

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. Haemoglobin contains 0.34% of iron by mass. The number of Fe atoms in 3.3 g of haemoglobin is
(Given : Atomic mass of Fe is 56 u, $N_A = 6.022 \times 10^{23} \text{ mol}^{-1}$)
- (A) 1.21×10^5 (B) 12.0×10^{16}
(C) 1.21×10^{20} (D) 3.4×10^{22}

Answer (C)

Sol. According to the question,

100 g of haemoglobin contains 0.34 g of iron

3.3 g of haemoglobin contains $\frac{0.34}{100} \times 3.3$ g of iron

$$\text{moles of Fe} = \frac{0.34 \times 3.3}{100 \times 56} = \frac{N}{N_A}$$

$$N = \frac{0.34 \times 3.3 \times 6.022 \times 10^{23}}{100 \times 56}$$

$$= 1.21 \times 10^{20}$$

2. Arrange the following in increasing order of their covalent character.
- A. CaF_2
B. CaCl_2
C. CaBr_2
D. CaI_2

Choose the correct answer from the option given below.

- (A) $B < A < C < D$ (B) $A < B < C < D$
(C) $A < B < D < C$ (D) $A < C < B < D$

Answer (B)

Sol. From Fajan's rule, for a given metal ion, as the size of anion increases, polarizability of anion increases and hence covalent character of the given ionic compound increases.

Hence, the increasing order of covalent character is $\text{CaF}_2 < \text{CaCl}_2 < \text{CaBr}_2 < \text{CaI}_2$

3. Class XII students were asked to prepare one litre of buffer solution of pH 8.26 by their Chemistry teacher. The amount of ammonium chloride to be dissolved by the student in 0.2 M ammonia solution to make one litre of the buffer is

(Given : $\text{p}K_b(\text{NH}_3) = 4.74$, Molar mass of $\text{NH}_3 = 17 \text{ g mol}^{-1}$, Molar mass of $\text{NH}_4\text{Cl} = 53.5 \text{ g mol}^{-1}$)

- (A) 53.5 g (B) 72.3 g
(C) 107.0 g (D) 126.0 g

Answer (C)

Sol. For basic Buffer, $\text{pOH} = \text{p}K_b + \log \frac{[\text{salt}]}{[\text{Base}]}$

$$\text{pOH} = 14 - 8.26 = 5.74$$

$$5.74 = 4.74 + \log \frac{[\text{NH}_4\text{Cl}]}{0.2}$$

$$[\text{NH}_4\text{Cl}] = 2 \text{ M}$$

Moles of $\text{NH}_4\text{Cl} = 2 \times 1 = 2$ moles

Weight of $\text{NH}_4\text{Cl} = 2 \times 53.5 = 107 \text{ g}$

4. At 30°C , the half life for the decomposition of AB_2 is 200 s and is independent of the initial concentration of AB_2 . The time required for 80% of the AB_2 to decompose is

(Given : $\log 2 = 0.30$, $\log 3 = 0.48$)

- (A) 200 s (B) 323 s
(C) 467 s (D) 532 s

Answer (C)

Sol. Since, half life is independent of the initial concentration of AB_2 . Hence, reaction is "First Order".

$$k = \frac{2.303 \log 2}{t_{1/2}}$$

$$\frac{2.303 \log 2}{t_{1/2}} = \frac{2.303}{t} \log \frac{100}{(100 - 80)}$$

$$\frac{2.303 \times 0.3}{200} = \frac{2.303}{t} \log 5$$

$$t = 467 \text{ s}$$

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

Assertion A : Finest gold is red in colour, as the size of the particles increases, it appears purple then blue and finally gold.

Reason R : The colour of the colloidal solution depends on the wavelength of light scattered by the dispersed particles.

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 (A)

Sol. Finest gold sol is red in colour; as the size of particles increases, it appears purple, then blue and finally golden.

The colour of colloidal solution depends on the wavelength of light scattered by the dispersed particles. The wavelength of light further depends on size and nature of the particles.

Hence, Both **A** and **R** are true and **R** is the correct explanation of **A**

6. The metal that has very low melting point and its periodic position is closer to a metalloid is

- (A) Al (B) Ga
 (C) Se (D) In

Answer (B)

Sol Among the given elements, Gallium has the lowest melting point, Gallium is also close to a metalloid

7. The metal that is not extracted from its sulfide ore is

- (A) Aluminium
 (B) Iron
 (C) Lead
 (D) Zinc

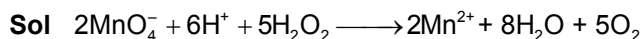
Answer (A)

Sol Aluminium is not extracted from sulphide ore. It is usually extracted from bauxite ore, leaching of bauxite ore is done followed by electrolytic reduction.

8. The products obtained from a reaction of hydrogen peroxide and acidified potassium permanganate are

- (A) Mn^{4+} , H_2O only
 (B) Mn^{2+} , H_2O only
 (C) Mn^{4+} , H_2O , O_2 only
 (D) Mn^{2+} , H_2O , O_2 only

Answer (D)



This reaction shows reducing action of H_2O_2 in acidic medium.

The products formed are Mn^{2+} , H_2O and O_2

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

Assertion A : LiF is sparingly soluble in water.

Reason R : The ionic radius of Li^+ ion is smallest among its group members, hence has least hydration enthalpy.

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 LiF is sparingly soluble in water.

The low solubility of LiF in water is due to its high lattice enthalpy (Since Li^+ and F^- are small in size). Also, due to small size of Li^+ , its hydration enthalpy is high.

Hence, Assertion is true but Reason is false

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

Assertion A: Boric acid is a weak acid

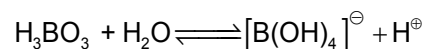
Reason R: Boric acid is not able to release H^+ ion on its own. It receives OH^- ion from water and releases H^+ ion.

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

- (A) Both **A** and **R** are correct and **R** is the correct explanation of **A**.
 (B) Both **A** and **R** are correct but **R** is NOT the correct explanation of **A**
 (C) **A** is correct but **R** is not correct
 (D) **A** is not correct but **R** is correct

Answer (A)

Sol Boric acid is a weak acid



Boric acid is not able to release H^+ ion on its own. It receives OH^- ion from water and releases H^+ ion as shown in the above reaction.

Hence, Both A and R are correct and R is the correct explanation of A.

11. The metal complex that is diamagnetic is (Atomic number : Fe, 26; Cu, 29)

- (A) $\text{K}_3[\text{Cu}(\text{CN})_4]$ (B) $\text{K}_2[\text{Cu}(\text{CN})_4]$
 (C) $\text{K}_3[\text{Fe}(\text{CN})_4]$ (D) $\text{K}_4[\text{FeCl}_6]$

Answer (A)

Sol. $\Rightarrow \text{K}_3[\text{Cu}(\text{CN})_4]$ is diamagnetic

$\text{Cu(I)} \Rightarrow d^{10}$ configuration \Rightarrow No unpaired electrons.

$\Rightarrow \text{K}_2[\text{Cu}(\text{CN})_4]$, $\text{K}_3[\text{Fe}(\text{CN})_4]$ and $\text{K}_4[\text{FeCl}_6]$ are paramagnetic in nature

12. Match **List I** with **List II**.

List I Pollutant	List II Source
A. Microorganisms	I. Strip mining
B. Plant nutrients	II. Domestic sewage
C. Toxic heavy metals	III. Chemical fertilizer
D. Sediment	IV. Chemical factory

Choose the correct answer from the options given below:

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

Answer (A)

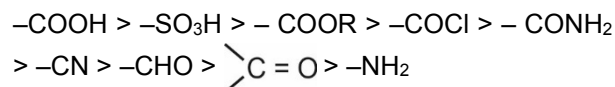
Sol. Pollutant	Source
Microorganisms	\rightarrow Domestic sewage
Plant nutrients	\rightarrow Chemical fertilizers
Toxic heavy metals	\rightarrow Chemical factory
Sediment	\rightarrow Strip mining

13. The correct decreasing order of priority of functional groups in naming an organic compound as per IUPAC system of nomenclature is

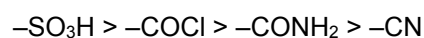
- (A) $-\text{COOH} > -\text{CONH}_2 > -\text{COCl} > -\text{CHO}$
 (B) $-\text{SO}_3\text{H} > -\text{COCl} > -\text{CONH}_2 > -\text{CN}$
 (C) $-\text{COOR} > -\text{COCl} > -\text{NH}_2 > \text{>C=O}$
 (D) $-\text{COOH} > -\text{COOR} > -\text{CONH}_2 > -\text{COCl}$

Answer (B)

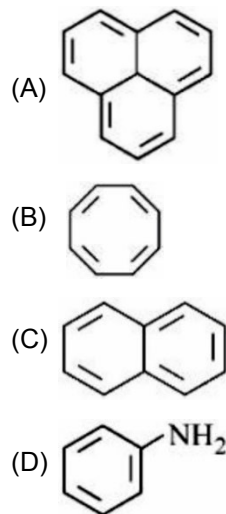
Sol. The order of decreasing priority for functional group is



Hence correct order is



14. Which of the following is not an example of benzenoid compound?



Answer (A) and (B)

Sol. and are not benzenoid compounds, since benzenoid compound contains benzene ring.

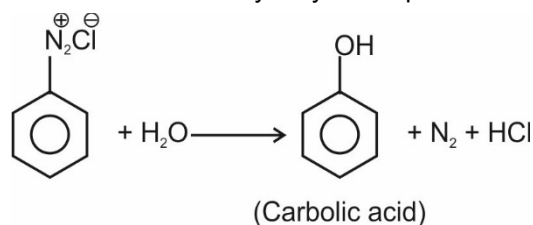
15. Hydrolysis of which compound will give carbolic acid?

- (A) Cumene
(B) Benzenediazonium chloride
(C) Benzal chloride
(D) Ethylene glycol ketal

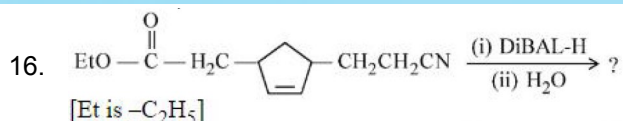
Answer (B)

Sol. Phenol, is known as Carbolic acid.

Diazonium salt are hydrolysed to phenols.



Benzal chloride on hydrolysis gives benzaldehyde

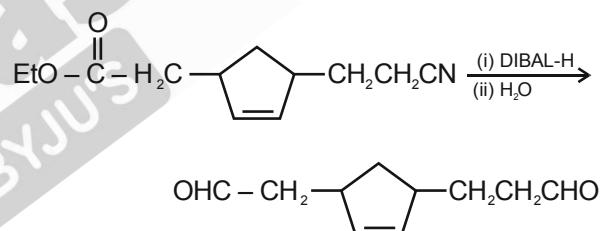


Consider the above reaction and predict the major product.

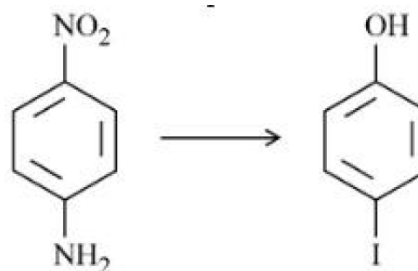
- (A) $\text{OHC}-\text{H}_2\text{C}-\text{Cyclopentene}-\text{CH}_2\text{CH}_2\text{CHO}$
- (B) $\text{EtO}-\overset{\text{O}}{\parallel}{\text{C}}-\text{H}_2\text{C}-\text{Cyclopentene}-\text{CH}_2\text{CH}_2\text{CHO}$
- (C) $\text{EtO}-\overset{\text{O}}{\parallel}{\text{C}}-\text{H}_2\text{C}-\text{Cyclopentene}-\text{CH}_2\text{CH}_2\text{COOH}$
- (D) $\text{OHC}-\text{H}_2\text{C}-\text{Cyclopentene}-\text{CH}_2\text{CH}_2\text{COOH}$

Answer (A)

Sol. DIBAL-H reduces both the cyanides and esters to aldehydes.



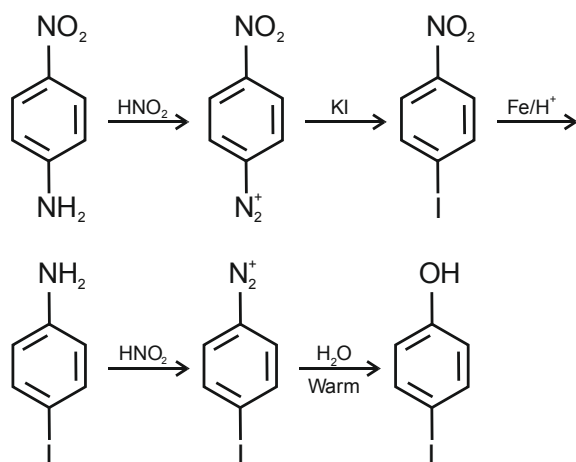
17. The correct sequential order of the reagents for the given reaction is



- (A) HNO_2 , Fe/H^+ , HNO_2 , KI , $\text{H}_2\text{O}/\text{H}^+$
(B) HNO_2 , KI , Fe/H^+ , HNO_2 , $\text{H}_2\text{O}/\text{warm}$
(C) HNO_2 , KI , HNO_2 , Fe/H^+ , $\text{H}_2\text{O}/\text{H}^+$
(D) HNO_2 , Fe/H^+ , KI , HNO_2 , $\text{H}_2\text{O}/\text{warm}$

Answer (B)

Sol.



18. Vulcanization of rubber is carried out by heating a mixture of

- (A) isoprene and styrene
- (B) neoprene and sulphur
- (C) isoprene and sulphur
- (D) neoprene and styrene

Answer (C)

Sol. When a mixture of isoprene and sulphur is heated, isoprene gets polymerised to natural rubber and then vulcanization of natural rubber with sulphur takes place.

19. Animal starch is the other name of

- (A) amylose
- (B) maltose
- (C) glycogen
- (D) amylopectin

Answer (C)

Sol. Animal starch is the other name of glycogen because its structure is similar to amylopectin.

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

Assertion A: Phenolphthalein is a pH dependent indicator, remains colourless in acidic solution and gives pink colour in basic medium.

Reason R: Phenolphthalein is a weak acid. It doesn't dissociate in basic medium. 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. Phenolphthalein is a pH dependent indicator. It is a weak acid which is colourless in the acidic solution but gives pink colour in basic medium. The pink colour is due to its conjugate form. Therefore, assertion (A) is true but Reason (R) is false.

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. A 10 g mixture of hydrogen and helium is contained in a vessel of capacity 0.0125 m^3 at 6 bar and 27°C . The mass of helium in the mixture is _____ g. (nearest integer)
Given : $R = 8.3 \text{ J K}^{-1} \text{ mol}^{-1}$
(Atomic masses of H and He are 1 u and 4 u, respectively)

Answer (8)

Sol. Number of moles of mixture of H_2 and He

$$= \frac{PV}{RT}$$

$$= \frac{6 \times 10^5 \times 0.0125}{8.3 \times 300} = 3$$

Let the mass of He in 10 g mixture be x g

$$\therefore \frac{x}{4} + \frac{10-x}{2} = 3$$

On solving $x = 8$ g

\therefore Mass of He in the mixture = 8 g

2. Consider an imaginary ion ${}^{48}_{22}X^{3-}$. The nucleus contains 'a' % more neutrons than the number of electrons in the ion. The value of 'a' is _____.
[nearest integer]

Answer (4)

Sol. Number of electrons in ${}^{48}_{22}X^{3-}$ is 25.

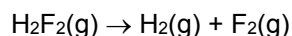
Number of neutrons = $48 - 22 = 26$.

% increase in the number of neutrons over electrons

$$= \left(\frac{26 - 25}{25} \right) 100 = 4\%$$

$\therefore a = 4$

3. For the reaction



$\Delta U = -59.6 \text{ kJ mol}^{-1}$ at 27°C .

The enthalpy change for the above reaction is
(-) _____ kJ mol^{-1} [nearest integer]

Given : $R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$.

Answer (57)

Sol. $H_2F_2(g) \longrightarrow H_2(g) + F_2(g)$

$\Delta U = -59.6 \text{ kJ mol}^{-1}$ at 27°C

$$\Delta H = \Delta U + \Delta n_g RT$$

$$= -59.6 + \frac{1 \times 8.314 \times 300}{1000}$$

$$= -57.10 \text{ kJ mol}^{-1}$$

4. The elevation in boiling point for 1 molal solution of non-volatile solute A is 3 K. The depression in freezing point for 2 molal solution of A in the same solvent is 6 K. The ratio of K_b and K_f i.e., K_b/K_f is 1 : X. The value of X is [nearest integer]

Answer (1)

Sol. Molality of a solution of non volatile solute (A) = 1

Elevation in boiling point is given by

$$\Delta T_b = K_b m$$

$$3 = K_b \times 1 \quad \dots (1)$$

Molality of (A) in the same solvent = 2

Depression in freezing point is given by

$$\Delta T_f = K_f m$$

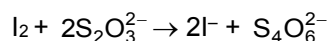
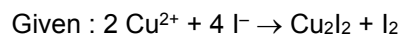
$$6 = K_f \times 2 \quad \dots (2)$$

Dividing (1) by (2)

$$\frac{K_b}{K_f} = \frac{1}{X} = \frac{1}{1}$$

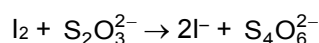
$$\therefore X = 1$$

5. 20 mL of 0.02 M hypo solution is used for the titration of 10 mL of copper sulphate solution, in the presence of excess of KI using starch as an indicator. The molarity of Cu^{2+} is found to be _____ $\times 10^{-2} \text{ M}$. [nearest integer]



Answer (4)

Sol. $2 \text{ Cu}^{2+} + 4 \text{ I}^- \rightarrow \text{Cu}_2\text{I}_2 + \text{I}_2$



Milliequivalents of hypo solution = $0.02 \times 20 = 0.4$

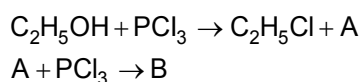
Milliequivalents of Cu^{2+} in 10 mL solution =

$$\begin{aligned} \text{Milliequivalents of } \text{I}_2 &= \text{Milliequivalents of hypo} \\ &= 0.4 \end{aligned}$$

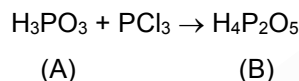
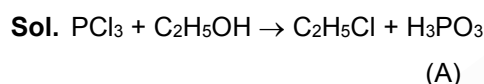
Millimoles of Cu^{2+} ions in 10 mL = 0.4

$$\begin{aligned} \text{Molarity of } \text{Cu}^{2+} \text{ ions} &= \frac{0.4}{10} = 0.04 \text{ M} \\ &= 4 \times 10^{-2} \text{ M} \end{aligned}$$

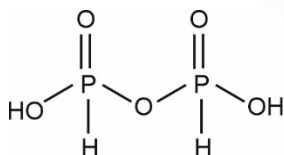
6. The number of non-ionisable protons present in the product B obtained from the following reactions is ____.



Answer (02.00)



Structure of $\text{H}_4\text{P}_2\text{O}_5$



Total 2 non-ionizable protons are present

7. The spin-only magnetic moment value of the compound with strongest oxidizing ability among MnF_4 , MnF_3 and MnF_2 is ____ B.M. [nearest integer]

Answer (05.00)

Sol. MnF_3 has the strongest oxidising ability

$$\begin{aligned} E^\circ_{\text{Mn}^{3+}/\text{Mn}^{2+}} &\approx 1.57 \text{ V} \\ \& E^\circ_{\text{Mn}^{4+}/\text{Mn}^{2+}} &\approx 1.2 \text{ V} \end{aligned}$$

So, spin only magnetic moment

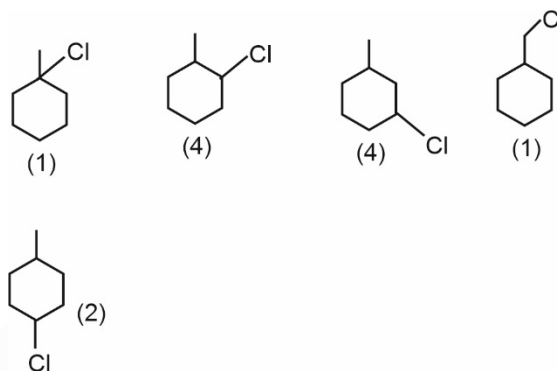
$$= \sqrt{4(4+2)} = \sqrt{24} \text{ B.M.}$$

$$\approx 5$$

8. Total number of isomers (including stereoisomers) obtained on monochlorination of methylcyclohexane is ____.

Answer (12.00)

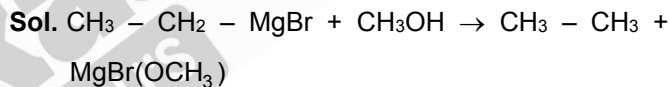
Sol. Compounds formed on mono-chlorination of methylcyclohexane are :



\therefore Total mono-chlorinated products formed = 12

9. A 100 mL solution of $\text{CH}_3\text{CH}_2\text{MgBr}$ on treatment with methanol produces 2.24 mL of a gas at STP. The weight of gas produced is ____ mg. [nearest integer]

Answer (03.00)



As 2.24 ml is formed at STP.

Number of moles of ethane gas produced

$$= \frac{2.24 \times 10^{-3}}{22.4}$$

$$= 10^{-4} \text{ mol}$$

Mass of ethane produced = $10^{-4} \times 30 = 3 \times 10^{-3} = 3 \text{ mg}$

10. How many of the following drugs is/are examples(s) of broad-spectrum antibiotics?

Ofloxacin, Penicillin G, Terpineol, Salvarsan.

Answer (01.00)

Sol. Ofloxacin is the only broad spectrum antibiotic given in the question

Penicillin – G is a narrow spectrum antibiotic.

Salvarsan is mainly active against spirochete, a bacteria that causes syphilis

Terpineol is an antiseptic.