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 of the following pair of molecules contain odd electron molecule and an expanded octet molecule?

(A) BCl_3 and SF_6 (B) NO and H_2SO_4

(C) SF_6 and H_2SO_4 (D) BCl_3 and NO

Answer (B)

Sol. NO is an odd electron species as N has 5 valence electrons and O has 6 valence electrons. Thus overall 1 electron on N remains unpaired.

S in H_2SO_4 has an expanded octet thus H_2SO_4 is expanded octet molecule.

2. $\underset{20\text{ g}}{N_{2(g)}} + \underset{5\text{ g}}{3H_{2(g)}} \rightleftharpoons 2NH_{3(g)}$

Consider the above reaction, the limiting reagent of the reaction and number of moles of NH_3 formed respectively are :

(A) H_2, 1.42 moles (B) H_2, 0.71 moles

(C) N_2, 1.42 moles (D) N_2, 0.71 moles

Answer (C)

Sol. $\underset{20\text{ g}}{N_{2(g)}} + \underset{5\text{ g}}{3H_{2(g)}} \rightleftharpoons 2NH_{3(g)}$

Ideally 28 g N_2 reacts with 6 g H_2 limiting reagent is N_2

$\therefore$ Amount of NH_3 formed on reacting 20 g N_2 is,

$$= \frac{34 \times 20}{28} = 24.28 \text{ g}$$

= 1.42 moles

3. 100 mL of 5% (w/v) solution of NaCl in water was prepared in 250 mL beaker. Albumin from the egg was poured into NaCl solution and stirred well. This resulted in a/an :

(A) Lyophilic sol (B) Lyophobic sol

(C) Emulsion (D) Precipitate

Answer (A)

Sol. Albumin from the egg was poured into 100 mL of 5% (w/v) NaCl solution in water. This would result in the formation of lyophilic sol. Albumin molecules get dispersed in water the colloidal particles of albumin are stabilised by hydrogen bond with water molecules.

4. The first ionization enthalpy of Na, Mg and Si, respectively, are : 496, 737 and 786 kJ mol^{-1}. The first ionization enthalpy (kJ mol^{-1}) of Al is:

(A) 487 (B) 768

(C) 577 (D) 856

Answer (C)

Sol. The first ionisation enthalpy of Al would be more than that of (sodium) Na but less than that of (silicon) Si and (magnesium) Mg.

Thus first ionisation enthalpy of Al would be 577 kJ/mole.

5. In metallurgy the term "gangue" is used for :

(A) Contamination of undesired earthy materials.

(B) Contamination of metals, other than desired metal.

(C) Minerals which are naturally occurring in pure form

(D) Magnetic impurities in an ore.

Answer (A)

Sol. The term "gangue" is used for earthy or undesired materials in ore.

6. The reaction of zinc with excess of aqueous alkali, evolves hydrogen gas and gives :

(A) $Zn(OH)_2$ (B) ZnO

(C) $[Zn(OH)_4]^{2-}$ (D) $[ZnO_2]^{2-}$

Answer (D)

Sol. Reaction of zinc with excess of aqueous alkali evolving hydrogen gas is as

$$Zn + 2NaOH \longrightarrow \underset{\text{Sodium zincate}}{Na_2ZnO_2} + \underset{\text{Hydrogen gas}}{H_2}$$

Thus along with H_2 it gives Na_2ZnO_2 or ZnO_2^{2-}

7. Lithium nitrate and sodium nitrate, when heated separately, respectively, give :

(A) $LiNO_2$ and $NaNO_2$ (B) Li_2O and Na_2O

(C) Li_2O and $NaNO_2$ (D) $LiNO_2$ and Na_2O

Answer (C)

Sol. Lithium nitrate when heated gives lithium oxide (Li_2O) whereas sodium nitrate on heating gives sodium nitrite

$4LiNO_3 \rightarrow 2Li_2O + 4NO_2 + O_2$

$2NaNO_3 \rightarrow 2NaNO_2 + O_2$

8. Number of lone pairs of electrons in the central atom of SCl_2, O_3, ClF_3 and SF_6, respectively, are:

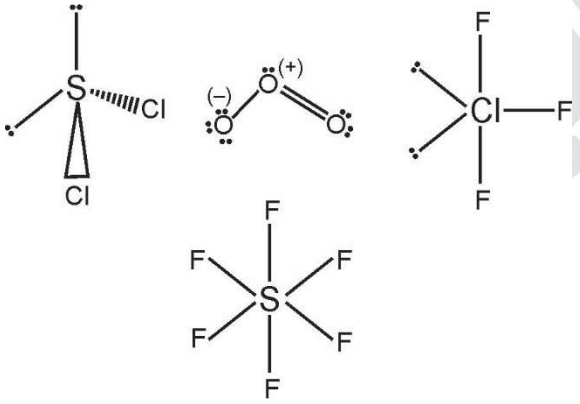
(A) 0, 1, 2 and 2 (B) 2, 1, 2 and 0

(C) 1, 2, 2 and 0 (D) 2, 1, 0 and 2

Answer (B)

Sol. The number of lone pair of electrons in the central atom of SCl_2, O_3, ClF_3 and SF_6 are 2, 1, 2 and O respectively

Their structures are as,



9. In following pairs, the one in which both transition metal ions are colourless is :

(A) Sc^{3+}, Zn^{2+} (B) Ti^{4+}, Cu^{2+}

(C) V^{2+}, Ti^{3+} (D) Zn^{2+}, Mn^{2+}

Answer (A)

Sol. Sc^{+3} and Zn^{+2} are colourless as they contain no unpaired electron. Whereas the transition metal ions Cu^{+2}, Ti^{+3}, V^{+2} and Mn^{+2} are coloured as they contain unpaired electrons.

The unpaired electron from lower energy *d* orbital gets excited to a higher energy *d* orbital on absorbing light of frequency which lies in visible region. The colour complementary to light absorbed is observed.

10. In neutral or faintly alkaline medium, $KMnO_4$ being a powerful oxidant can oxidize, thiosulphate almost quantitatively, to sulphate. In this reaction overall change in oxidation state of manganese will be

(A) 5 (B) 1

(C) 0 (D) 3

Answer (D)

Sol. In neutral or Faintly alkaline medium,

thiosulphate is oxidised almost quantitatively to sulphate ion according to reaction given below,

$$8MnO_4^- + 3S_2O_3^{2-} + H_2O \rightarrow 8MnO_2 + 6SO_4^{2-} + 2OH^-$$

Here the Mn changes from Mn^{+7} to Mn^{+4}

Thus overall change in its oxidation number would be of 3.

11. Which among the following pairs has only herbicides?

(A) Aldrin and Dieldrin

(B) Sodium chlorate and Aldrin

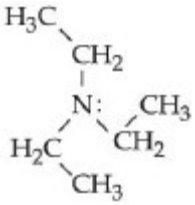
(C) Sodium arsinate and Dieldrin

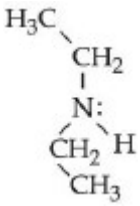
(D) Sodium chlorate and sodium arsinite

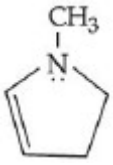
Answer (D)

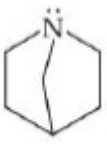
Sol. Aldrin and Dieldrin are examples of pesticides whereas Sodium chlorate ($NaClO_3$) and Sodium arsinite (Na_3ASO_3) are examples of herbicides.

12. Which among the following is the strongest Bronsted base?

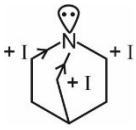
(A) 

(B) 

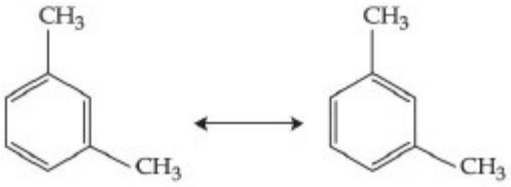
(C) 

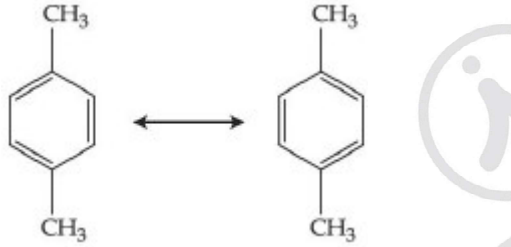
(D) 

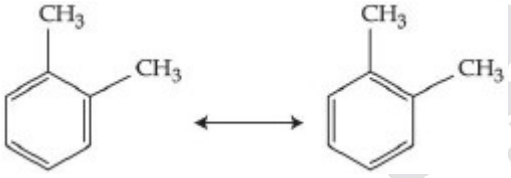
Answer (D)

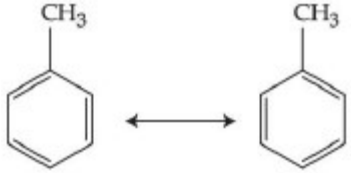
Sol.  is the strongest base among the given compounds due to the maximum +I effect and the lone pair of N is not in dynamic state so it can be donated easily.

13. Which among the following pairs of the structures will give different products on ozonolysis? (Consider the double bonds in the structures are rigid and not delocalized)

(A) 

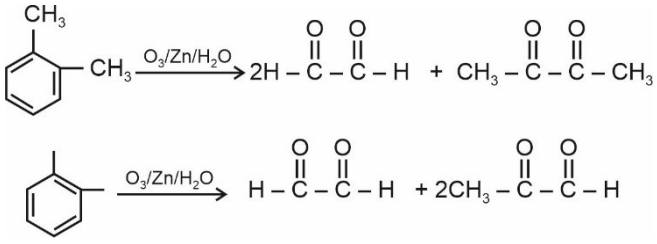
(B) 

(C) 

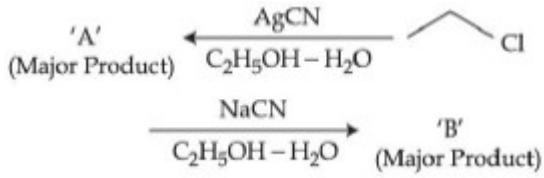
(D) 

Answer (C)

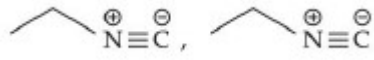
Sol.

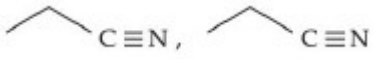


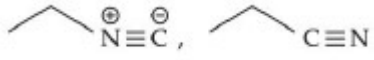
$\therefore$ in option (C) different products are produced.

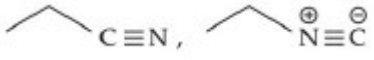
14. 

Considering the above reactions, the compound 'A' and compound 'B' respectively are :

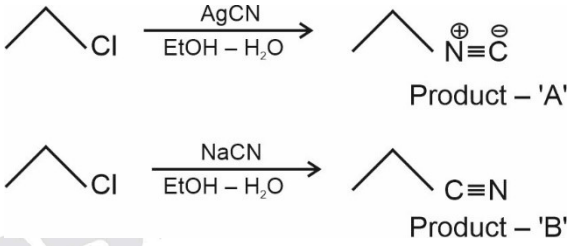
(A) 

(B) 

(C) 

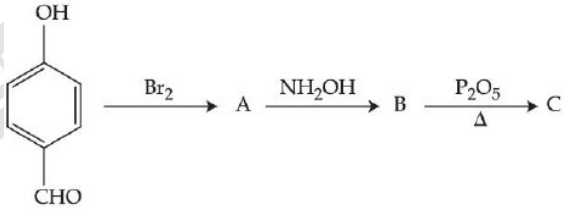
(D) 

Answer (C)

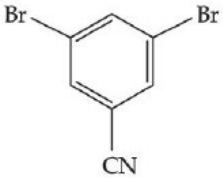
Sol. 

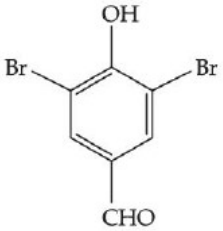
KCN is ionic so $\overset{\ominus}{C}N$ attacks through 'C' – atom.

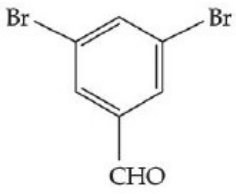
AgCN is covalent so CN attacks through 'N' – atom.

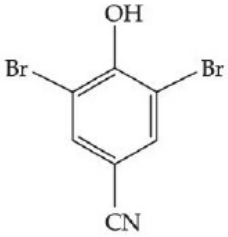
15. 

Consider the above reaction sequence, the product 'C' is

(A) 

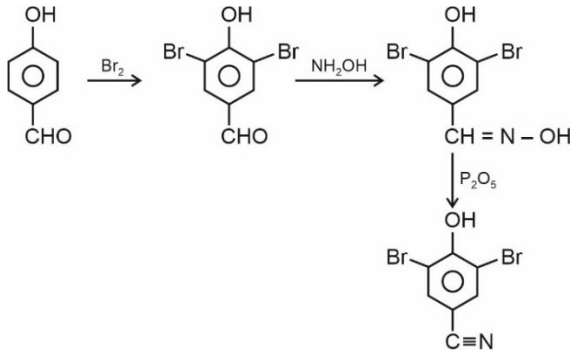
(B) 

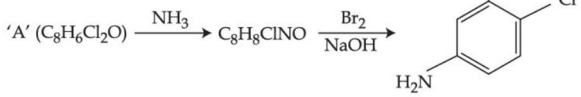
(C) 

(D) 

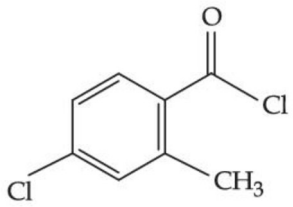
Answer (D)

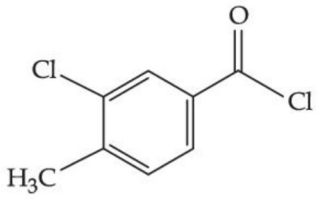
Sol.

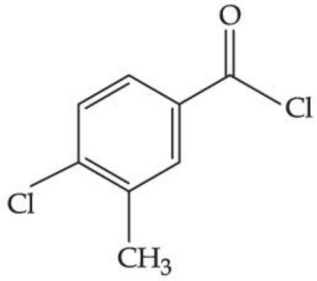


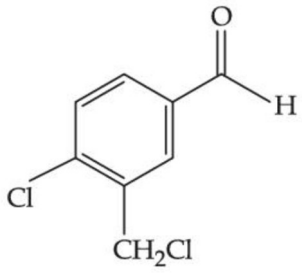
16. 

Consider the above reaction, the compound 'A' is :

(A) 

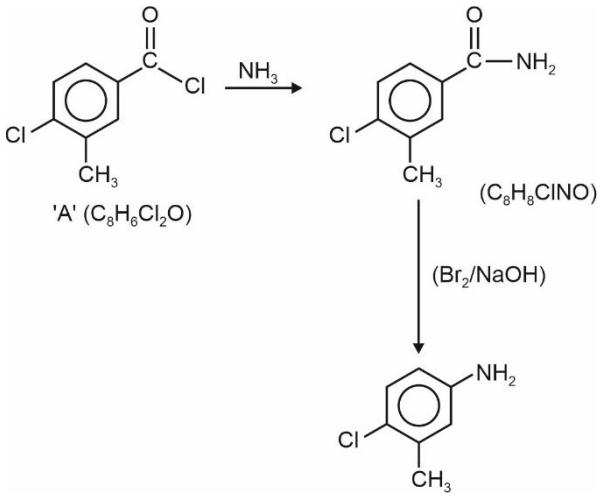
(B) 

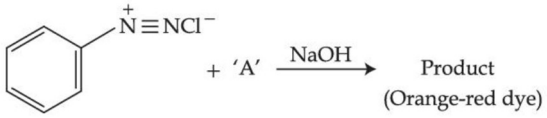
(C) 

(D) 

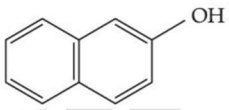
Answer (C)

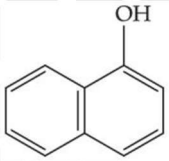
Sol.

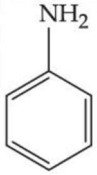


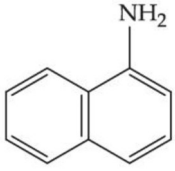
17. 

Which among the following represent reagent 'A'?

(A) 

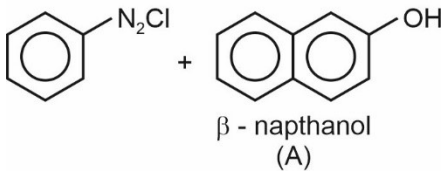
(B) 

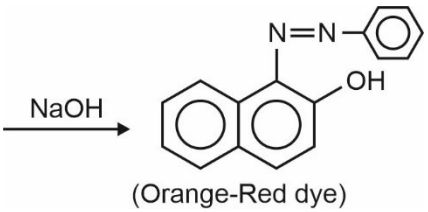
(C) 

(D) 

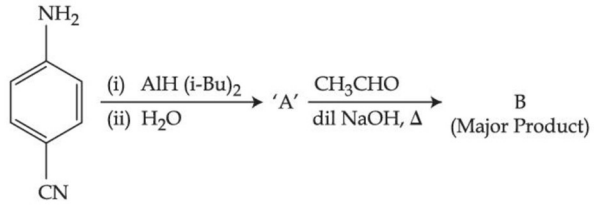
Answer (A)

Sol.

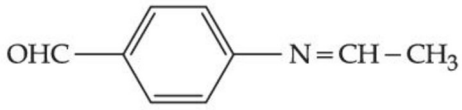


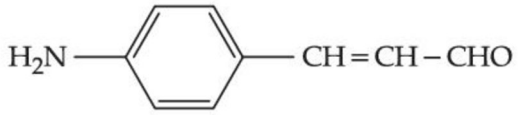


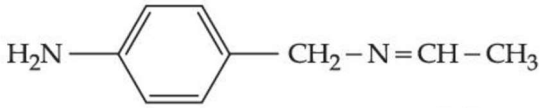
18. Consider the following reaction sequence :

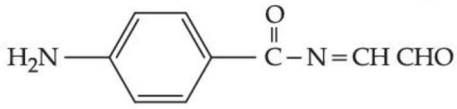


The product 'B' is :

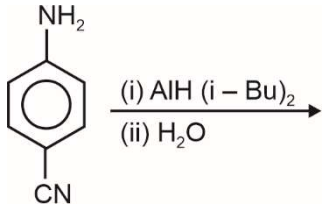
(A) 

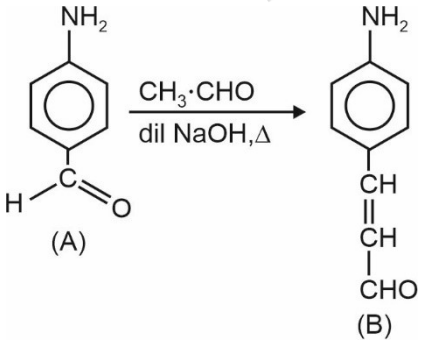
(B) 

(C) 

(D) 

Answer (B)

Sol. 



2nd reaction is the cross aldol reaction.

19. Which of the following compounds is an example of hypnotic drug?

(A) Seldane (B) Amytal

(C) Aspartame (D) Prontosil

Answer (B)

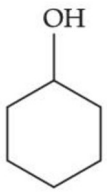
Sol. Seldane → Antihistamine

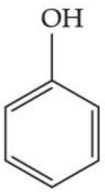
Amytal → Barbiturate (Hypnotic)

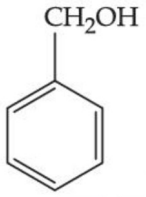
Aspartame → Artificial sweetener

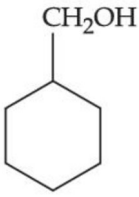
Prontosil → Antibiotics

20. A compound 'X' is acidic and it is soluble in NaOH solution, but insoluble in $NaHCO_3$ solution. Compound 'X' also gives violet colour with neutral $FeCl_3$ solution. The compound 'X' is :

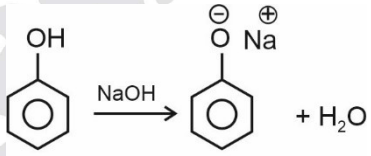
(A) 

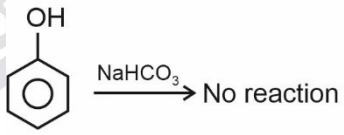
(B) 

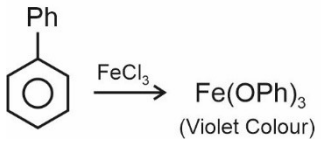
(C) 

(D) 

Answer (B)

Sol. 





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. Resistance of a conductivity cell (cell constant 129 m^{-1}) filled with 74.5 ppm solution of KCl is 100 Ω (labelled as solution 1). When the same cell is filled with KCl solution of 149 ppm, the resistance is 50 Ω (labelled as solution 2). The ratio of molar conductivity of solution 1 and solution 2 is $\frac{\Lambda_1}{\Lambda_2} = x \times 10^{-3}$. The value of x is _____. (Nearest integer)

(Given : molar mass of KCl is 74.5 g mol^{-1}).

Answer (1000)

Sol. Solution 1, $\Lambda_{m_1} = \frac{1000\ K}{M}$

$$M = \frac{74.5}{74.5} \times \frac{1000}{10^6} = 10^{-3}\ M$$

[density of solution = 1 g/mol]

$$\Lambda_1 = \frac{1000 \times 129 \times 10^{-4}}{10^{-3}} = 129 \times 10^2\ Scm^2\ mol^{-1}$$

$$\left[K = \frac{x}{R} = \frac{129 \times 10^{-2}}{100}\right]$$

Solution 2,

$$K = \frac{129 \times 10^{-2}}{50}$$

$$\Lambda_2 = \frac{1000 \times 129 \times 10^{-2}}{50\ M}$$

$$M = \frac{149}{74.5} \times \frac{1000}{10^6} = 2 \times 10^{-3}\ M$$

$$\Lambda_2 = \frac{1000 \times 129 \times 10^{-2}}{50 \times 2 \times 10^{-3}} = 129 \times 10^2\ Scm^2\ mol^{-1}$$

$$\frac{\Lambda_1}{\Lambda_2} = 1 = 1000 \times 10^{-3}$$

$\Rightarrow x = 1000$

2. Ionic radii of cation A^+ and anion B^- are 102 and 181 pm respectively. These ions are allowed to crystallize into an ionic solid. This crystal has cubic close packing for B^-. A^+ is present in all octahedral voids. The edge length of the unit cell of the crystal AB is _____pm. (Nearest integer)

Answer (566)

Sol. In cubic close packing, octahedral voids form at edge centers and body center of the cube

$a = 2(r_{A^+} + r_{B^-})$

$a = 2\ (102 + 181)$

$a = 566$ pm

3. The minimum uncertainty in the speed of an electron in an one dimensional region of length $2a_0$ (Where a_0 = Bohr radius 52.9 pm) is _____ km s^{-1}.

(Given : Mass of electron = 9.1×10^{-31} kg, Planck's constant h = 6.63×10^{-34} Js)

Answer (548)

Sol. $\Delta x.\Delta v \geq \frac{h}{4\pi m}$

$\Delta x = 2 \times 52.9 \times 10^{-12}$ m

$$\Delta v \geq \frac{6.63 \times 10^{-34}}{4 \times 3.14 \times 9.1 \times 10^{-31} \times 2 \times 52.9 \times 10^{-12}}$$

$\Delta v \geq 5.48 \times 10^{-4} \times 10^9$ m/s

$\Delta v \geq 548$ km/s (Rounded off to the nearest integer)

4. When 600 mL of 0.2 M HNO_3 is mixed with 400 mL of 0.1 M NaOH solution in a flask, the rise in temperature of the flask is _____ × 10^{-2} °C.

(Enthalpy of neutralisation = 57 kJ mol^{-1} and Specific heat of water = 4.2 $JK^{-1}\ g^{-1}$)

(Neglect heat capacity of flask)

Answer (54)

Sol.

	$H^+ + OH^- \rightarrow$		H_2O
m moles	120	40	–
	80	–	40

Heat liberated from reaction

$= 40 \times 10^{-3} \times 57 \times 10^3$ J ...(1)

Heat gained by solution = $mC\Delta T$

m = mass of solution = V × d = 1000 × 1

= 1000 g

Heat gained by solution = $1000 \times 4.2 \times \Delta T$ ...(2)

From (1) and (2)

Heat liberated = Heat gained

$40 \times 10^{-3} \times 57 \times 10^3 = 1000 \times 4.2 \times \Delta T$

$\Delta T = 54 \times 10^{-2}$ °C

(Rounded off to the nearest integer)

5. If O_2 gas is bubbled through water at 303 K, the number of millimoles of O_2 gas that dissolve in 1 litre of water is_____. (Nearest integer)

(Given : Henry's Law constant for O_2 at 303 K is 46.82 k bar and partial pressure of O_2 = 0.920 bar)

(Assume solubility of O_2 in water is too small, nearly negligible)

Answer (1)

Sol. From Henry's law,

$$X(\text{oxygen}) = \frac{p(\text{oxygen})}{K_H} = \frac{0.920}{46.82\times10^3} = 1.96\times10^{-5}$$

As 1 litre of water contains 55.5 mol of it, therefore,

$\rightarrow$ n represents moles of O_2 in solution.

$$X(\text{oxygen}) = \frac{n}{n+55.5} \simeq \frac{n}{55.5}(n << 55.5)$$

$$\frac{n}{55.5} = 1.96\times10^{-5}$$

$n = 108.8 \times 10^{-5} = 1.08 \times 10^{-3}$ moles

m moles of oxygen $= 1.08 \times 10^{-3} \times 10^3 = 1$ m mole

6. If the solubility product of PbS is 8×10^{-28}, then the solubility of PbS in pure water at 298 K is $x \times 10^{-16}$ mol L^{-1}. The value of x is _____. (Nearest integer)

[Given : $\sqrt{2}$ = 1.41]

Answer (282)

Sol. $PbS(s) \rightleftharpoons \underset{S}{Pb^{2+}}(aq) + \underset{S}{S^{2-}}(aq)$

$K_{sp} = S^2$

$8 \times 10^{-28} = S^2$

$S = 2\sqrt{2} \times 10^{-14}$ mol/L

$\Rightarrow 2.82\times10^{-14}$ mol/L $= 282\times10^{-16}$ mol/L

Hence,

x = 282

7. The reaction between X and Y is first order with respect to X and zero order with respect to Y.

Experiment	[X] / mol L^{-1}	[Y] / mol L^{-1}	Initial rate / mol L^{-1} min^{-1}
I	0.1	0.1	2×10^{-3}
II	L	0.2	4×10^{-3}
III	0.4	0.4	$M\times10^{-3}$
IV	0.1	0.2	2×10^{-3}

Examine the data of table and calculate ratio of numerical values of M and L. (Nearest integer)

Answer (40)

Sol. Rate $\propto [X]^1[Y]^0$

Rate = k[X]

From Exp I and II,

$$\frac{4\times10^{-3}}{2\times10^{-3}} = \left(\frac{L}{0.1}\right)^1\left(\frac{0.2}{0.1}\right)^0$$

$2 = (10\ L)^1$.

Hence L = 0.2 mol/L

From Exp III and IV,

$$\frac{M\times10^{-3}}{2\times10^{-3}} = \left(\frac{0.4}{0.1}\right)\left(\frac{0.4}{0.2}\right)^0$$

$$\frac{M}{2} = 4$$

M = 8

$$\frac{M}{L} = \frac{8}{0.2} = 40$$

8. In a linear tetrapeptide (constituted with different amino acids) – (number of peptide bonds) is _____.

Answer (1)

Sol. In a linear tetrapeptide, four amino acids are linked and three peptide bonds are present.

Hence, 4 – 3 = 1

9. In bromination of Propyne, with Bromine 1,1,2,2-tetrabromopropane is obtained in 27% yield. The amount of 1,1,2,2-tetrabromopropane obtained from 1 g of Bromine in this reaction is _____ $\times 10^{-1}$ g. (Nearest integer)

(Molar Mass : Bromine = 80 g/mol)

Answer (3)

Sol. $CH_3-C\equiv CH + 2Br_2 \xrightarrow{CCl_4} CH_3-\underset{Br}{\overset{Br}{C}}-\underset{Br}{\overset{Br}{C}}-H$

Propyne

1,1,2,2-tetrabromopropane

2 moles $Br_2 \equiv$ 1 mole 1,1,2,2-tetrabromopropane

$\frac{1}{160}$ mole Br_2

$\equiv \frac{1}{2}\times\frac{1}{160}$ mole 1,1,2,2-tetrabromopropane

But yield of reaction is only 27%

Moles of 1,1,2,2-tetrabromopropane

$$= \frac{1}{2}\times\frac{1}{160}\times\frac{27}{100}$$

Molar mass of 1,1,2,2-tetrabromopropane = 360 g

Mass of 1,1,2,2-tetrabromopropane

$$= \frac{1}{2}\times\frac{1}{160}\times\frac{27}{100}\times360\ g$$

$\approx 3\times10^{-1}$ g

10. $[Fe(CN)^6]^{3-}$ should be an inner orbital complex. Ignoring the pairing energy, the value of crystal field stabilization energy for this complex is (–) _____ Δ_0. (Nearest integer)

Answer (2)

Sol. In $[Fe(CN)^6]^{3-}$, Fe is present in (+3) oxidation state Fe(III) $\Rightarrow$ inner orbital complex $\Rightarrow d^5$ (with pairing)

Configuration $\Rightarrow$ t_{2g}^5

$$CFSE = 5\times\frac{-2}{5}\Delta_0 = -2\Delta_0$$