CBSE Board
Class XI Chemistry

Time: 3 Hours **Total Marks: 70**

General Instructions

1. All questions are compulsory.
2. Question nos. 1 to 8 are very short answer questions and carry 1 mark each.
3. Question nos. 9 to 18 are short answer questions and carry 2 marks each.
4. Question nos. 19 to 27 are also short answer questions and carry 3 marks each
5. Question nos. 28 to 30 are long answer questions and carry 5 marks each
6. Use log tables if necessary, use of calculators is not allowed.

Q. 1 What happens when sodium metal is heated in free supply of air? [1]

Q. 2 Given: [1]

$$2Al(s) + \frac{3}{2} O_2(g) \rightarrow Al_2O_3(s), \Delta_f H^\theta = -1{,}670 \text{ kJ/mol for } Al_2O_3(s).$$

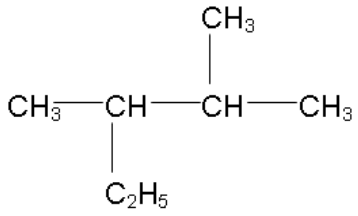
Determine ΔH^θ for the reaction $2Al_2O_3(s) \rightarrow 4Al(s) + 3O_2(g)$.

Q. 3 Explain why BeH_2 molecule has zero dipole moment although the Be-H bonds are polar? [1]

Q. 4 Predict the shape of the PH_3 molecule according to VSEPR theory. [1]

Q. 5 Which isotope of hydrogen is radioactive? [1]

Q. 6 Write the correct IUPAC name of the compound given below: [1]



Q. 7 How many mono substituted derivatives of naphthalene are possible? [1]

Q. 8 Name any two gases responsible for greenhouse effect. [1]

Q. 9 Arrange the following ions in order of increasing ionic radius: K^+, P^{3-}, S^{2-},Cl^-. Give reason. [2]

Q. 10 The successive ionization energies of a certain element are I_1 = 589.5 kJ/mol, I_2 =1145 kJ/mol, I_3= 4900 kJ/mol, I_4 = 6500 kJ/mol, and I_5 = 8100

kJ/mol. This pattern of ionization energies suggests that the unknown element is: [2]

a) K

b) Si

c) Ca

d) As

Explain your answer.

Q. 11 A sample of gas occupies 3.00 L at 760 torr. Calculate the volume the gas will occupy if the pressure is changed to 1.45 atm and the temperature remains constant. [2]

Q. 12 A mixture of hydrogen and oxygen at 1 bar pressure contains 20 % by mass of hydrogen .Calculate the partial pressure of hydrogen. [2]

Q. 13 Complete the following reactions [2]

(i) $P_4O_{10}(s) + H_2O(l) \rightarrow$

(ii) $SiCl_4(l) + H_2O(l) \rightarrow$

OR

Give reasons for the following

(a) Alkali metals impart colour to the flame.

(b) Explain why alkali and alkaline earth metals cannot be obtained by chemical reduction methods?

Q. 14 Explain: [2]

(i) Alkali metals are soft and can be cut with help of a knife.

(ii) Potassium is more reactive than sodium.

Q. 15 [2]

(i) How would you distinguish between $BeSO_4$ and $BaSO_4$?

(ii) Which is thermally most stable alkaline earth metal carbonate among $MgCO_3$, $CaCO_3$, $SrCO_3$, $BaCO_3$? Why?

Q.16 Calculate the number of atoms in each of the following: [2]

(i) 52 mol of Ar (ii)52 u of He

Q. 17 Arrange benzene, hexane and ethyne in decreasing order of acidic behavior. Also give reasons for this behaviour. [2]

Q. 18 State the difference between classical smog and photochemical smog. [2]

Q. 19 50 kg of $N_2(g)$ & 10.0 kg of $H_2(g)$ are mixed to produce $NH_3(g)$, identify the limiting reagent. Also, calculate the amount of NH_3 formed. [3]

Q. 20 (i) Calculate the wavelength in nanometers, of visible light having a frequency of $4.37\times10^{14}\ s^{-1}$. [3]

(ii) What are frequency and wavelength of a photon emitted during a transition from n = 6 to n = 1 state in the hydrogen atom.

Q. 21 (i) Explain why the following electronic configuration is not possible: [3]

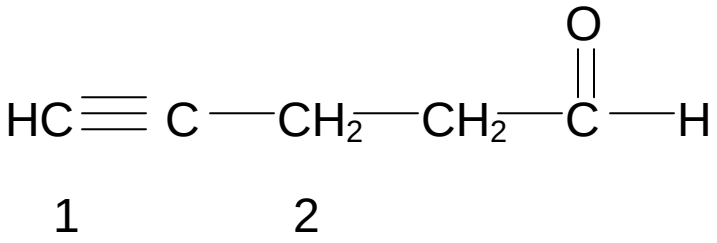
$$n=1, l=0, m_l = +1, \ m_s = +\frac{1}{2}$$

(ii) Write electric configurations of Cu & Cu^{2+}.

Q. 22 (i) Draw the resonating structures of carbon dioxide molecule. [3]

(ii) Why is NF_3 trigonal pyramidal while BF_3 is trigonal planar, though both are tetra atomic molecules?

(iii) State the hybridization of carbon atoms numbered 1 & 2:



Q. 23 How much volume of 0.1M CH_3COOH should be added to 50 mL of 0.2M of CH_3COONa solution to prepare a buffer solution of pH=4.91(Given pK_a of CH_3COOH is 4.76) [3]

Q. 24 (i) Calculate the concentration of hydroxyl ion in 0.1 M solution of NH_4OH having $K_b = 1.8\times10^{-5}$. [3]

(ii) K_{sp} value of two sparingly soluble salts $Ni(OH)_2$ and AgCN are 2×10^{-15} and 6.0×10^{-17} respectively. Which salt is more soluble?

Q. 25 Ajit had a very important cricket match but after 1 hour practicing, he was feeling very weak and so his mother gave him some glucon-D. After 10 minutes, he started feeling better and went back for playing. [3]

(a) What made Ajit energetic after drinking Glucon-D? Give plausible reasons for this.

(b) What value do you get from this?

OR

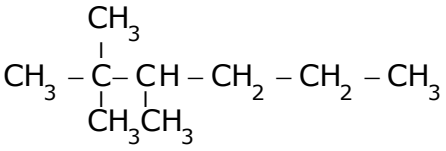
(a) Calculate the total number of electrons present in one mole of methane.

An atomic orbital has n = 3. What are the possible values of l and m_l ?

Q. 26. (i) Draw the structural isomers of pentane. [3]

(ii) Give the IUPAC names of the following compounds.

a)



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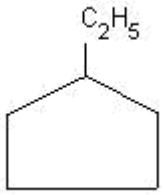

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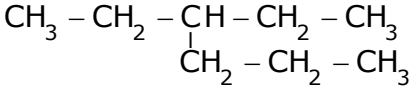


Q. 27 (i) 0.2475 g of an organic compound gave on combustion 0.4950 g of carbon dioxide and 0.2025 g of water. Calculate the percentage of C and H in it. [3]

(ii) What will happen during Lassaigne's test for nitrogen if the compound also contains sulphur?

Q. 28 (i) In a process, 701 J of heat is absorbed by a system and 394 J of work is done by the system. What is the change in internal energy for the process? [5]

(ii) The equilibrium constant for the reaction is 10. Calculate the value of ΔG^{θ}. Given R = 8.0 J mol^{-1} K^{-1}; T = 300 K

OR

(i) Calculate lattice energy for the change

$Li^{+}(g)+Cl^{-}(g) \rightarrow LiCl(s)$

Given that:

$\Delta_{sub} H^{\theta}$ of Li $=160.67$ kJ/mol

$\Delta_{diss} H^{\theta}$ of $Cl_2 = 244.34$ kJ/mol

$\Delta_{ie} H^{\theta}$ of $Li(g) = 520.07$ kJ/mol

$\Delta_{eg} H^{\theta}$ of $Cl(g) = -365.26$ kJ/mol

$\Delta_f H^{\theta}$ of $LiCl(s) = -401.66$ kJ/mol

(ii)

For a reaction; $2A(g)+B(g) \rightarrow 2D(g)$

$\Delta U^{\theta} = -10.5$ kJ & $\Delta S^{\theta} = -34.1$ J

Calculate ΔG^{θ} for the reaction & predict whether the reaction is spontaneous or not at 298 K.

Q. 29 [5]

(i) What happens when borax solution is acidified. Write the chemical reactions for the reaction.

(ii) Explain why BF_3 exists whereas BH_3 does not?

(iii) SiO_2 is solid but CO_2 is a gas at room temperature.

OR

When a metal X is treated with NaOH a white precipitate (A) is obtained, which is soluble in excess of NaOH to give soluble complex (B). Compound (A) is soluble in dilute HCl to form compound (C).The compound (A) when heated strongly gives D which is used to extract metal. Identify (X), (A), (B), (C) & D. Write suitable equations to support their identities.

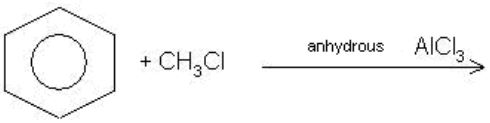
Q. 30 Complete the following reactions. [5]

(i) $CH_3CH_3 + O_2 \xrightarrow[\Delta]{(CH_3COO)_2Mn}$

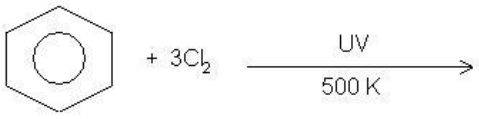
(ii) $CH_2\ Br-CH_2\ Br + Zn \rightarrow$

(iii) $CH_3-\underset{\underset{CH_3}{|}}{C}=CH_2 + H_2O \xrightarrow{H^+}$

(iv)



(v)



OR

(i) Outline all the steps in the synthesis of the compound styrene from benzene.

(ii) Give the products of ozonolysis of mesitylene.

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Solution

Ans. 1 On heating sodium in free supply of air, it forms sodium peroxide. $\left(\frac{1}{2}\right)$

$2\ Na(s) + O_2\ (Air) \rightarrow Na_2O_2$

(Sodium peroxide) $\left(\frac{1}{2}\right)$

Ans. 2 ΔH^{θ} = 2 x (+ (1,670)) kJ/mol = + 3,340 kJ/ mol (1)

Ans. 3 BeH_2 is a linear molecule with H-Be-H bond angle as 180°. Although the Be-H bonds are polar, the bond polarities cancel each other and the net dipole moment is zero. (1)

Ans. 4 Trigonal pyramidal (1)

Ans. 5 Tritium (1)

Ans. 6 2,3-Dimethylpentane (1)

Ans. 7 3 (1)

Ans. 8 Carbon dioxide and methane (1)

Ans. 9 $K^+ < Cl^- < S^{2-} < P^{3-}$ (1)

Reason: All the ions are isoelectronic with 18 electrons. If the number of electrons is the same, as the number of protons increase, the nuclear charge increases and hence the outermost electrons will experience a greater force of attraction towards the nucleus. This results in the decrease in ionic radii. Since the nuclear charge decreases from K^+ to P^{3-}, the ionic radii increases from K^+ to P^{3-}. (1)

Ans. 10 The unknown element is Ca (1)

Here the third ionization energy is very high which suggest that the removal of the third electron is difficult. The electronic configuration of calcium is [Ar] $4s^2$. First two electrons can be removed without much difficulty. But the removal of third electron from the stable electronic configuration of argon is difficult. Hence, the third ionization energy is high. (1)

Ans. 11 The given question is based on Boyle's law Therefore,

$$P_1V_1 = P_2V_2 \quad (\text{At constant temperature}) \qquad (1)$$

$$\Rightarrow \frac{760\,\text{torr}}{760\,\text{torr/atm}} \times 3\,\text{L} = 1.45\,\text{atm} \times V_2\,\text{L}$$

$$\Rightarrow V_2 = 2.07\,\text{L} \qquad (1)$$

Ans. 12 Since 20 % by mass of hydrogen is present in the mixture, mass of

hydrogen in the mixture is 20 g in 100 g of the mixture present.

Remaining mass in the mixture is of oxygen = 80 g

No. of moles of hydrogen =20 g / 2 g mol^{-1} = 10 mol

No. of moles of oxygen = 80 g / 32 g mol^{-1} = 2.5 mol

Mole fraction of hydrogen

$$x_{H_2} = \frac{n_{H_2}}{n_{H_2} + n_{O_2}} \qquad \left(\frac{1}{2}\right)$$

$$= \frac{10}{10 + 2.5}$$

$$= \frac{10}{12.5}$$

$$= 0.8 \qquad \left(\frac{1}{2}\right)$$

Partial pressure of hydrogen

$$p_{H_2} = x_{H_2} \times p_{total} \qquad \left(\frac{1}{2}\right)$$

$$= 0.8 \times 1\,\text{bar}$$

$$= 0.8\,\text{bar} \qquad \left(\frac{1}{2}\right)$$

Therefore partial pressure of hydrogen is 0.8 bar.

Ans. 13

(i) $P_4O_{10}(s) + 6H_2O(l) \rightarrow 4H_3PO_4(aq)$ (1)

(ii) $SiCl_4(l) + 2H_2O(l) \rightarrow SiO_2(s) + 4HCl(aq)$ (1)

OR

(a) Alkali metals have loosely held electron. Energy from the flame is sufficient to excite the electron to a high energy level. When electron falls to lower level the energy released falls in the visible region of spectrum thus imparting colour to the flame. (1)

(b)Alkali and alkaline earth metals are themselves very strong reducing agents and therefore cannot be reduced by chemical reduction methods. (1)

Ans. 14

(i) Alkali metals have large atomic size with only one valence electron. Thus, they have weak metallic bonding between the atoms of the metal. Because of weak metallic bonding, alkali metals are soft and can be cut with a knife. (1)

(ii) Reactivity of metals depends on ionization enthalpy. Smaller is the i onization enthalpy, greater is the reactivity. Potassium has a larger atomic size than sodium. Thus, the ionization enthalpy of potassium is less than sodium. Hence, potassium is more reactive than sodium. (1)

Ans. 15

(i) $BeSO_4$ and $BaSO_4$ can be differentiated by solubility test. $BeSO_4$ is soluble in water and $BaSO_4$ is insoluble in water. (1)

(ii) $BaCO_3$ is thermally most stable alkaline earth metal carbonate because Ba^{2+} ion being larger in size is more stabilized by larger CO_3^{2-} ion through

formation of stable lattice. (1)

Ans. 16

(i) 1 mol of Ar contains =6.022 x 10^{23} atoms

52 mol of Ar will contains = (52 x 6.022 x 10^{23}) atoms

= 3.13 x 10^{25} atoms (1)

(ii) 4 u of He = 1 atom

52 u of He = $\frac{1}{4} \times 52 = 13$ atoms (1)

Ans. 17

The decreasing order of acidic behaviour is:

Ethyne > benzene > n-pentane (1)

The C-H bond in ethyne, benzene and n-pentane are formed by sp-s, sp^2 –s and sp^3-s overlap.

Now, greater the percentage s character, greater is the electronegativity.

Therefore, sp-hybridised carbon in ethyne is more electronegative then sp^2 hybridised carbon of benzene which in turn is more electronegative than sp^3 hybridised carbon of n-pentane.

Therefore, the polarity of the C-H bond is in order of:

Ethyne > benzene > pentane

Hence the acidity order is:

Ethyne > benzene > pentane (1)

Ans. 18

Classical Smog	Photochemical Smog
1. It occurs in cool humid climate. $\left(\frac{1}{2}\text{mark}\right)$	1. It occurs in warm, dry and sunny climate. $\left(\frac{1}{2}\text{mark}\right)$
2. It is a mixture of smoke, fog & sulphur dioxide.	2. Components of photochemical smog result from the action of sunlight on unsaturated hydrocarbons & oxides of

$\left(\frac{1}{2}\text{ mark}\right)$	nitrogen produced by automobiles & factories. $\left(\frac{1}{2}\text{ mark}\right)$

Ans. 19

$$\text{Moles of } N_2 = \frac{\text{Mass}}{\text{Molar mass}}$$

$$= \frac{50\times10^3\text{ g}}{28\text{ g/mol}} \qquad \left(\frac{1}{2}\right)$$

$$= 1.786\times10^3\text{ mol}$$

$$\text{Moles of } H_2 = \frac{\text{Mass}}{\text{Molar Mass}}$$

$$= \frac{10\times10^3\text{g}}{2\text{ g/mol}} \qquad \left(\frac{1}{2}\right)$$

$$= 5.0\times10^3\text{mol}$$

$$N_2(g) + 3H_2\ g \rightleftharpoons 2NH_3(g) \qquad \text{(Eqn 1)}$$

According to equation (1),

1 mole of N_2 (g) reacts with = 3 moles of H_2 (g)

Therefore 1.786×10^3 mol of N_2 (g) will react with = $\frac{3\times1.786\times10^3}{1}$ moles of H_2(g)

$= 5.36\times10^3$ mol $\qquad \left(\frac{1}{2}\right)$

But we are having 5.0×10^3 mol of H_2 (g) only.

Hence, H_2 (g) is the limiting reagent. $\qquad \left(\frac{1}{2}\right)$

To calculate the amount of NH_3 formed,

3 moles of H_2 (g) give = 2 moles of NH_3 (g)

Therefore,

$$5.0\text{ x }10^3\text{ moles of } H_2 \text{ will give} = \frac{2}{3}\text{x}5\text{x}10^3\text{ moles of } NH_3 \qquad \left(\frac{1}{2}\right)$$

$$= 3.3\text{x}10^3\text{ moles of } NH_3$$

$$\text{Mass of } NH_3 \text{ produced} = 3.3\text{x}10^3\text{ x}17\text{ g of } NH_3$$

$$= 56.1\text{ kg} \qquad \left(\frac{1}{2}\right)$$

Ans. 20

(i)

$$\nu = \frac{c}{\lambda} \qquad \left(\frac{1}{2}\right)$$

$$\lambda = \frac{c}{\nu} = \frac{3\times10^{8}\,m/s}{4.37\times10^{14}\,s^{-1}}$$

$$\therefore \lambda = 0.686\times10^{-6}\,m$$

$$\therefore \lambda = 686\,nm \qquad \left(\frac{1}{2}\right)$$

(ii)

Here $n_1=6$ & $n_2=1$

The energy gap between two orbits for a hydrogen atom is given as

$$\Delta E = 2.18\times10^{-18}\,J\left(\frac{1}{n_1^2}-\frac{1}{n_2^2}\right) \qquad \left(\frac{1}{2}\right)$$

$$= 2.18\times10^{-18}\,J\left(\frac{1}{6^2}-\frac{1}{1^2}\right)$$

$$= 2.18\times10^{-18}\,J\left(\frac{1-36}{36}\right)$$

$$\Delta E = -2.11\times10^{-18}\,J \qquad \left(\frac{1}{2}\right)$$

Since ΔE is negative, energy is emitted.

Now, frequency of photon is given by

$$\nu = \frac{\Delta E}{h} \qquad \left(\frac{1}{2}\right)$$

$$= \frac{2.11\times10^{-18}\,J}{6.626\times10^{-34}\,Js}$$

$$= 3.18\times10^{15}\,s^{-1}$$

$$\nu = 3.18\times10^{15}\,Hz \qquad \left(\frac{1}{2}\right)$$

Ans. 21

(i) For n =1,

Value of $l = n-1$

$= 1-1$

$= 0$

For each value of l,

Value of $m_l = -l,.....,0,.....,+l$ $\qquad \left(\frac{1}{2}\right)$

Therefore,

For $n=1, l=0,$

$m_l = 0$

Thus the value of $m_l = 1$ is not possible. $\left(\frac{1}{2}\right)$

(ii)

Electronic configuration of $Cu(Z = 29)$ is $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^1$ (1)

Electronic configuration of Cu^{2+} is $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^9$ (1)

Ans. 22

(i) Resonating structures of CO_2 molecule

$$:\ddot{O}=C=\ddot{O}: \leftrightarrow {}^{-}:\ddot{\underset{\cdot\cdot}{O}}-C\equiv\overset{+}{O}: \leftrightarrow :\overset{+}{O}\equiv C-\ddot{\underset{\cdot\cdot}{O}}:^{-} \quad (1)$$

(ii) In NF_3, N atom involves sp^3 hybridization and one position is occupied by a lone pair. Therefore the molecule is trigonal pyramidal. But in BF_3, B involves sp^2 hybridization having trigonal planar geometry. Thus NF_3 is trigonal pyramidal while BF_3 is trigonal planar, even though both are tetra atomic molecules. (1)

(iii)

$C_1 \rightarrow sp$

$C_2 \rightarrow sp^3$ $\left(\frac{1}{2}\times 2 = 1\,\text{mark}\right)$

Ans. 23 According to Henderson's equation

$$pH = pK_a + \log\frac{[Salt]}{[Acid]} \quad (1)$$

Given $pH = 4.91$ $pK_a = 4.76$

$$4.91 = 4.76 + \log\frac{[Salt]}{[Acid]}$$

$$\log\frac{[CH_3COONa]}{[CH_3COOH]} = 4.91 - 4.76 \quad \left(\frac{1}{2}\right)$$

$$\frac{[CH_3COONa]}{[CH_3COOH]} = \text{antilog}(0.15) = 1.41 \quad \left(\frac{1}{2}\right)$$

If V is the volume of 0.1 CH_3COOH required.

$$\frac{[CH_3COONa]}{[CH_3COOH]} = \frac{\frac{0.2\times 50}{1000}}{\frac{0.1\times V}{1000}} = 1.41 \quad \left(\frac{1}{2}\right)$$

$$\frac{0.2 \times 50}{0.1 \times V} = 1.41$$

$$V = \frac{0.2 \times 50}{0.1 \times 1.41} = 70.92 \qquad \left(\frac{1}{2}\right)$$

Therefore, Volume of 0.1 M acetic acid required =70.92 mL

Ans. 24

(i) $NH_4OH\ aq \rightleftharpoons NH_4^+(aq) + OH^-\ aq$

$$K_b = \frac{\left[NH_4^+\right]\left[OH^-\right]}{\left[NH_4OH\right]} \qquad \left(\frac{1}{2}\right)$$

Now, $\left[NH_4^+\right] = \left[OH^-\right]$ $\left(\frac{1}{2}\right)$

$\left[NH_4OH\right] = 0.1M$

$$K_b = \frac{\left[OH^-\right]^2}{\left[NH_4OH\right]}$$

$$\left[OH^-\right]^2 = 1.8 \times 10^{-5} \times 0.1$$

$$= 0.18 \times 10^{-5}$$

$$\therefore \left[OH^-\right] = 1.34 \times 10^{-3}\ mol/L \qquad \left(\frac{1}{2}\right)$$

(ii) $AgCN \rightleftharpoons Ag^+ + CN^-$

Let x mol/L be the solubility of AgCN

Thus $\left[Ag^+\right] = x,\ [CN^-] = x$

$$K_{sp} = \left[Ag^+\right]\left[CN^-\right]$$

$$= x^2$$

$$x = \sqrt{K_{sp}} \qquad \left(\frac{1}{2}\right)$$

$$= \sqrt{6.0 \times 10^{-17}}$$

$$= 7.75 \times 10^{-9}$$

$Ni(OH)_2 \rightleftharpoons Ni^{2+} + 2OH^-$

Let y mol/L be the solubility of $Ni(OH)_2$

Thus $\left[Ni^{2+}\right] = y$ & $\left[OH^-\right] = 2y$

$$K_{sp} = \left[Ni^{2+}\right]\left[OH^-\right]^2$$

$$= y \times (2y)^2$$

$$= 4y^3$$

$$y = \left(\frac{K_{sp}}{4}\right)^{1/3}$$

$$y=\left(\frac{2\times10^{-15}}{4}\right)^{1/3}$$

$$y = \sqrt[3]{0.5}\times10^{-5} \qquad \left(\frac{1}{2}\right)$$

Since solubility of $Ni(OH)_2$ is more than AgCN, $Ni(OH)_2$ is more soluble than AgCN. $\left(\frac{1}{2}\right)$

Ans. 25

(a) Ajit started feeling energetic after drinking glucose because of the redox reactions occurring in our body. In our body, glucose is oxidized to carbon dioxide and water and energy is released.This energy made him feel energetic.

(2)

(b) Application of knowledge of chemistry in our daily life and care for others.

(1)

OR

(a) Number of electrons in 1 molecule of methane = 6 + 4 =10 electrons

Number of molecules in 1 mole of methane $= 6.022 \times 10^{23}$ molecules of methane

Number of electrons in 1 mole of methane $= 6.022 \times 10^{24}$ electrons

(1)

(b) n = 3

$l = 0\ to (n-1)$

= 0, 1, 2 (1)

For $l = 0$,

$m_l = 0$

For $l = 1$

$m_l = -1, 0, +1$

For $l = 2$

$m_l = -2, -1, 0, +1, +2$ (1)

Ans. 26 (i) There are 3 structural isomers of pentane:

$CH_3 - CH_2 - CH_2 - CH_2 - CH_3$
n – Pentane $\left(\frac{1}{2}\right)$

$CH_3 - CH_2 - \underset{\displaystyle CH_3}{\underset{|}{CH}} - CH_3$
2 – Methylbutane $\left(\frac{1}{2}\right)$

$CH_3 - \underset{\displaystyle CH_3}{\underset{|}{\overset{\displaystyle CH_3}{\overset{|}{C}}}} - CH_3$
2,2 – Dimethylpropane $\left(\frac{1}{2}\right)$

(ii) a) 2,2,3 –Trimethylhexane $\left(\frac{1}{2}\right)$

b) Ethylcyclopentane $\left(\frac{1}{2}\right)$

c) 3 – Ethylhexane $\left(\frac{1}{2}\right)$

Ans 27

(i) Mass of organic compound = 0.2475 g

Mass of CO_2 produced = 0.4950 g

Mass of H_2O produced = 0.2025 g

$$\% \text{ of } C = \frac{12}{44} \times \frac{\text{Mass of } CO_2}{\text{Mass of compound taken}} \times 100$$

$$= \frac{12}{44} \times \frac{0.4950}{0.2475} \times 100 = 54.54 \quad (1)$$

$$\% \text{ of } H = \frac{2}{18} \times \frac{\text{Mass of } H_2O}{\text{Mass of compound taken}} \times 100$$

$$= \frac{2}{18} \times \frac{0.2025}{0.2475} \times 100 = 9.09 \quad (1)$$

(ii) Blood red colouration due to Fe(CNS) will be produced. (1)

Ans. 28

(i) Heat absorbed by the system (q) = + 701 J $\left(\frac{1}{2}\right)$

Work done by the system (w) = -394 J $\left(\frac{1}{2}\right)$

Change in internal energy (ΔU) = q + w $\left(\frac{1}{2}\right)$

= 701 -394

= +307 J $\left(\frac{1}{2}\right)$

(ii)

$\Delta G^o = -2.303RT\log K$ (1)

$R = 8.0\,JK^{-1}\,mol^{-1}$

$T = 300K$

$K = 10$

$\Delta G^o = -2.303RT\log K$

$= -2.303 \times 8.0 \times 300 \times \log 10$ (1)

$= -5527.2\,Jmol^{-1}$ (1)

OR

(i) $\Delta_f H^o = \Delta_{sub}\ H^o + \Delta_{ie} H^o + \frac{1}{2}\,\Delta_{diss}\,H^o + \Delta_{eg}\ H^o + \Delta_{lattice}\ H^o$

$\left(\frac{1}{2}\right)$

$\Delta_{lattice} H^o = -401.66 - (160.67) - (520.07) - \frac{1}{2}(244.34) - (-365.26)$

$\Delta_{lattice} H^o = -839.31$ kJ/mol $\left(\frac{1}{2}\right)$

(ii)

$\Delta U^o = -10.5$ kJ, $\Delta n(g) = -1$ mol, $T = 298$ K

$R = 8.314 \times 10^{-3}$ kJ $K^{-1} mol^{-1}$

$$\Delta H^{o} = \Delta U^{o} + \Delta n(g)\, RT \qquad \left(\frac{1}{2}\right)$$

$$\Delta H^{o} = -10.5 + \left[-1\,mol \times 8.314 \times 10^{-3}\,kJ\,K^{-1}mol^{-1} \times 298\,K\right] \qquad \left(\frac{1}{2}\right)$$

$$= -10.5\ kJ - 2.478\ kJ$$

$$= -12.978\ kJ \qquad \left(\frac{1}{2}\right)$$

$$\Delta G^{o} = \Delta H^{o} - T\Delta S^{o} \qquad \left(\frac{1}{2}\right)$$

$$= -12978\,J - 298(-34.1\,J) \qquad \left(\frac{1}{2}\right)$$

$$= -12978 + 10161.8$$

$$= -2816.2\,J \qquad \left(\frac{1}{2}\right)$$

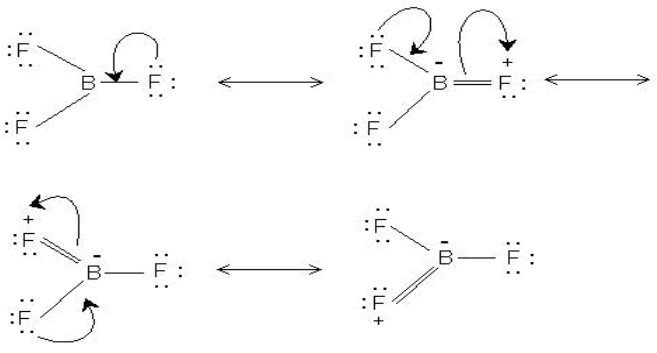
Since the value of ΔG^{θ} is negative, the reaction is spontaneous. (1)

Ans. 29 (i) Borax solution on acidification forms boric acid.

$$Na_2B_4O_7 + 2HCl + 5H_2O \rightarrow 2NaCl + 4H_3BO_3 \qquad (1)$$

(ii) BF_3 is trigonal planar molecule. Due to $p\pi - p\pi$ back bonding, lone pair of electrons of F is back donated to B atom. This delocalization reduces the deficiency of electrons of boron thereby increasing the stability of BF_3 molecule. $\left(\frac{1}{2}\right)$

The mechanism is as follows:



$\left(\frac{1}{2}\right)$

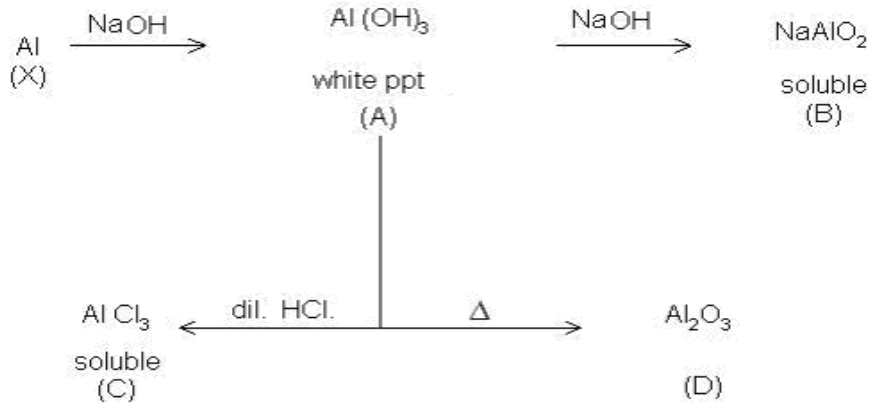
Due to absence of lone pair of electrons on H atom this compensation does not occur in BH_3. $\left(\frac{1}{2}\right)$

In other words electron deficiency of B stays & hence it reduces its electron deficiency as BH_3 dimerises to form B_2H_6. $\left(\frac{1}{2}\right)$

(iii) Carbon is able to form $p\pi - p\pi$ bond with O atom and constitute a stable non - polar molecule $O = C = O$. Due to weak inter particle force its boiling point is low and it is gas at room temperature. (1)

Si on the other hand is not able to from $p\pi - p\pi$ bond with O atoms because of its relatively large size. In order to complete its octet Si is linked to four O atoms around it by sigma bond & these constitutes network structure, which is responsible for its solid state. (1)

OR



2 marks for writing reactions

1 mark for identifying X

$\left(\frac{1}{2}\text{mark}\right)$ each for correctly identifying A, B, C and D.

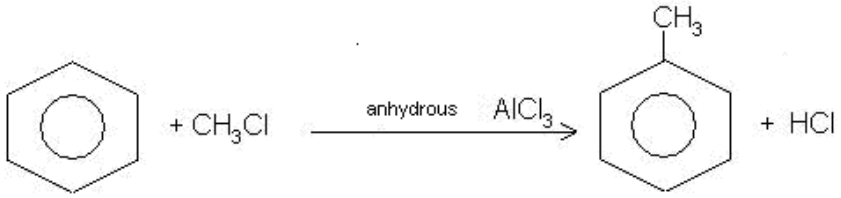
Ans. 30

(i) $2CH_3CH_3 + 3O_2 \xrightarrow[\Delta]{(CH_3COO)_2Mn} 2CH_3COOH + 2H_2O$ (1)

(ii) $CH_2\,Br\text{-}CH_2Br + Zn \rightarrow CH_2{=}CH_2 + ZnBr_2$ (1)

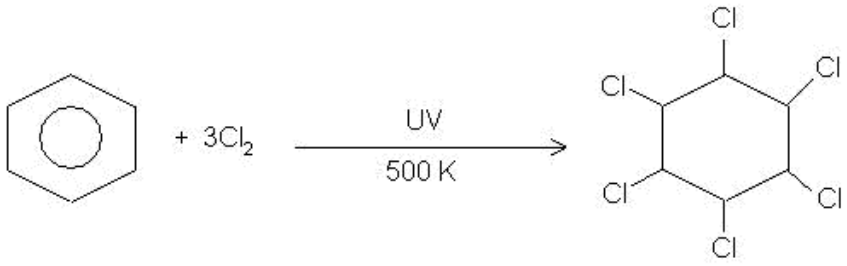
(iii) $CH_3-\underset{\underset{CH_3}{|}}{C}=CH_2 + H_2O \xrightarrow{H^+} CH_3-\underset{\underset{CH_3}{|}}{\overset{\overset{OH}{|}}{C}}-CH_3$ (1)

(iv)



(1)

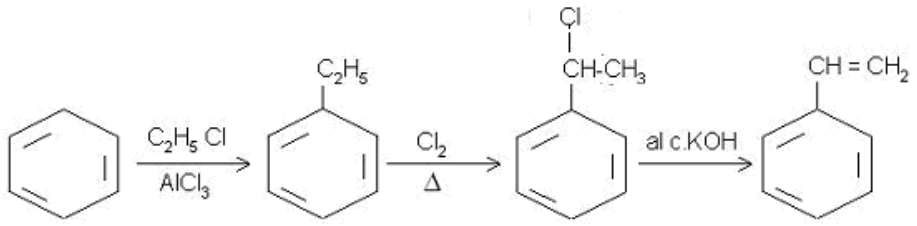
(v)



(1)

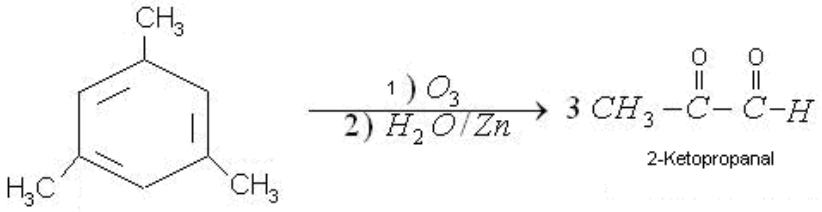
OR

(i)



(1) (1) (1)

(ii)



(1 mark for the correct product + 1 mark for the correct reagents)