

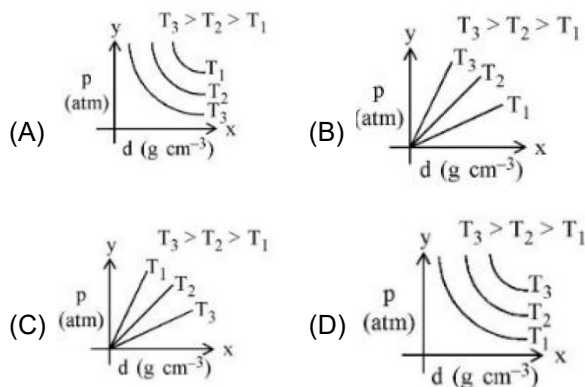
# CHEMISTRY

## 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. Which amongst the given plots is the correct plot for pressure (p) vs density (d) for an ideal gas?

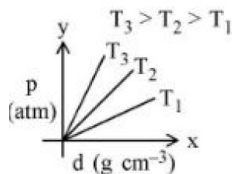


**Answer (B)**

**Sol.**  $\therefore d = \frac{pM}{RT}$

Hence,  $dRT = pM$

$p \propto T$

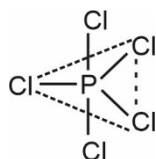


2. Identify the **incorrect** statement for  $\text{PCl}_5$  from the following.

- (A) In this molecule, orbitals of phosphorous are assumed to undergo  $sp^3d$  hybridization.
- (B) The geometry of  $\text{PCl}_5$  is trigonal bipyramidal.
- (C)  $\text{PCl}_5$  has two axial bonds stronger than three equatorial bonds.
- (D) The three equatorial bonds of  $\text{PCl}_5$  lie in a plane

**Answer (C)**

**Sol.**  $\text{PCl}_5$



- All three equatorial bonds in a plane
- $sp^3d$  hybridization
- Trigonal bipyramidal
- Axial bonds are weaker than equatorial bonds.

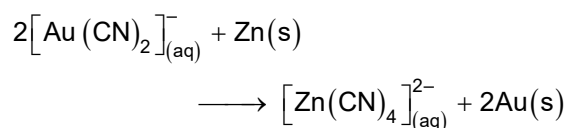
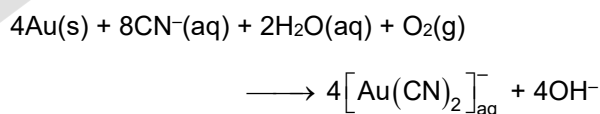
3. Statement-I : Leaching of gold with cyanide ion in absence of air/ $\text{O}_2$  leads to cyano complex of  $\text{Au(III)}$ .  
Statement-II : Zinc is oxidized during the displacement reaction carried out for gold extraction.

In the light of the above statements, choose the **correct** answer from the 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.** Leaching of gold with cyanide ion is done in presence of air/ $\text{O}_2$  leading to cyano complex  $[\text{Au}(\text{CN})_2]^-$  where Au is in +1 oxidation state.



Zinc is oxidised from (0) to +2 oxidation state during displacement reaction carried out for gold extraction.

4. The correct order of increasing intermolecular hydrogen bond strength is
- (A)  $\text{HCN} < \text{H}_2\text{O} < \text{NH}_3$
  - (B)  $\text{HCN} < \text{CH}_4 < \text{NH}_3$
  - (C)  $\text{CH}_4 < \text{HCN} < \text{NH}_3$
  - (D)  $\text{CH}_4 < \text{NH}_3 < \text{HCN}$

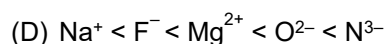
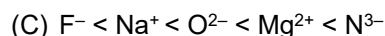
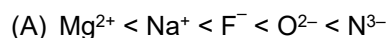
**Answer (C)**

**Sol.** Due to high difference in electronegativity of H and N the H-bond strength of  $\text{NH}_3$  is highest. There is no H-bond in  $\text{CH}_4$ .



Hence, correct option is (C)

5. The correct order of increasing ionic radii is

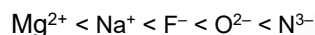


**Answer (A)**

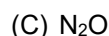
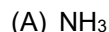
**Sol.** For isoelectronic species

$$\text{Ionic radii} \propto \frac{(-)\text{ve charge}}{(+)\text{ve charge}}$$

Hence, correct order of ionic radii is

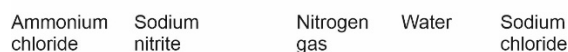
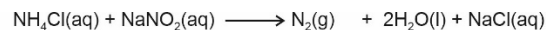


6. The gas produced by treating an aqueous solution of ammonium chloride with sodium nitrite is



**Answer (B)**

**Sol.**  $\text{N}_2$  gas is produced by treating an aqueous solution of ammonium chloride with sodium nitrite.



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

**Assertion A:** Fluorine forms one oxoacid.

**Reason R:** Fluorine has smallest size amongst all halogens and is highly electronegative.

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

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

(2) Both **A** and **R** are correct but **R** is NOT the correct explanation of **A**.

(3) **A** is correct but **R** is not correct.

(4) **A** is not correct but **R** is correct.

**Answer (A)**

**Sol.** Due to smaller size, fluorine forms only one oxoacid.

Both the Assertion and Reason are correct and Reason is the correct explanation.

8. In 3d series, the metal having the highest  $\text{M}^{2+}/\text{M}$  standard electrode potential is



**Answer (C)**

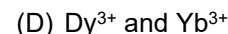
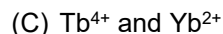
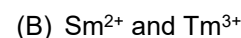
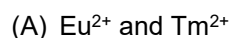
**Sol.** Metal  $E^\circ \text{M}^{2+}/\text{M}$



The metal having highest  $E^\circ(\text{M}^{2+}/\text{M})$  standard reduction potential is Cu.

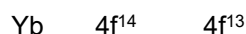
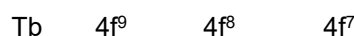
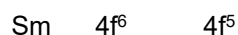
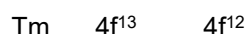
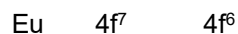
9. The 'f' orbitals are half and completely filled, respectively in lanthanide ions

[Given: Atomic no. Eu, 63; Sm, 62; Tm, 69; Tb, 65; Yb, 70; Dy, 66]



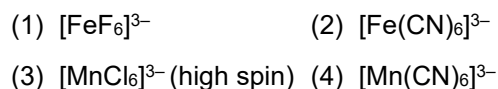
**Answer (C)**

**Sol.**  $+2 \quad +3 \quad +4$



Hence, the pair  $\text{Tb}^{+4} \text{ Yb}^{+2}$  have half filled and completely filled f subshells respectively.

10. Arrange the following coordination compounds in the increasing order of magnetic moments. (Atomic numbers: Mn = 25; Fe = 26)



Choose the correct answer from the options given below:

- (A)  $1 < 2 < 4 < 3$  (B)  $2 < 4 < 3 < 1$   
 (C)  $1 < 3 < 4 < 2$  (D)  $2 < 4 < 1 < 3$

**Answer (B)**

**Sol.**

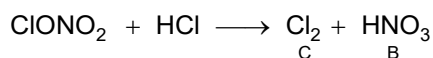
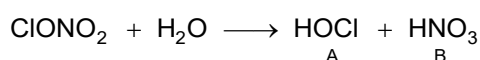
| Coordination Compound                   | Number of unpaired $e^-$ (n) | Magnetic moment ( $\mu$ ) (B.M) |
|---|------------------------------|---------------------------------|
| A $[\text{FeF}_6]^{3-} - d^5$           | 5                            | 5.91                            |
| B $[\text{Fe}(\text{CN})_6]^{3-} - d^5$ | 1                            | 1.73                            |
| C $[\text{MnCl}_6]^{3-} - d^4$          | 4                            | 4.89                            |
| D $[\text{Mn}(\text{CN})_6]^{3-} - d^4$ | 2                            | 2.82                            |

Hence, correct order of magnetic moment is  $2 < 4 < 3 < 1$

11. On the surface of polar stratospheric clouds, hydrolysis of chlorine nitrate gives A and B while its reaction with HCl produces B and C. A, B and C are, respectively
- (A) HOCl,  $\text{HNO}_3$ ,  $\text{Cl}_2$   
 (B)  $\text{Cl}_2$ ,  $\text{HNO}_3$ , HOCl  
 (C)  $\text{HClO}_2$ ,  $\text{HNO}_2$ , HOCl  
 (D) HOCl,  $\text{HNO}_2$ ,  $\text{Cl}_2\text{O}$

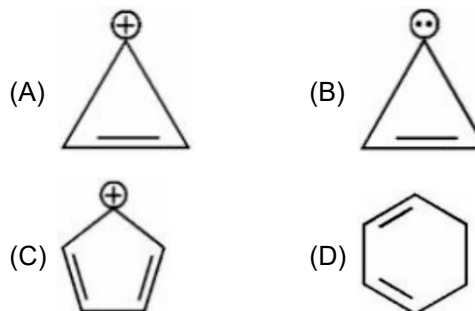
**Answer (A)**

**Sol.** On the surface of polar stratospheric clouds, hydrolysis of chlorine nitrate as

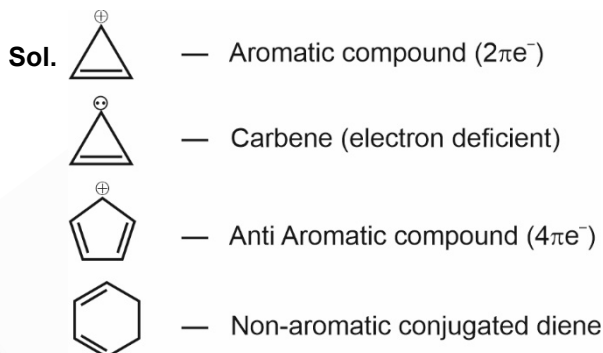


Hence A, B and C are HOCl,  $\text{HNO}_3$  and  $\text{Cl}_2$  respectively.

12. Which of the following is most stable?

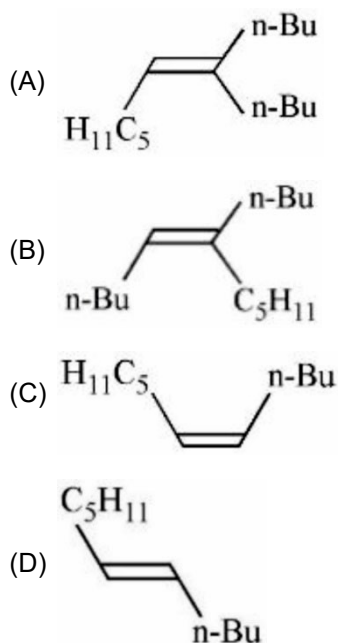
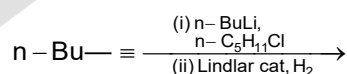


**Answer (D)**

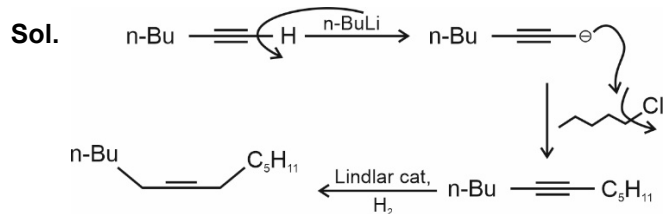


1,3-cyclohexadiene is most stable because it is a neutral molecule. All others are intermediates and hence less stable.

13. What will be the major product of following sequence of reactions?

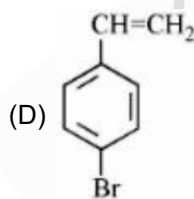
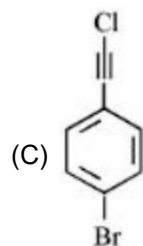
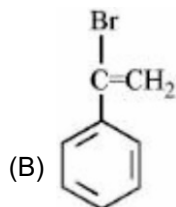
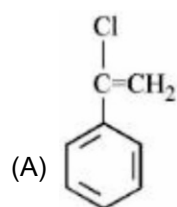
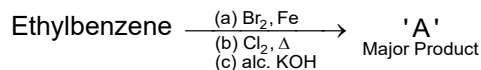


**Answer (C)**



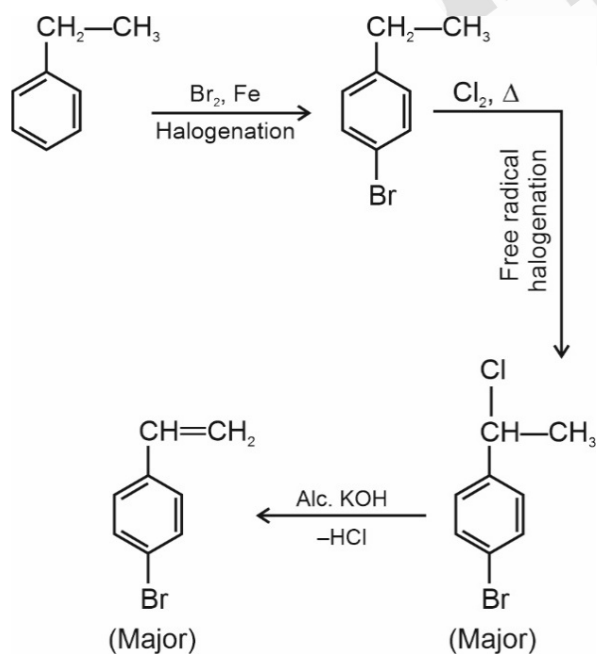
Hence correct option is (C).

14. Product 'A' of following sequence of reactions is



**Answer (D)**

**Sol.**



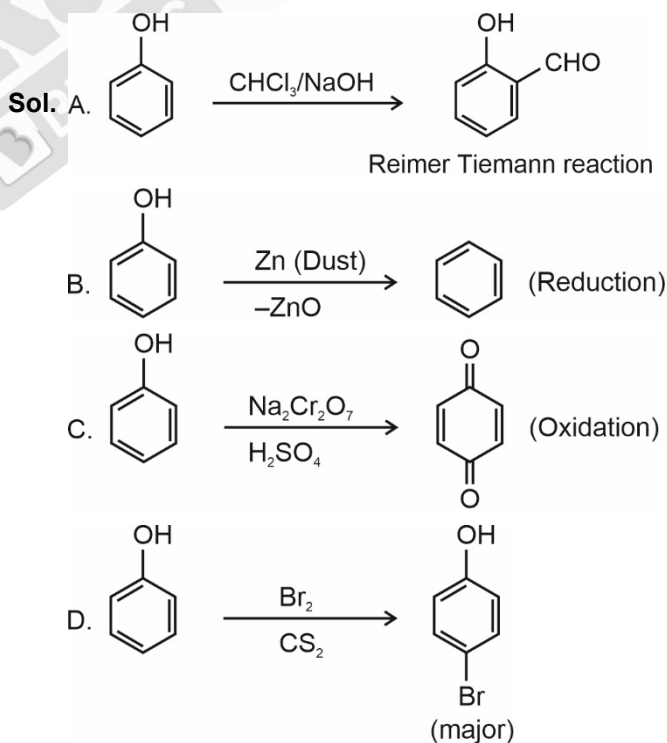
15. Match List I with List II.

| List I | List II   |
|--------|---|
| A.     | I. Br <sub>2</sub> in CS <sub>2</sub>   |
| B.     | II. Na <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub> / H <sub>2</sub> SO <sub>4</sub> |
| C.     | III. Zn   |
| D.     | IV. CHCl <sub>3</sub> /NaOH   |

Choose the correct answer from the options given below:

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

**Answer (A)**



∴ Correct match is

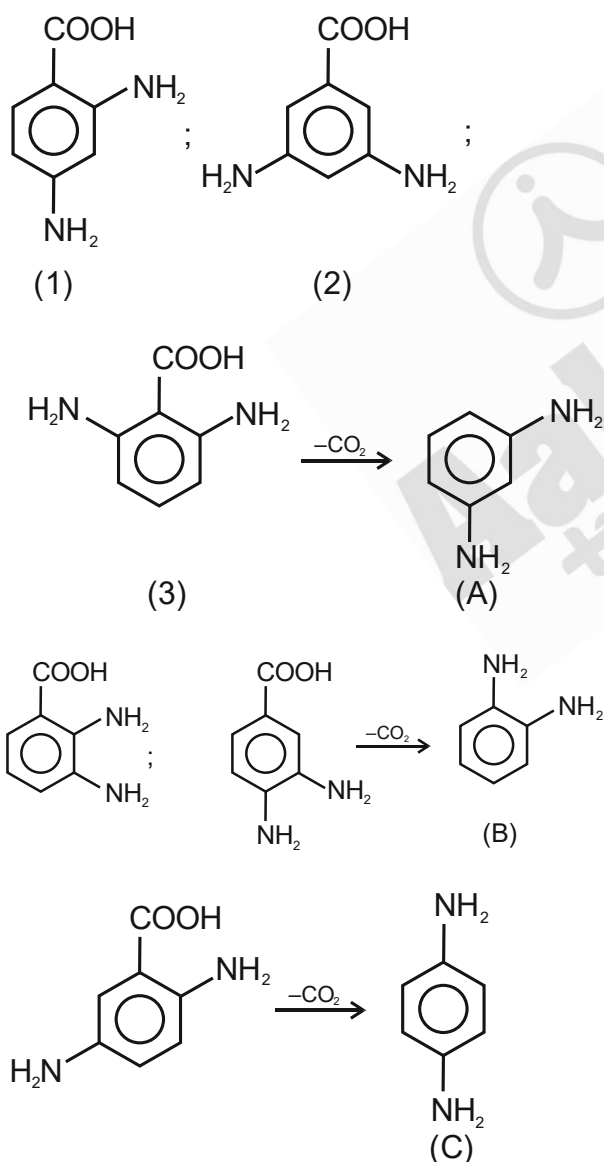
- (A) - IV, (B) - III, (C) - II, (D) - I

16. Decarboxylation of all six possible forms of diaminobenzoic acid  $C_6H_3(NH_2)_2COOH$  yields three products A, B and C. Three acids give a product 'A', two acids give a product 'B' and one acid gives a product 'C'. The melting point of product 'C' is

- (A)  $63^\circ C$   
 (B)  $90^\circ C$   
 (C)  $104^\circ C$   
 (D)  $142^\circ C$

**Answer (D)**

**Sol.** The six possible forms of diaminobenzoic acid are



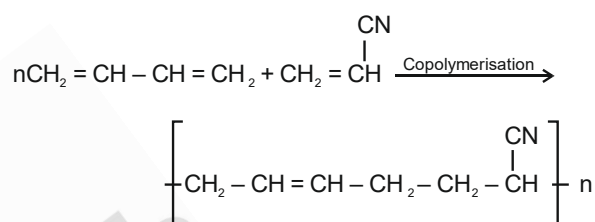
Melting point of product (C) =  $142^\circ C$

17. Which is true about Buna-N?

- (A) It is a linear polymer of 1, 3-butadiene  
 (B) It is obtained by copolymerization of 1, 3-butadiene and styrene  
 (C) It is obtained by copolymerization of 1, 3-butadiene and acrylonitrile  
 (D) The suffix N in Buna-N stands for its natural occurrence.

**Answer (C)**

**Sol.** Buna-N is formed by copolymerisation of 1-3-butadiene and acrylonitrile



18. Given below are two statements

**Statement I:** Maltose has two  $\alpha$ -D-glucose units linked at  $C_1$  and  $C_4$  and is a reducing sugar.

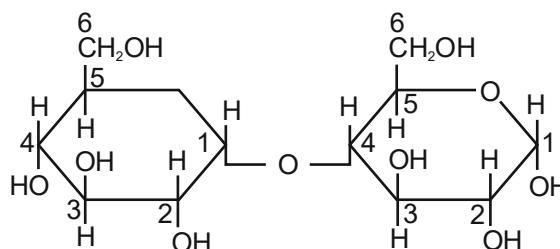
**Statement II:** Maltose has two monosaccharides:  $\alpha$ -D-glucose and  $\beta$ -D-glucose linked at  $C_1$  and  $C_6$  and it is a non-reducing sugar.

In the light of the above statements, choose the **correct** answer from the options given below.

- (A) Both Statement I and Statement II are true  
 (B) Both Statement I and Statement II are false  
 (C) Statement I is true but Statement II is false  
 (D) Statement I is false but Statement II is true

**Answer (C)**

**Sol.** Maltose is composed of two  $\alpha$ -D-glucose units in which  $C_1$  of one glucose unit and  $C_4$  of second glucose unit are linked.



19. Match **List I** with **List II**.

| List I |              | List II |                           |
|--------|--------------|---------|---------------------------|
| A.     | Antipyretic  | I.      | Reduces pain              |
| B.     | Analgesic    | II.     | Reduces stress            |
| C.     | Tranquilizer | III.    | Reduces fever             |
| D.     | Antacid      | IV.     | Reduces acidity (stomach) |

Choose the correct answer from the options given below:

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

**Answer (A)**

**Sol.** Antipyretic – Reduces fever  
Analgesic – Reduces pain  
Tranquilizer – Reduces stress  
Antacid – Reduces Acidity (stomach)

20. Match **List I** with **List II**.

| List I<br>(Anion) |                               | List II<br>(gas evolved on reaction with dil H <sub>2</sub> SO <sub>4</sub> ) |  |
|-------------------|-------------------------------|---|--|
| A.                | CO <sub>3</sub> <sup>2-</sup> | I.  | Colourless gas which turns lead acetate paper black.                           |
| B.                | S <sup>2-</sup>               | II.   | Colourless gas which turns acidified potassium dichromate solution green       |
| C.                | SO <sub>3</sub> <sup>2-</sup> | III.  | Brown fumes which turns acidified KI solution containing starch blue.          |
| D.                | NO <sub>2</sub> <sup>-</sup>  | IV.   | Colourless gas evolved with brisk effervescence, which turns lime water milky. |

Choose the correct answer from the options given below:

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

**Answer (D)**

**Sol.** CO<sub>3</sub><sup>2-</sup> : On action of dil sulphuric acid, CO<sub>2</sub> gas is released which turns lime water milky.

S<sup>2-</sup> : On action of dil sulphuric acid, H<sub>2</sub>S gas is released which turns lead acetate paper black.

SO<sub>3</sub><sup>2-</sup> : On action of dil H<sub>2</sub>SO<sub>4</sub>, SO<sub>2</sub> gas is evolved which turns acidified potassium dichromate solution green.

NO<sub>2</sub><sup>-</sup> : On action of dil H<sub>2</sub>SO<sub>4</sub>, NO<sub>2</sub> gas is evolved which turns KI solution containing starch blue.

### 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. 116 g of a substance upon dissociation reaction, yields 7.5 g of hydrogen, 60 g of oxygen and 48.5 g of carbon. Given that the atomic masses of H, O and C are 1, 16 and 12, respectively. The data agrees with how many formulae of the following?

- A. CH<sub>3</sub>COOH      B. HCHO  
C. CH<sub>3</sub>OOCH<sub>3</sub>      D. CH<sub>3</sub>CHO

**Answer (2)**

**Sol.**

| Element | Mass% | Moles% | Relative moles |
|---------|-------|--------|----------------|
| H       | 6.46  | 6.46   | 2              |
| O       | 51.72 | 3.23   | 1              |
| C       | 41.81 | 3.48   | 1              |



∴ Empirical formula = COH<sub>2</sub>

The empirical formula goes with acetic acid CH<sub>3</sub>COOH and formaldehyde HCHO.

Thus data agrees with 2 formulae.

2. Consider the following set of quantum numbers.

|    | n | l | m <sub>l</sub> |
|----|---|---|----------------|
| A. | 3 | 3 | -3             |
| B. | 3 | 2 | -2             |
| C. | 2 | 1 | +1             |
| D. | 2 | 2 | +2             |

The number of correct sets of quantum numbers is \_\_\_\_\_.

**Answer (2)**

**Sol.** The correct sets of Quantum numbers are, (02)

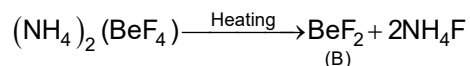
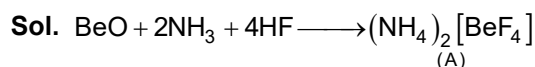
$$n = 3 \quad l = 2 \quad m_l = -2$$

$$\text{and } n = 2 \quad l = 1 \quad m_l = +1$$

l can have values from 0 to (n - 1) and m can have values from -l..... 0 .....+l (2l + 1)

3. BeO reacts with HF in presence of ammonia to give [A] which on thermal decomposition produces [B] and ammonium fluoride. Oxidation state of Be in [A] is \_\_\_\_\_

**Answer (2)**



Oxidation State of Be in (A) is (+2)

4. When 5 moles of He gas expand isothermally and reversibly at 300 K from 10 litre to 20 litre, the magnitude of the maximum work obtained is \_\_\_\_\_ J. [nearest integer] (Given : R = 8.3 J K<sup>-1</sup> mol<sup>-1</sup> and log 2 = 0.3010)

**Answer (8630)**

$$\begin{aligned} \text{Sol. } W_{\text{rev}} &= -2.303 nRT \log_{10} \left( \frac{V_2}{V_1} \right) \\ &= -2.303 \times 5 \times 8.3 \times 300 \times \log_{10} \left( \frac{20}{10} \right) \\ &\approx -8630 \text{ J} \end{aligned}$$

5. A solution containing  $2.5 \times 10^{-3}$  kg of a solute dissolved in  $75 \times 10^{-3}$  kg of water boils at 373.535 K. The molar mass of the solute is \_\_\_\_\_ g mol<sup>-1</sup>. [nearest integer] (Given : K<sub>b</sub>(H<sub>2</sub>O) = 0.52 K kg mol<sup>-1</sup> and boiling point of water = 373.15 K)

**Answer (45)**

$$\text{Sol. } W_{\text{solute}} = 2.5 \times 10^{-3} \text{ kg}$$

$$W_{\text{solvent}} = 75 \times 10^{-3} \text{ kg}$$

$$\Delta T_b = 373.535 - 373.15$$

$$= 0.385 \text{ K}$$

$$K_b(\text{H}_2\text{O}) = 0.52 \text{ K kg mol}^{-1}$$

$$\Delta T_b = \frac{K_b \times 10^3 \times W_{\text{solute}}}{M_{\text{solute}} \times W_{\text{solvent}}}$$

$$M_{\text{solute}} = \frac{0.52 \times 10^3 \times 2.5 \times 10^{-3}}{75 \times 10^{-3} \times 0.385}$$

$$= 45.02$$

$$\approx 45$$

6. pH value of 0.001 M NaOH solution is \_\_\_\_\_.

**Answer (11)**

$$\text{Sol. } [\text{OH}^-] = 0.001 = 10^{-3} \text{ M}$$

$$[\text{H}^+][\text{OH}^-] = 10^{-14}$$

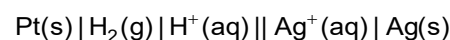
$$[\text{H}^+] = 10^{-11}$$

$$\text{pH} = -\log[\text{H}^+]$$

$$= -\log(10^{-11})$$

$$\text{pH} = 11$$

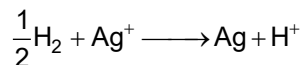
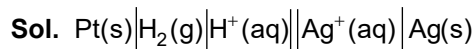
7. For the reaction taking place in the cell:



$$E^\circ_{\text{cell}} = +0.5332 \text{ V.}$$

The value of  $\Delta_r G^\ominus$  is \_\_\_\_\_ kJ mol<sup>-1</sup> [in nearest integer]

**Answer (51)**



$$n = 1$$

$$E_{\text{cell}}^\circ = 0.5332$$

$$\Delta G^\circ = -nFE^\circ$$

$$= -1 \times 96500 \times 0.5332$$

$$= -51.453 \text{ kJ/mole}$$

$$\approx -51 \text{ kJ/mole}$$

8. It has been found that for a chemical reaction with rise in temperature by 9 K the rate constant gets doubled. Assuming a reaction to be occurring at 300 K, the value of activation energy is found to be \_\_\_\_\_ kJ mol<sup>-1</sup>. [nearest integer]

(Given  $\ln 10 = 2.3$ ,  $R = 8.3 \text{ J K}^{-1} \text{ mol}^{-1}$ ,  $\log 2 = 0.30$ )

**Answer (59)**

**Sol.**  $T_1 = 300 \text{ K}$

(Rate constant)

$$K_2 = 2K_1, \text{ on increase temperature by } 9\text{K}$$

$$T_2 = 309 \text{ K}$$

$$E_a = ?$$

$$\log \frac{K_2}{K_1} = \frac{E_a}{2.3R} \left[ \frac{T_2 - T_1}{T_2 \cdot T_1} \right]$$

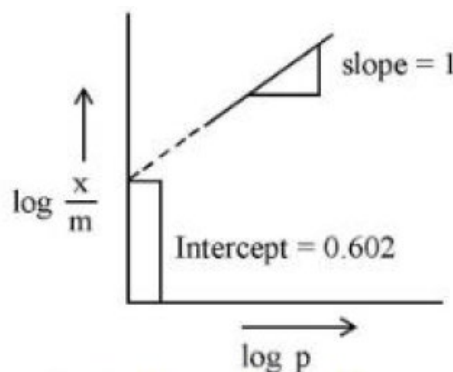
$$\log 2 = \frac{E_a}{2.3 \times 8.3} \left[ \frac{9}{309 \times 300} \right]$$

$$E_a = \frac{0.3 \times 309 \times 300 \times 2.3 \times 8.3}{9}$$

$$= 58988.1 \text{ J / mole}$$

$$\approx 59 \text{ kJ/mole}$$

9.



If the initial pressure of a gas 0.03 atm, the mass of the gas absorbed per gram of the adsorbent is \_\_\_\_\_  $\times 10^{-2}$ g.

**Answer (12)**

**Sol.** Given that  $\log K = \text{intercept} = 0.602 = \log 4$

$$\therefore K = 4$$

$$\text{Slope} = \frac{1}{n} = 1$$

and initial pressure = 0.03 atm

$$\frac{x}{m} = K(p)^{1/n} = 4 \times 0.03 = 0.12 = 12 \times 10^{-2}$$

$$\therefore \text{mass of gas absorbed per gm of adsorbent} = 12 \times 10^{-2} \text{ g}$$

10. 0.25 g of an organic compound containing chlorine gave 0.40 g of silver chloride in Carius estimation. The percentage of chlorine present in the compound is \_\_\_\_\_. [in nearest integer]

(Given : Molar mass of Ag is 108 g mol<sup>-1</sup> and that of Cl is 35.5 g mol<sup>-1</sup>)

**Answer (40)**

**Sol.** Mass of organic compound = 0.25 g

$$\text{Mass of AgCl} = 0.40 \text{ g}$$

$$\% \text{ Cl} = \frac{35.5 \times (\text{mass of AgCl})}{143.5 \times (\text{mass of organic compound})} \times 100$$

$$= \frac{35.5 \times 0.40 \times 100}{143.5 \times 0.25}$$

$$= 39.581$$

$$\approx 40$$

$$\% \text{ Cl} = 40 \%$$