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 Write the formula of the compound Nickel (II) sulphate? [1]

Q. 2 T emporary hardness in water is due to presence of which salts? [1]

Q. 3 What is the mass of one atom of oxygen? [1]

Q. 4 What is the ratio of molecules between 1 mole of H_2O and 1 mole of sucrose ($C_{12}H_{22}O_{11}$)? [1]

Q. 5 Give the values for principal quantum number and magnetic quantum number for 19th electron of K (Potassium). [1]

Q. 6 What shapes are associated with sp^3d and sp^3d^2 hybrid orbitals? [1]

Q. 7 Why is an organic compound fused with sodium for testing halogens, nitrogen, sulphur and phosphorous? [1]

Q. 8 $2A(g) + B(g) \rightarrow 4C(g) + Heat$ [1]

What is the effect of adding He at a constant volume on above equilibrium?

Q. 9 Which of the following has largest size? Mg, Mg^{2+}, Al^{3+}, Al [2]

Q. 10 Give IUPAC name and symbol of element with atomic number 110 and 115. [2]

Q. 11 Give reasons: [2]

(i) Anhydrous $AlCl_3$ is covalent but hydrated $AlCl_3$ is electrovalent. Explain
(ii) (ii)Boric acid behaves as Lewis acid? Explain

Q. 12 $N_2 \rightarrow N_2^+$ $O_2 \rightarrow O_2^+$ [2]

Why is there an increase in bond order in going from O_2 to O_2^+ while a decrease in going from N_2 to N_2^+ ?

Q. 13 Calculate the total pressure of a mixture of 8g of O_2 (g) and 4g of H_2 (g) in a

vessel of 1dm^3 at 27^0C. (Atomic mass of O=16$gmol^{-1}$and H=1 $gmol^{-1}$.R=0.083 bar dm^3/K mol). [2]

Q. 14 Give equations to prove amphoteric nature of water. [2]

OR

Arrange benzene, hexane and ethyne in decreasing order of acidic behavior. Also give reasons for this behaviour.

Q. 15 Balance the following equation in an alkaline medium by half reaction method. [2]

$$Cr(OH)_3 + IO_3^- \rightarrow I^- + CrO_4^{2-}$$

Q. 16 The wavelength of first spectral line in Balmer series is 6561 Å. Calculate the wavelength of second spectral line in Balmer series. [2]

Q. 17 On a ship sailing in Pacific Ocean where temperature is 23.4°C, a balloon is filled with 2 L air. What will be the volume of the balloon when the ship reaches Indian Ocean, where temperature is 26.1°C? [2]

Q. 18 All C-O bond lengths in CO_3^{2-} are equal. Account for this observation. [2]

Q. 19 (a): Which of the two is more concentrated and why? 1 M or 1 m aqueous solution of a solute. [3]

(b) Calculate the total number of molecules of methane present in 1.6 g?

Q. 20 At 60°C, dinitrogen tetroxide is fifty percent dissociated. Calculate the standard free energy change at this temperature and at one atmosphere. [3]

Q. 21 What type of isomerism is exhibited by following pair of compounds? [3]

(i) Ethanol and Methoxy methane
(ii) o-cresol and m-cresol
(iii) Pentan-3-one and pentan-2-one

Q. 22 When a metal X is treated with sodium hydroxide, a white precipitate A is obtained, which is soluble in an excess of NaOH to give soluble complex B. Compound A is soluble in diluted HCl to form compound C. The compound A when heated strongly gives D, which is used to extract metal. Identify X, A, B,

C and D. Write suitable equations to support their identities. [3]

Q. 23 Calculate the energy associated with the first orbit of He^+. What is the radius of this orbit? [3]

Q. 24 Rashmi and Rekha are doing a research on the people working with coal tar. According to the report prepared by them, people who work under prolonged exposure to coal tar suffers from skin cancer and asks the authorities to vacant the factories. [3]

(a) What is the reason behind the people getting infected with skin cancer?
(b) What values are associated with it?

Q. 25 Calculate the enthalpy of combustion of glucose from the following data [3]

$$C\ (graphite) + O_2 \rightarrow CO_2\ (g)\ ; \quad \Delta_r H^\theta = -395kJ$$

$$H_2\ (g) + \frac{1}{2}O_2\ (g) \rightarrow H_2O(l)\ ; \quad \Delta_r H^\theta = -269.4kJ$$

$$6C\ (graphite) + 6H_2(g) + 3O_2(g) \rightarrow C_6H_{12}O_6(s)\ ; \quad \Delta_r H^\theta = -1169.9kJ$$

Q. 26 [3]

(a) Fish do not grow as well in warm water as in cold water. Why?
(b) Why does rain water normally have a pH about 5.6?
(c) Name two major greenhouse gases.

Q. 27 0.2325g of an organic compound was analysed for nitrogen by Duma's method. 31.7mL of moist nitrogen was collected at 25^0C and 755.8mm Hg pressure. Calculate the percentage of N in the sample. (Aq. Tension of water at 25^oC is 23.8mm). [3]

OR

(a) Why cannot sulphuric acid be used to acidify sodium extract for testing S using lead acetate solution?
(b) Which of the carbocations is most stable and why?

$$(CH_3)_3\overset{+}{C} \quad , \quad CH_3CH_2\overset{+}{C}H_2 \quad , \quad CH_3\overset{+}{C}HCH_2CH_3$$

(c) Why does a liquid vaporize below its boiling point in steam distillation process?

Q. 28 [5]

(a) Convert:

(i) Propene to propane-1,2-diol

(ii) Isopropylbromide to n-propylbromide

(b) An alkene on ozonolysis gives butan-2-one and 2-methylpropanal.Give the structure and IUPAC name of Alkene. What products will be obtained when it is treated with hot, concentrated $KMnO_4$?

OR

Complete the equations:

(i) $CH_2=CHBr \xrightarrow{NaNH_2} A \xrightarrow[873K]{\text{Red hot iron tube}} B$

(ii) $C_6H_6 + CH_3COCl \xrightarrow[AlCl_3]{\text{Anhdrous}} A + B$

(iii) $CH_3COOH \xrightarrow{NaOH(aq)} A \xrightarrow[\Delta]{\text{Sodalime}} B$

(iv) $CH_2 = CH - CH_2 - CH_2 - CH_2 - CH_3 + HBr \xrightarrow{\text{No peroxide}}$

(v) $CH_2 = CH - CH_2 - CH_2 - CH_2 - CH_3 + HBr \xrightarrow{\text{Peroxide}}$

Q. 29 Calculate the pH of a 0.10M ammonia solution. Calculate the pH after 50.0 mL of this solution is treated with 25.0 mL of 0.10M HCl. The dissociation constant of ammonia, $K_b = 1.77 \times 10^{-5}$. [5]

OR

Calculate the pH of the resultant mixtures:

10mL of 0.2M $Ca(OH)_2$ + 25 mL of 0.1 M HCl

Q. 30 Give reasons for the following [5]

(a) Unlike Na_2CO_3, K_2CO_3 cannot be prepared by Solvay process. Why?
(b) Why are alkali metals not found in nature?
(c) Sodium is less reactive than potassium why?
(d) Alkali metals are good reducing agents. Why?
(e) Alkali metals are paramagnetic but their salts are diamagnetic. Why?

OR

Complete the following reactions:

(a) Why does the solubility of alkaline earth metal carbonates and sulphates in water decrease down the group?
(b) (b)Arrange the following alkali metal ions in decreasing order of their mobility: Li^+, Na^+ , K^+, Rb^+, Cs^+ .Explain
(c) NaOH is a stronger base than LiOH. Explain
(d) Why are alkali metals kept in paraffin or kerosene ?
(e) Why does lithium show properties uncommon to the rest of the alkali metals?

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Solution

Ans. 1

$NiSO_4$ (1)

Ans. 2 Temporary hardness in water is due to salts of magnesium and calcium in the form of hydrogen carbonates. (1)

Ans. 3

N_A or 6.023×10^{23} atoms of oxygen have a mass of 16g

where N_A is Avogadro's number

So, mass of one atom of oxygen $= \frac{16}{6.023 \times 10^{23}}$ (1)

$= 2.65 \times 10^{-23}$ g

Ans. 4 One mole of H_2O and $C_{12}H_{22}O_{11}$ contain same number of molecules. So, the ratio of molecules is 1:1 (1)

Ans. 5 Electronic configuration of K = $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$

This means that the 19^{th} electron lies in the s- subshell, Thus it is 4s, so values for principal quantum number ,n=4 and magnetic quantum number, $m_l = 0$ (1)

Ans. 6 (a) sp^3d hybrid orbitals -Trigonal bipyramidal $\left(\frac{1}{2}\right)$

(b) sp^3d^2 hybrid orbitals-Octahedral $\left(\frac{1}{2}\right)$

Ans. 7 Organic compound is fused with sodium metal to convert N, S, P and halogens present in organic compound to their corresponding sodium salts. (1)

Ans. 8 There will be no effect of adding He at constant volume. This is due to the fact that when an inert gas is added to equilibrium at constant volume, the total pressure

will increase. But the concentration of reactants and products will not change. (1)

Ans. 9 Atomic radii decrease across a period. Cations is smaller than their parent atoms. Among isoelectronic species, the one with the larger positive nuclear charge will have a smaller radius. Hence the largest species is Mg; the smallest one is Al^{3+}. (2)

Ans 10 (a) Name and symbol of element with atomic number 110

Name: Ununnillium $\left(\frac{1}{2}\right)$

Symbol: Uun $\left(\frac{1}{2}\right)$

(b) Name and symbol of element with atomic number 115

Name: Ununpentium $\left(\frac{1}{2}\right)$

Symbol: Uup $\left(\frac{1}{2}\right)$

Ans. 11 (i)Anhydrous $AlCl_3$ is covalent but hydrated $AlCl_3$ is electrovalent because when it is dissolved in water the high heat of hydration is sufficient to break the covalent bond of $AlCl_3$ into Al^{3+} and Cl^- ions. (1)

(ii) Boric acid behaves as Lewis acid by accepting a pair of electron from OH^- ion (in water). $\left(\frac{1}{2}\right)$

$$B(OH)_3 + 2H\text{-}O\text{-}H \rightarrow [B(OH)_4]^- + H_3O^+ \qquad \left(\frac{1}{2}\right)$$

Ans. 12 Electronic configuration of O_2 is

$$(\sigma 1s)^2(\sigma^* 1s)^2(\sigma 2s)^2(\sigma^* 2s)^2(\sigma 2p_z)^2(\pi 2p_x^2 = \pi 2p_y^2)(\pi^* 2p_x^1 = \pi^* 2p_y^1) \qquad \left(\frac{1}{2}\right)$$

In going from O_2 to O_2^+, an electron is lost from an antibonding molecular orbital. Bond order is calculated as one half of the difference in number of electrons in bonding and antibonding molecular orbital. Thus bond order increases. $\left(\frac{1}{2}\right)$

Electronic configuration of N_2 is

$$(\sigma 1s)^2(\sigma^* 1s)^2\ (\sigma 2s)^2(\sigma^* 2s)^2(\pi 2p_x^{\ 2} = \pi 2p_y^{\ 2})(\sigma 2p_z)^2$$

In going from N_2 to N_2^+, the electron is lost from a bonding molecular Orbital.

Bond order is calculated as one half of the difference in number of electrons in bonding and antibonding molecular orbital. Thus bond order decreases. $\left(\frac{1}{2}\right)$

Ans. 13

No. of moles of $O_2 = \frac{8}{32} = 0.25$

No. of moles of $H_2 = \frac{4}{2} = 2$ $\left(\frac{1}{2}\right)$

$pV=nRT$

$\therefore p_{O_2} = \frac{0.25 \times 0.083 \times 300}{1} = 6.23 \text{bar}$ $\left(\frac{1}{2}\right)$

$p_{H_2} = \frac{2 \times 0.083 \times 300}{1} = 49.8$ bar $\left(\frac{1}{2}\right)$

Total pressure = $p_{O_2} + p_{H_2}$

= 6.23 + 49.8

= 56.03 bar $\left(\frac{1}{2}\right)$

Ans. 14 Amphoteric nature means H_2O can act as an acid as well as a base

$$\underset{\text{(Acid)}}{H_2O} + NH_3 \rightarrow NH_4^+ + OH^- \quad (1)$$

$$\underset{\text{(Base)}}{H_2O} + HCl \rightarrow H_3O^+ + Cl^- \quad (1)$$

OR

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. 15

a) First, we will write down the oxidation number of each atom

$$\overset{+3}{Cr}(\overset{-2}{O}\overset{+1}{H})_3 + \overset{+5}{I}\overset{-2}{O_3}^- \rightarrow \overset{-1}{I}^- + \overset{+6}{Cr}\overset{-2}{O_4}^{2-}$$

b) Write separately oxidation & reduction half reactions

Oxidation half reaction:

$$\overset{+3}{Cr}(OH)_3 \rightarrow \overset{+6}{Cr}O_4^{2-} + 3e^-$$

Reduction half reaction:

$$\overset{+5}{I}O_3^- + 6e^- \rightarrow \overset{-1}{I}^- \qquad \left(\frac{1}{2}\right)$$

c) Balance O atoms by adding H_2O molecules to the side deficient in 'O' atoms and then balancing H atoms

$$Cr(OH)_3 + H_2O \rightarrow CrO_4^{2-} + 3e^-$$

$$IO_3^- + 6e^- \rightarrow I^- + 3H_2O \qquad \left(\frac{1}{2}\right)$$

d) Balance H atoms. Since the medium is alkaline, therefore H_2O molecules are added to the side deficient in H atoms and equal no. of OH^- ions to the other side :

$$Cr(OH)_3 + 5OH^- \rightarrow CrO_4^{2-} + 3e^- + 4H_2O$$

$$(\because Cr(OH)_3 + H_2O + 5OH^- \rightarrow CrO_4^{2-} + 3e^- + 5H_2O)$$

$$IO_3^- + 6e^- + 3H_2O \rightarrow I^- + 6OH^-$$

$$(\because IO_3^- + 6e^- + 6H_2O \rightarrow I^- + 3H_2O + 6OH^-) \qquad \left(\frac{1}{2}\right)$$

e) Equalise the electrons lost and gained by multiplying the oxidation half reaction with 2.

$$2Cr(OH)_3 + 10OH^- \rightarrow 2CrO_4^{2-} + 6e^- + 8H_2O$$

Adding the oxidation half reaction and reduction half reaction we get

$$2Cr(OH)_3 + 10OH^- \rightarrow 2CrO_4^{2-} + 6e^- + 8H_2O$$

$$IO_3^- + 6e^- + 3H_2O \rightarrow I^- + 6OH^-$$

$$2Cr(OH)_3 + IO_3^- + 4OH^- \rightarrow 2CrO_4^{2-} + I^- + 5H_2O \qquad \left(\frac{1}{2}\right)$$

Ans. 16 According to Rydberg equation,

$$\bar{\nu} = 109,677 \left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right) \ cm^{-1}$$

R = 109,677 which is the Rydberg's constant

$$\bar{\nu} = \frac{1}{\text{Wavelength}}$$

For first line in Balmer series, $n_1 = 2$, $n_2 = 3$

Given wavelength of 1st spectral line = 6561 Å

Therefore, $\frac{1}{6561} = R\left(\frac{1}{2^2} - \frac{1}{3^2}\right) = R\left(\frac{5}{36}\right)$ (i) $\left(\frac{1}{2}\right)$

For second line in Balmer series, $n_1 = 2$, $n_2 = 4$

Therefore, $\frac{1}{\text{Wavelength}} = R\left(\frac{1}{2^2} - \frac{1}{4^2}\right) = R\left(\frac{3}{16}\right)$ (ii) $\left(\frac{1}{2}\right)$

Dividing eq. (i) by (ii), we get:

$$\frac{\text{Wavelength}}{6561} = \frac{5 \times 16}{36 \times 3} \qquad \left(\frac{1}{2}\right)$$

$\therefore$ Wavelength = 4860 Å $\left(\frac{1}{2}\right)$

Ans. 17

$V_1 = 2\ L$

$T_1 = (23.4 + 273)\ K$
$= 296.4\ K$

$T_2 = (26.1 + 273)\ K$
$= 299.1\ K$

From Charles law

$$\frac{V_1}{T_1} = \frac{V_2}{T_2} \qquad \left(\frac{1}{2}\right)$$

$$\Rightarrow V_2 = \frac{V_1 T_2}{T_1}$$

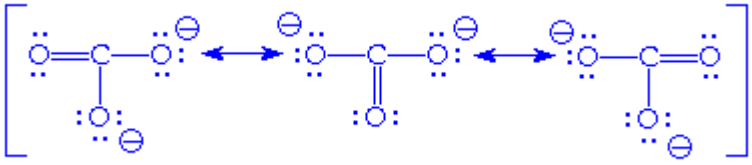
$$\Rightarrow V_2 = \frac{2L \times 299.1\ K}{296.4\ K} \qquad \left(\frac{1}{2}\right)$$

$$= 2\ L \times 1.009$$

$$= 2.018\ L \qquad (1)$$

Ans. 18 All C-O bond lengths in CO_3^{2-} are equal because of resonance. All bonds have

partial double bond character (1)



(1)

Ans. 19

(a) 1 molar solution contains 1mole of solute in 1 L of solution while

1 molal solution contains 1 mole of solute in 1000g of solvent. $\left(\frac{1}{2}\right)$

Considering density of water as almost 1g/mL, then 1mole of solute is present in 1000mL of water in 1molal solution while 1mole of it is present in less than 1000mL of water in 1 molar solution

(1000mL solution in molar solution = Volume of solute + Volume of solvent). (1)

Thus 1M solution is more concentrated than 1m solution. $\left(\frac{1}{2}\right)$

(b) Number of moles of methane in 1.6g = $\frac{1.6}{16} = 0.1\text{mole}$ $\left(\frac{1}{2}\right)$

1 mole of methane contains =6.022 x 10^{23} molecules

Therefore, 0.1 mole of methane contains = 0.1 x 6.022 x 10^{23} molecules

= 6.022 x 10^{22}

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

Ans. 20

$N_2O_4(g) \rightleftharpoons 2NO_2(g)$

If N_2O_4 is 50% dissociated, the mole fraction of both the substances is given by

$x_{N_2O_4} = \frac{1-0.5}{1+0.5} = \frac{0.5}{1.5}$; $\left(\frac{1}{2}\right)$

$x_{NO_2} = \frac{2\times 0.5}{1+0.5} = \frac{1}{1.5}$ $\left(\frac{1}{2}\right)$

$p_{N_2O_4} = \frac{0.5}{1.5}\times 1 \text{ atm} = \frac{0.5}{1.5}$ $\left(\frac{1}{2}\right)$

$p_{NO_2} = \frac{1}{1.5}\times 1 \text{ atm} = \frac{1}{1.5}$ $\left(\frac{1}{2}\right)$

The equilibrium constant K_P is given by

$$K_P = \frac{pNO_2{}^2}{pN_2O_4}$$

$$= \frac{1.5}{(1.5)^2(0.5)}$$

$$= 1.33 \text{ atm} \qquad \left(\frac{1}{2}\right)$$

$$\text{Since } \Delta_r G^\theta = -RT\ln K_P$$

$$\Delta_r G^\theta = (-8.314 \text{ JK}^{-1}\text{mol}^{-1}) \times (333 \text{ K}) \times (\ln(1.33))$$

$$= (-8.314 \text{ JK}^{-1}\text{mol}^{-1}) \times (333 \text{ K}) \times (2.303) \times (0.1239)$$

$$= -789.98 \text{ kJ mol}^{-1} \qquad \left(\frac{1}{2}\right)$$

Ans. 21

(i) Functional isomerism or functional group isomerism
(ii) Position isomerism
(iii) Metamerism

(1 × 3 = 3)

Ans. 22 Since metal X reacts with NaOH to first give a white ppt. A which dissolves in excess of NaOH to give a soluble complex B , therefore metal X is aluminium ;ppt A is $Al(OH)_3$ and complex B is sodium teterahydroxoaluminate (III)

$$\underset{\text{X}}{Al} + 3NaOH \rightarrow \underset{\text{Aluminium hydroxide}}{Al(OH)_3} + 3Na^+$$

$$\underset{\text{A}}{Al(OH)_3} + NaOH \rightarrow \underset{\text{Sodium tetrahydroxoaluminate (III)}}{Na^+[Al(OH)_4]^-} \qquad (1)$$
B

Since A is amphoteric in nature, it reacts with dilute HCl to form compound C which is $AlCl_3$

$$\underset{\text{A}}{Al(OH)_3} + 3HCl \longrightarrow \underset{\text{C}}{AlCl_3} + 3H_2O \qquad (1)$$

Since A on heating gives D which is used to extract metal, therefore, D must be alumina (Al_2O_3)

$$\underset{A}{2Al(OH)_3} \xrightarrow{\Delta} \underset{D}{Al_2O_3} + 3H_2O \qquad (1)$$

Ans. 23

$$E_n = -\frac{\left(2.18 \times 10^{-18}\ J\right)Z^2}{n^2}\ atom^{-1} \qquad \left(\frac{1}{2}\right)$$

For $He^+, n = 1, Z = 2$

$$E_1 = -\frac{\left(2.18 \times 10^{-18}\ J\right)\left(2^2\right)}{1^2}$$

$$= -8.72 \times 10^{-18}\ J \qquad (1)$$

The radius of the orbit is given by equation

$$r_n = \frac{(0.0529\ nm)n^2}{Z} \qquad \left(\frac{1}{2}\right)$$

Since $n = 1$, and $Z = 2$

$$r_n = \frac{(0.0529\ nm)1^2}{2}$$

$$= 0.02645\ nm \qquad (1)$$

Ans. 24

(a) Skin cancer is caused due to the polynuclear hydrocarbon fraction present in coal tar. Polynuclear hydrocarbons are toxic and carcinogenic. (2)

(b) (i) Care and concern for others.

(ii) One should be careful while working with these polynuclear hydrocarbons. (1)

Ans. 25

Given

$C\ (graphite) + O_2 \rightarrow CO_2(g)$; $\Delta_r H^\theta$=-395kJ (Eq.1)

$H_2(g)+\frac{1}{2}O_2(g) \rightarrow H_2O(l)$; $\Delta_r H^\theta$=-269.4kJ (Eq.2)

$C_6H_{12}O_6(s) \rightarrow 6C(graphite)+ 6H_2(g)+3O_2(g)$; $\Delta_r H^\theta$=1169.9kJ (Eq.3)

Combustion of graphite is given by the equation shown below

$C_6H_{12}O_6(s)+6O_2(g) \rightarrow 6CO_2(g)+6H_2O(g)$ (Eq.4) $\left(\frac{1}{2}\right)$

Thus enthalpy for combustion reaction can be obtained

by multiplying Eq.1 and Eq.2 by 6 and adding equation Eq.3 $\left(\frac{1}{2}\right)$

$6C(graphite) + 6O_2 \rightarrow 6CO_2\ (g)$; $\Delta_r H^\theta$= -2370kJ (Eq.6) $\left(\frac{1}{2}\right)$

$6H_2(g) + 3O_2(g) \rightarrow 6\ H_2O(l)$; $\Delta_r H^\theta$= -1614.4kJ (Eq.7) $\left(\frac{1}{2}\right)$

$C_6H_{12}O_6(s) \rightarrow 6C\ (graphite)+6H_2(g)+3O_2(g)$; $\Delta_r H^\theta$=1169.9kJ (Eq.8) $\left(\frac{1}{2}\right)$

$C_6H_{12}O_6\ (s) + 3O_2\ (g) \rightarrow 6CO_2\ (g) + 6H_2O\ (g)$

Reaction enthalpy = (-2370 kJ-1614kJ) + (1169.9 kJ+0)

= -2814.1kJ $\left(\frac{1}{2}\right)$

Ans 26:

(a) As the temperature increases solubility of gas in water decreases. Due to high temperature of water, amount of dissolved oxygen is less, which creates a problem for fish. So, fish do not grow well in warm water (1)

(b) Rain water is acidic due to dissolution of CO_2 in it, leading to formation of H_2CO_3 which lowers the pH. Hence the pH is about 5.6

$CO_2 + H_2O \rightarrow H_2CO_3$

$H_2CO_3 \rightarrow 2H^+ + CO_3^{2-}$ (1)

(c) Carbon dioxide and methane are two major greenhouse gases. (1)

Ans 27:

Calculation of volume of nitrogen at S.T.P
Experimental conditions

Pressure of dry gas P_1 = 755.8 - 23.8 = 732 mL $\left(\frac{1}{2}\right)$

V_1 = 31.7 mL
T_1 = 25+273 = 298 K
S.T.P condition
P_2 = 760 mm
V_2 = ?
T_2 = 273 K

Applying gas equation,

$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$ $\left(\frac{1}{2}\right)$

$\therefore \frac{732 \times 31.7}{298} = \frac{760 \times V_2}{273}$

$\Rightarrow V_2$ = 27.97 mL $\left(\frac{1}{2}\right)$

$$\% \text{ of Nitrogen} = \frac{28 \times \text{Volume of } N_2 \text{ at S.T.P} \times 100}{22400 \times \text{Mass of compound}}$$ $\left(\frac{1}{2}\right)$

$$= \frac{28 \times 27.97 \times 100}{22400 \times 0.2325}$$ $\left(\frac{1}{2}\right)$

$$= 15.04$$ $\left(\frac{1}{2}\right)$

OR

(a) This is because, in the presence of sulphuric acid, lead acetate will react with it forming white precipitate of $PbSO_4$, thus interfering with the test. (1)

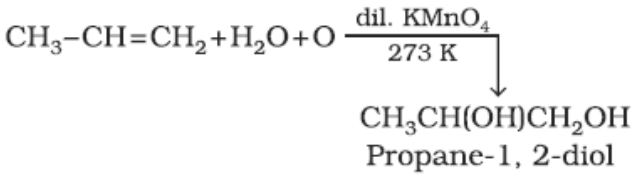
(b) $(CH_3)_3C^+$ is most stable because it has the maximum number of alkyl groups i.e. three. Greater the number of alkyl groups on the carbon carrying positive charge, greater would be the dispersal of charge and hence more will be the stability of carbocation. So, tertiary carbocation is the most stable due to maximum dispersal of charge. (1)

(c) In steam distillation, water and organic substance vaporize together and total pressure becomes equal to atmospheric pressure. Thus organic substance vaporizes and distils at a temperature lower than its boiling point. (1)

Ans. 28

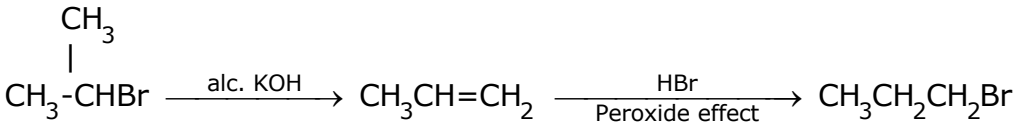
(a)

(i)



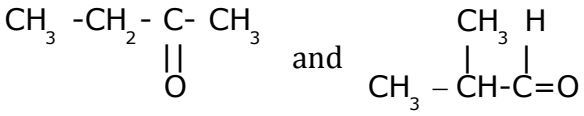
(1 mark)

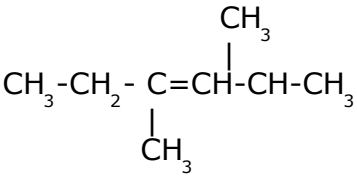
(ii)



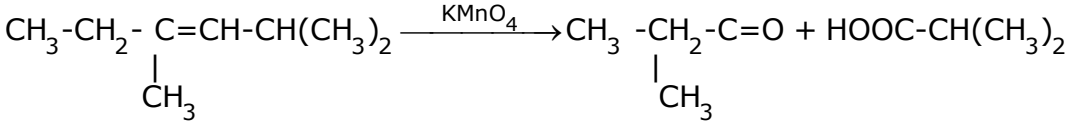
(1)

(b) From the given products of Ozonolysis,



The alkene would be:  (1)

IUPAC Name: 2, 4-dimethylhex-3-ene (1)



Butane-2-one $\left(\frac{1}{2}\text{mark}\right)$ 2-Methylpropanoic acid $\left(\frac{1}{2}\text{mark}\right)$

OR

(i)

$$CH_2=CHBr \xrightarrow{NaNH_2} \underset{\left(\frac{1}{2}\text{mark}\right)}{\overset{A}{HC \equiv CH}} \xrightarrow[873K]{\text{Red hot iron tube}} \underset{\left(\frac{1}{2}\text{mark}\right)}{\overset{B}{C_6H_6}}$$

(ii)

$$C_6H_6 + CH_3COCl \xrightarrow[AlCl_3]{\text{Anhydrous}} \underset{\left(\frac{1}{2}\text{mark}\right)}{\overset{A}{C_6H_5COCH_3}} + \underset{\left(\frac{1}{2}\text{mark}\right)}{\overset{B}{HCl}}$$

(iii)

$$CH_3COOH \xrightarrow{NaOH\ (aq)} \underset{\left(\frac{1}{2}\text{mark}\right)}{\overset{A}{CH_3COONa}} \xrightarrow[\Delta]{\text{Sodalime}} \underset{\left(\frac{1}{2}\text{mark}\right)}{\overset{B}{CH_4}}$$

(iv)

$$\underset{\text{Hex}-1-\text{ene}}{CH_2=CH-CH_2-CH_2-CH_2-CH_3} + HBr \xrightarrow{\text{No peroxide}} \underset{2-\text{Bromohexane}}{CH_3-\underset{\displaystyle Br}{\underset{|}{CH}}-CH_2-CH_2-CH_2-CH_3}$$

(v)

$$\underset{\text{Hex}-1-\text{ene}}{CH_2=CH-CH_2-CH_2-CH_2-CH_3} + HBr \xrightarrow{\text{peroxide}} \underset{1-\text{Bromohexane}}{CH_2-\underset{\displaystyle Br}{\underset{|}{CH_2}}-CH_2-CH_2-CH_2-CH_3}$$

Ans. 29

$NH_3 + H_2O \rightarrow NH_4^+ + OH^-$

$K_b = \frac{[NH_4^+][OH^-]}{[NH_3]} = 1.77 \times 10^{-5}$ $\left(\frac{1}{2}\right)$

Before neutralization,

$[NH_4^+] = [OH^-] = x$

$[NH_3] = 0.10 - x \approx 0.10$ $\left(\frac{1}{2}\right)$

Thus

$K_b = \frac{x^2}{0.10} = 1.77 \times 10^{-3}$

$\therefore x = 1.33 \times 10^{-3} = [OH^-]$ $\left(\frac{1}{2}\right)$

Now $K_w = [H^+][OH^-]$

$\therefore [H^+] = K_w / [OH^-]$

$= \frac{10^{-14}}{1.33 \times 10^{-3}}$

$= 7.51 \times 10^{-12}$

$pH = -\log(7.5 \times 10^{-12}) = 11.12$ $\left(\frac{1}{2}\right)$

On addition of 25 mL of 0.1M HCl solutions (i.e., 2.5 mmol of HCl) to 50 mL of 0.1M ammonia solution (i.e., 5 mmol of NH_3), 2.5 mmol of ammonia molecules are neutralized. The resulting 75 mL solution contains the remaining unneutralized 2.5 mmol of NH_3 molecules and 2.5 mmol of NH_4^+.

$$NH_3 + HCl \rightarrow NH_4^+ + Cl$$

2.5 2.5 0 0 $\left(\frac{1}{2}\right)$

At equilibrium

0 0 2.5 2.5

The resulting 75 mL of solution contains 2.5 mmol of NH_4^+ ions (i.e., 0.033 M) and 2.5 mmol (i.e., 0.033 M) of uneutralized NH_3 molecules. This NH_3 exists in the following equilibrium.

$$NH_4OH \rightleftharpoons NH_4^+ + OH^-$$

0.033M - y y y

Where, $y = [OH^-] = [NH_4^+]$

The final 75 mL solution after neutralization already contains 2.5 m mol NH_4^+ ions (i.e., 0.033M), thus total concentration of NH_4^+ ions is given as:

$[NH_4^+] = 0.033 + y$ $\left(\frac{1}{2}\right)$

As y is small, $[NH_4OH] = 0.033$ M and $[NH_4+] = 0.033$M.

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

$$= \frac{y(0.033)}{(0.033)}$$

$= 1.77 \times 10^{-5}$ M $\left(\frac{1}{2}\right)$

Thus, $y = 1.77 \times 10^{-5} = [OH-]$

$$[H^+] = \frac{10^{-14}}{1.77 \times 10^{-5}} \quad \left(\frac{1}{2}\right)$$

$= 0.56 \times 10\text{-}9$

Hence, pH = 9.24 $\left(\frac{1}{2}\right)$

OR

10 mL of 0.2 M $Ca(OH)_2 = 10 \times \frac{0.2}{1000}$

$= 2 \times 10^{-3}$ moles $\left(\frac{1}{2}\right)$

25 mL of 0.1 M HCl $= 25 \times \frac{0.1}{1000}$

$= 2.5 \times 10^{-3}$ moles $\left(\frac{1}{2}\right)$

$Ca(OH)_2 + 2\,HCl \rightarrow CaCl_2 + 2H_2O$

2 moles of HCl reacts with 1 mole of $Ca(OH)_2$

$\therefore 2.5 \times 10^{-3}$ moles of HCl will react with 1.25×10^{-3} moles of $Ca(OH)_2$ $\left(\frac{1}{2}\right)$

Therefore moles of $Ca(OH)_2$ left unreacted $= 2 \times 10^{-3} - 1.25 \times 10^{-3}$

$= 0.75 \times 10^{-3}$ moles $\left(\frac{1}{2}\right)$

Total volume = 10+ 25 = 35 mL

Molarity of $Ca(OH)_2 = \frac{0.75 \times 10^{-3} \times 1000}{35}$

$= 0.0214$ M $\left(\frac{1}{2}\right)$

$[OH^-]$ in $Ca(OH)_2 = 2 \times 0.0214 = 4.28 \times 10^{-2}$ M $\left(\frac{1}{2}\right)$

$pOH = -\log(4.28 \times 10^{-2})$

$= -(-2+0.6314)$

$= 1.368$ (1)

$pH = 14 - 1.368 = 12.632$ (1)

Ans. 30 Unlike $NaHCO_3$, the intermediate $KHCO_3$ formed during reaction, is highly soluble in water and thus cannot be taken out from solution to obtain K_2CO_3.Hence, K_2CO_3 cannot be prepared by Solvay process. (1)

(a) Alkali metals are highly reactive because of low ionization enthalpy value and therefore are not found in nature. They are present in combined state only in form of halides, oxides etc. (1)

(b) Ionization Energy of potassium is less than sodium because of large size or less effective nuclear charge. Thus, potassium is more reactive than sodium. (1)

(c) Alkali metals are strong reducing agents due to their greater ease to lose electrons. (1)

(d) Alkali metals have one unpaired electrons (ns^1) and are paramagnetic. However, during the salt formation, the unpaired electron is lost by alkali metals to other atom forming anion. Their salts have all paired electrons and show diamagnetic nature. (1)

OR

(a) The size of anions being much larger compared to cations, the lattice enthalpy will remain almost constant within a particular group. Since the hydration enthalpies decrease down the group, solubility will decrease as found for alkaline earth metal carbonates and sulphates. (1)

(b) $Cs^+ > Rb^+ > K^+ > Na^+ > Li^+$

Smaller the size of the ion greater is the degree of hydration. Lithium being small in size is hydrated to a large extent and cesium being large in size is hydrated to small extent. (1)

(c)The M-OH bond in hydroxides of alkali metal is very weak and can easily ionize to form M^+ ions and OH^- ions. This accounts for the basic character. Since ionization energy decreases down the group, bond between metal and oxygen becomes weak. Therefore basic strength of hydroxides increases accordingly. Thus NaOH is a stronger base than LiOH. (1)

(d) Alkali metals are highly sensitive towards air and water and are kept therefore in kerosene or paraffin oil. (1)

(e) This is because of exceptionally small size of Lithium and high charge to radius ratio of Li^+. (1)