO_2 + H_2O \rightarrow HNO_3 + HNO_2$

(C) $MnO_4^- + 4H^+ + 3e^- \rightarrow MnO_2 + 2H_2O$

(D) $3MnO_4^{2-} + 4H^+ \rightarrow 2MnO_4^- + MnO_2 + 2H_2O$

Answer (C)

Sol. $\overset{+7}{Mn}O_4^- + 4H^+ + 3e^- \longrightarrow \overset{+4}{Mn}O_2 + 2H_2O$

The above reaction involves the reduction of MnO_4^- to MnO_2.

9. The dark purple colour of $KMnO_4$ disappears in the titration with oxalic acid in acidic medium. The overall change in the oxidation number of manganese in the reaction is :

(A) 5 (B) 1

(C) 7 (D) 2

Answer (A)

Sol. $2K\overset{+7}{Mn}O_4 + 5H_2C_2O_4 + 3H_2SO_4 \rightarrow$

$K_2SO_4 + 2\overset{+2}{Mn}SO_4 + 10CO_2 + 8H_2O$

Change is oxidation state Mn is 5.

10. $\dot{Cl} + CH_4 \rightarrow A + B$

A and B in the above atmospheric reaction step are:

(A) C_2H_6 and Cl_2 (B) $\dot{C}HCl_2$ and H_2

(C) $\dot{C}H_3$ and HCl (D) C_2H_6 and HCl

Answer (C)

Sol. $\dot{Cl} + CH_4 \rightarrow \underset{\text{(A)}}{\dot{C}H_3} + \underset{\text{(B)}}{HCl}$

11. Which technique among the following, is most appropriate in separation of a mixture of 100 mg of *p*-nitrophenol and picric acid?

(A) Steam distillation

(B) 2-5 ft long column of silica gel

(C) Sublimation

(D) Preparative TLC (Thin Layer Chromatography)

Answer (D)

Sol. Thin layer chromatography is a technique used to isolate non-volatile mixtures.

Hence, mixture of p-nitrophenol and Picric acid is separated by TLC.

12. The difference in the reaction of phenol with bromine in chloroform and bromine in water medium is due to:

(A) Hyperconjugation in substrate

(B) Polarity of solvent

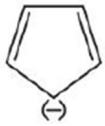
(C) Free radical formation

(D) Electromeric effect of substrate

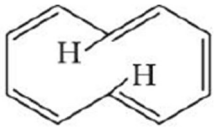
Answer (B)

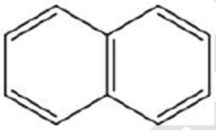
Sol. Phenol gives different products with bromine in chloroform and water medium due to the polarity difference between chloroform and water acting as solvent

13. Which of the following compounds is **not** aromatic?

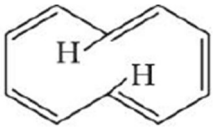
(A) 

(B) 

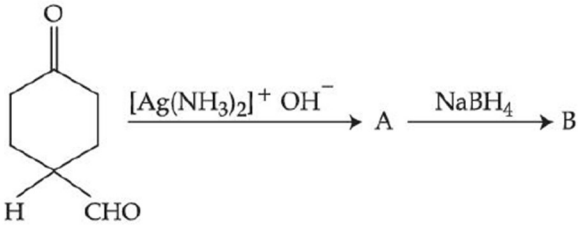
(C) 

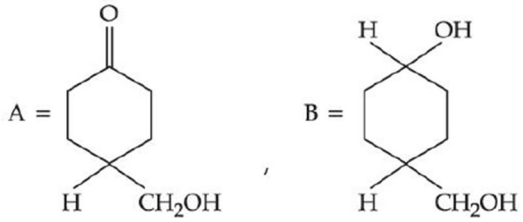
(D) 

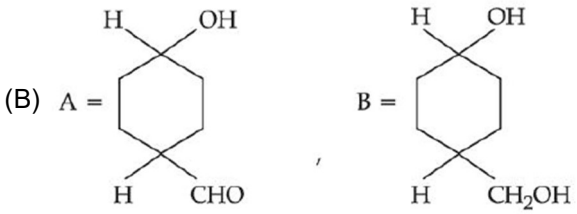
Answer (C)

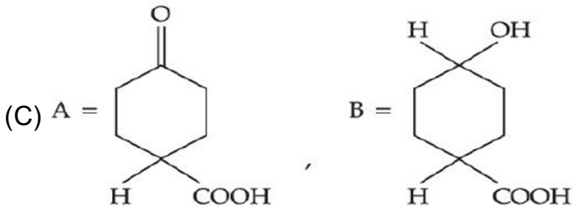
Sol.  is a non-planar compound, hence it is not aromatic.

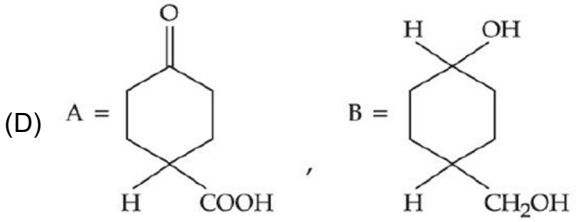
14. The products formed in the following reaction, **A** and **B** are



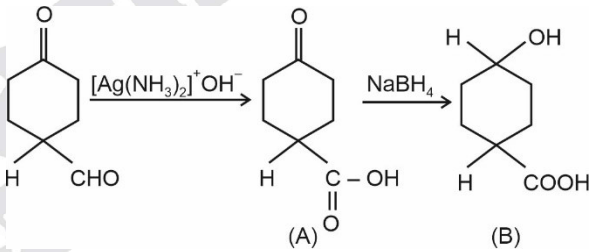
(A) 

(B) 

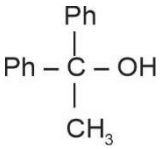
(C) 

(D) 

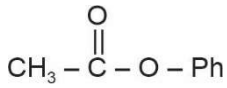
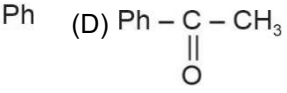
Answer (C)

Sol. 

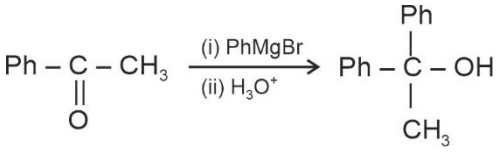
15. Which reactant will give the following alcohol on reaction with one mole of phenyl magnesium bromide (PhMgBr) followed by acidic hydrolysis?



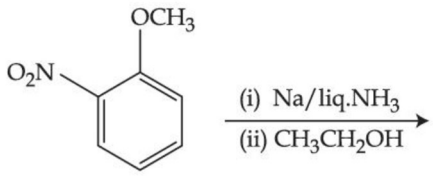
(A) $CH_3 - C \equiv N$ (B) $Ph - C \equiv N$

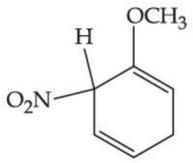
(C)  (D) 

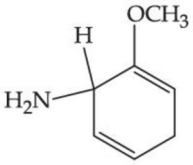
Answer (D)

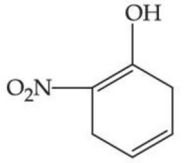
Sol. 

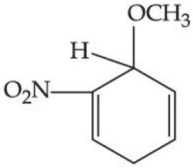
16. The major product of the following reaction is



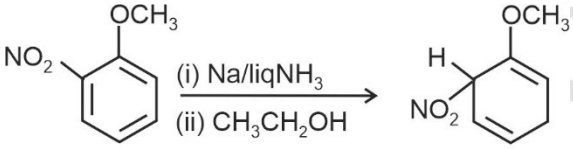
(A) 

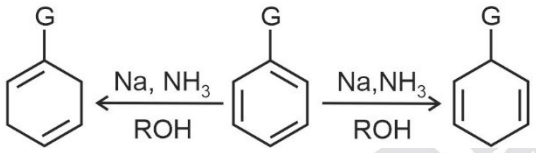
(B) 

(C) 

(D) 

Answer (A)

Sol. 

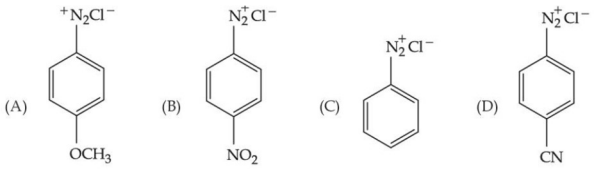


(When G = EDG) (When G = EWG)

EDG → Electron donating group

EWG → Electron withdrawing group

17. The correct stability order of the following diazonium salt is



(A) (A) > (B) > (C) > (D)

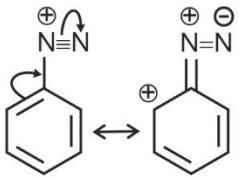
(B) (A) > (C) > (D) > (B)

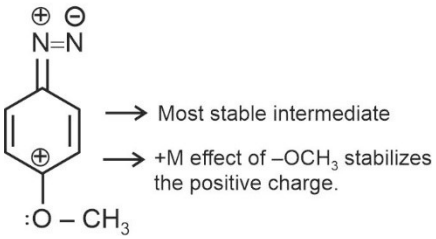
(C) (C) > (A) > (D) > (B)

(D) (C) > (D) > (B) > (A)

Answer (B)

Sol. Diazonium salt containing aryl group directly linked to electron donating group is most stable due to resonance. The +M effect stabilizes the intermediate whereas Electron withdrawing group on benzene destabilizes the intermediate at para position.





Order will be A > C > D > B.

18. Stearic acid and polyethylene glycol react to form which one of the following soap/s detergents?

(A) Cationic detergent (B) Soap

(C) Anionic detergent (D) Non-ionic detergent

Answer (D)

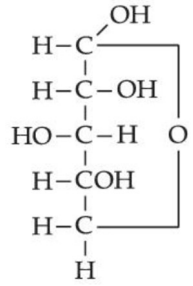
Sol. $CH_3(CH_2)_{16}COOH + HO(CH_2CH_2O)_nCH_2CH_2OH$

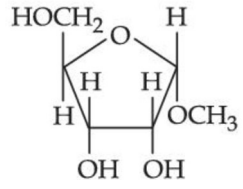
(Stearic acid) $\xrightarrow{-H_2O}$ (Polyethylene glycol)

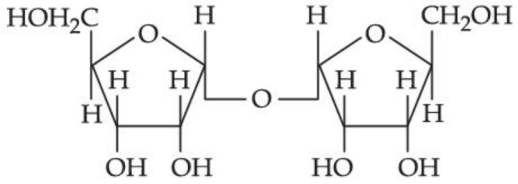
$CH_3(CH_2)_{16}COO(CH_2CH_2O)_n\,CH_2CH_2OH$

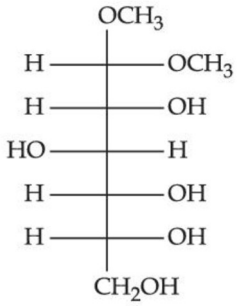
The product do not contain any ion in their constitution hence it is a non-ionic detergent.

19. Which one of the following is a reducing sugar?

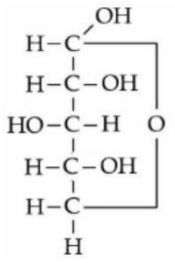
(A) 

(B) 

(C) 

(D) 

Answer (A)

Sol. 

The sugar gives +ve Tollen's test hence it's a reducing sugar.

20. Given below are two statements: one is labelled as **Assertion (A)** and the other is labelled as **Reason (R)**.

Assertion (A) : Experimental reaction of CH_3Cl with aniline and anhydrous $AlCl_3$ does not give *o* and *p*-methylaniline.

Reason (R) : The $-NH_2$ group of aniline becomes deactivating because of salt formation with anhydrous $AlCl_3$ and hence yields *m*-methyl aniline as the product.

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

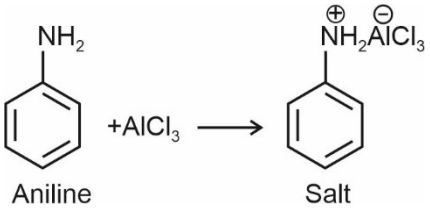
(A) Both **(A)** and **(R)** are true and **(R)** is the correct explanation of **(A)**.

(B) Both **(A)** and **(R)** are true but **(R)** is not the correct explanation of **(A)**.

(C) **(A)** is true, but **(R)** is false.

(D) **(A)** is false, but **(R)** is true.

Answer (C)

Sol. 

Aniline does not undergo Friedel Craft reaction because the reagent $AlCl_3$ being electron deficient acts as a Lewis acid.

SECTION - B

Numerical Value Type Questions: This section contains 10 questions. In Section B, attempt any five questions out of 10. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the second decimal place; e.g. 06.25, 07.00, –00.33, –00.30, 30.27, –27.30) using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer.

1. Chlorophyll extracted from the crushed green leaves was dissolved in water to make 2 L solution of Mg of concentration 48 ppm. The number of atoms of Mg in this solution is x × 10^{20} atoms. The value of x is _____. (Nearest integer)

(Given : Atomic mass of Mg is 24 g mol^{-1}; N_A = 6.02 × 10^{23} mol^{-1})

Answer (24)

Sol. In 2L → 96 mg of Mg

$$\text{Number of atoms of Mg} = \frac{96\times10^{-3}}{24}\times N_A$$

$$= 4\times10^{-3}\times6\times10^{23}$$

$$= 24 \times 10^{20}$$

x = 24

2. A mixture of hydrogen and oxygen contains 40% hydrogen by mass when the pressure is 2.2 bar. The partial pressure of hydrogen is _____ bar. (Nearest integer)

Answer (2)

Sol. 40% w/w hydrogen gas is given in mixture of H_2 and oxygen.

Wt. of H_2 = 40 g

Wt. of O_2 = 60 g

$$\chi_{H_2} = \frac{n_{H_2}}{n_{H_2} + n_{O_2}}$$

$$= \frac{\frac{40}{2}}{\frac{40}{2} + \frac{60}{32}}$$

$$= \frac{20}{20 + 1.875}$$

$$= \frac{20}{21.875} = 0.914$$

$$P_{H_2} = \chi_{H_2} \times P_T$$

$$= 0.914 \times 2.2$$

$$= 2.01 \simeq 2 \text{ bar}$$

3. The wavelength of an electron and a neutron will become equal when the velocity of the electron is x times the velocity of neutron. The value of x is _____. (Nearest integer)

(Mass of electron is 9.1×10^{-31} kg and mass of neutron is 1.6×10^{-27} kg)

Answer (1758)

Sol. $\lambda_e = \frac{h}{m_e \times V_e}$, $\lambda_N = \frac{h}{m_N \times V_N}$

$\lambda_e = \lambda_N$ When $V_e = xV_N$

$$\frac{1}{m_e V_e} = \frac{1}{m_N \times V_N}$$

$$\frac{m_N}{m_e} = \frac{V_e}{V_N} = x$$

$$x = \frac{1.6 \times 10^{-27}}{9.1 \times 10^{-31}}$$

$$= 0.17582 \times 10^4$$

$$\simeq 1758$$

4. 2.4 g coal is burnt in a bomb calorimeter in excess of oxygen at 298 K and 1 atm pressure. The temperature of the calorimeter rises from 298 K to 300 K. The enthalpy change during the combustion of coal is –x kJ mol^{-1}. The value of x is _____. (Nearest integer)

(Given : Heat capacity of bomb calorimeter is 20.0 kJ K^{-1}. Assume coal to be pure carbon)

Answer (200)

Sol. $Q \text{ (Heat evolved)} = -\frac{C_{system}\ \Delta T}{n}$

$$n_{coal} = \frac{2.4}{12}$$

$$Q = \frac{-20(300 - 298)}{0.2}$$

$$Q = -200 \text{ kJ / mol}$$

$$x = 200$$

5. When 800 mL of 0.5 M nitric acid is heated in a beaker, its volume is reduced to half and 11.5 g of nitric acid is evaporated. The molarity of the remaining nitric acid solution is $x \times 10^{-2}$ M. (Nearest integer)

(Molar mass of nitric acid is 63 g mol^{-1})

Answer (54)

Sol. m moles of $HNO_3 = 800 \times 0.5$

Moles of $HNO_3 = 400 \times 10^{-3}$

$= 0.4$ moles

Weight of $HNO_3 = 0.4 \times 63$ g

$= 25.2$ g

Remaining acid = 25.2 – 11.5

= 13.7 g

$$M = \frac{13.7 \times 1000}{400 \times 63}$$

$$= \frac{137}{252} = 0.54$$

$$= 54 \times 10^{-2}$$

6. At 298 K, the equilibrium constant is 2×10^{15} for the reaction:

$Cu(s) + 2Ag^+(aq) \rightleftharpoons Cu^{2+}(aq) + 2Ag(s)$

The equilibrium constant for the reaction

$$\frac{1}{2}Cu^{2+}(aq) + Ag(s) \rightleftharpoons \frac{1}{2}Cu(s) + Ag^+(aq)$$

is $x \times 10^{-8}$. The value of x is _____ (Nearest integer)

Answer (2)

Sol. $Cu(s) + 2Ag^+(aq) \rightleftharpoons Cu^{2+}(aq) + 2Ag(s)$

$k = 2 \times 10^{15}$

$$\frac{1}{2}Cu(s) + Ag^+(aq) \rightleftharpoons Cu^{+2}(aq) + 2Ag(s)$$

$$K' = \frac{1}{(K)^{1/2}} = \frac{1}{\left(2\times10^{15}\right)^{1/2}}$$

$= 2{\cdot}23 \times 10^{-8}$

$x \simeq 2$

7. The amount of charge in F(Faraday) required to obtain one mole of iron from Fe_3O_4 is _____. (Nearest integer)

Answer (3)

Sol. For Fe_3O_4,

$$x = \frac{+8}{3}$$

where x is oxidation state of Fe.

$$Fe_3O_4 + 8H^+ + 8e^- \longrightarrow 3Fe + 4H_2O$$

Charge required = $\frac{8}{3}\times F = \frac{8F}{3} \simeq 3F$

8. For a reaction $A \rightarrow 2B + C$ the half lives are 100 s and 50 s when the concentration of reactant A is 0.5 and 1.0 mol L^{-1} respectively. The order of the reaction is _____. (Nearest integer)

Answer (2)

Sol. $t_{1/2} \propto \frac{1}{(a_0)^{n-1}}$

$t_{1/2} = 100$ sec $\quad a_0 = 0{\cdot}5$

$t_{1/2} = 50$ sec $\quad a_0 = 1$

$$\frac{100}{50} = \left(\frac{1}{0{\cdot}5}\right)^{n-1}$$

$(2) = (2)^{n-1}$

$n - 1 = 1$

$n = 2$

9. The difference between spin only magnetic moment value of $[Co(H_2O)_6]Cl_2$ and $[Cr(H_2O)_6]Cl_3$ is _____.

Answer (0)

Sol. $Co \rightarrow 4s^2\ 3d^7$

H_2O is weak field ligand.

$Co^{+2} \rightarrow 3d^7$

$n = 3 \quad \mu_1 = \sqrt{n(n+2)}$

$= \sqrt{15}$ B.M.

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

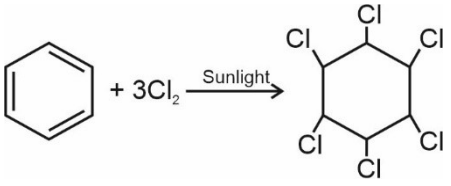
$Co^{+3} \rightarrow 3d^3$

$n = 3 \quad \mu_2 = \sqrt{15}$ B.M.

$\mu_1 - \mu_2 = 0$

10. In the presence of sunlight, benzene reacts with Cl_2 to give product X. The number of hydrogens in X is _____.

Answer (6)

Sol. 

Total number of hydrogens are 6.