LAST LOOK

✍ Question (no. 4) ✍

🕮 Problems 🕮

Chemical Calculation

1- Calculate the volume of 0.1 of CO_2 gas at S.T.P.

Volume of CO_2 gas at S.T.P = 0.1 × 22.4 = 2.24 liter

2- Calculate the density of oxygen (O_2) at (STP) . [O=16]

Molecular mass = 2 × 16 = 32 grams

The molecular mass = The density × volume of one mole

32 = The density × 22.4

The density = 32 ÷ 22.4 = 1.43 grams / liter

3- **Calculate the volume of chlorine gas evolved at (S.T.P) during the electrolysis of sodium chloride (NaCl) solution by passing an electric current, its intensity is 10 amperes for 20 minutes. (Cl = 35.45)**

The equivalent mass of chlorine $= \frac{35.45}{1} = 35.45$ gm

The mass of chlorine $= \frac{10 \times 20 \times 60 \times 35.45}{96500} = 4.4$ gm

The number of chlorine moles $= \frac{4.4}{70.9} = 0.062$ moles

The volume of chlorine at S.T.P = 0.062 × 22.4 = 1.3888 liters

4- Potassium super oxide KO_2 is a compound used to purify atmospheric air from carbon dioxide in a closed atmosphere as following equation .

$$4KO_2 + 2CO_2 \xrightarrow{CuCl_2} 2K_2CO_3 + 3O_2$$

If 14.2 gm of KO_2 is used, calculate the volume of oxygen formed in liters

(K=39 , O=16)

$$4KO_2 + 2CO_2 \longrightarrow 2K_2CO_3 + 3O_2$$

$4(39 + 2 \times 16)$ 3×22.4 liters

284 grams ⟶ 67.2 liters

14.2 grams ⟶ (X) liters

Volume of Oxygen $= \frac{14.2 \times 67.2}{284} = 3.36$ liters

5- Calculate the mass of calcium oxide produced from the thermal decomposition of 50 gram calcium carbonate, then calculate the volume of carbon dioxide gas evolve. **(Ca = 40 , O = 16 , C = 12)**

$CaCO_3 \longrightarrow CaO + CO_2$

$40 + 12 + 3 \times 16 \longrightarrow 40 + 16$

100 grams $\longrightarrow$ 56 grams

50 grams $\longrightarrow$ (X) grams

(X) Mass of calcium oxide = $\frac{50 \times 56}{100}$ = 28 grams

$CaCO_3 \longrightarrow CaO + CO_2$

100 grams $\longrightarrow$ 22.4 liter

50 grams $\longrightarrow$ (X) liter

Volume of CO_2 = $\frac{50 \times 22.4}{100}$ = 11.2 liter

6- Calculate the number of ions produce by dissolving 7.1 grams of sodium sulphate (Na_2SO_4) in water.

$Na_2SO_4 + H_2O_{(l)} \longrightarrow 2Na^+_{(aq)} + SO_4^{2-}{}_{(aq)}$

Molecular mass of sodium sulphate = $(23 \times 2) + (32 \times 1) + (16 \times 4) = 142$ grams

Number of moles of sodium sulphate = $\frac{7.1}{142}$ = 0.05 mole

Each mole of sodium sulphate gives 3 moles of ions.

Total number of moles of the produced ions = $3 \times 0.05 = 0.15$ mole

Total number of the produced ions = $0.15 \times 6.02 \times 10^{23} = 0.9 \times 10^{23}$ ions

7- A two gram of impure sodium chloride was dissolved in water, Excess of silver nitrate was added to precipitate 4.628 grams of silver chloride. Calculate the percentage of chlorine in the sample. Given that :

(0 = 16 , N = 14 , Na = 23 , Cl = 35.5 , Ag = 108)

$NaCl + AgNO_3 \longrightarrow AgCl + NaNO_3$

Mole of AgCl = $(1 \times 108) + (1 \times 35.5) = 143.5$ gram

143.5 gram AgCl $\longrightarrow$ 35.5 gram chlorine

4.628 gram AgCl $\longrightarrow$ (X) gram chlorine

Therefore mass of chlorine in silver chloride = mass of chlorine in sodium chloride

$= \frac{4.628 \times 35.5}{143.5} = 1.145$

$\frac{\text{Mass of chlorine the sample} \times 1}{\text{Mass of the sample}} = \frac{1.145 \times 100}{2} = 57.245\ \%$

8- 25 ml of 0.5 molar hydrochloric acid was neutralized with 20 ml of calcium hydroxide solution. Calculate the concentration of calcium hydroxide (mole/liter)

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

$$\frac{M_1 \times V_1}{M_a} = \frac{M_2 \times V_2}{M_b} \rightarrow \frac{0.5 \times 2}{2} = \frac{M_2 \times V_2}{1}$$

Concentration of calcium hydroxide (M_2) = $\frac{0.5 \times 25}{40}$ = 0.3125 moles / liter

9- 10 ml of 0.1 molar sulphuric acid added to 0.2 grams of impure sample of calcium carbonate until complete reaction takes place. Calculate the percent of calcium carbonate in The equation for the reaction is :

$$CaCO_3 + H_2SO_4 \longrightarrow CaSO_4 + CO_2 + H_2O$$

The number of moles of H_2SO_4 = $\frac{10 \times 0.1}{1000}$ = 0.001 mole

The balanced equation shows that :

The number of moles of $CaCO_3$ = the number of moles of H_2SO_4

The number of moles of $CaCO_3$ reacting with H_2SO_4 = 0.001 moles

One moles of $CaCO_3$ = 40 + 12 + (3 × 16) = 100 gm.

Mass of one $CaCO_3$ in the sample = 100 × 0.001 = 0.1 gm .

% of $CaCO_3$ in the impure sample = $\frac{0.1 \times 100}{0.2}$ = 50 %

10- 0.2 gm of a mixture of solid substance containing sodium hydroxide and sodium chloride was titrated wih 0.1 molar of hydrochloric. The complete reaction takes place by the consumption of 10 ml of the acid. Calaulate the percentage of sodium hydroxide in the mixture. (Na = 23. O = 16. H = 1)

Number of moles of HCI = $\frac{10 \times 0.1}{1000}$ = 0.001 mole

Number of moles of NaOH = 0.001 mole

The mass of one mole of NaOH = 23 + 16 + 1 = 40 gm

The mass of NaOH in the mixture = 40 x 0.001 = 0.04 gm

The percentage of NaOH the mixture = $\frac{0.04 \times 100}{0.2}$ = 20%

11- Four grams of impure Sodium chloride was dissolved in water and an excess of silver nitrate solution was added to precipitate 9.256 gram of silver choride. Calculate the percentage of sodium chloride in the sample.

(Na = 23,Cl = 35.5,Ag = 108)

$$NaCl + AgNo_3 \longrightarrow NaNo_3 + AgCl$$

The molecular mass in grams of AgCl = 108 + 35.5 = 143.5 gm

The molecular mass in grams of NaCl = 23 + 35.5 = 58.5 gm .

Each 58.5gm. of NaCl $\xrightarrow{\text{Produced}}$ 143.5gm.ofAgCl

(X) gm. of NaCl $\xrightarrow{\text{Produced}}$ 9.256gm.ofAgCl

The mass of NaCl in the sample = $\frac{58.5 \times 9.256}{143.5}$ = 3.7733gm.

% NaCl = $\frac{3.773}{4}$ x 100 = 94.3325%

12- A sample of 1.47grams of hydrated calcium chloride salt ($CaCl_2$. × H_2O). was heated several times till a constant mass of 1.11 grams., Find out the number of water molecules of crystallization in the molecule of hydrated calcium chloride.

(H = 1.O = 16.Ca = 40.Cl = 35.5)

The mass of water of crystallization in the sample = 1.47 – 1.11 = 0.36 gram.

Each 1.11gram of anhydrous ($CaCl_2$) bind with 0.36 gram water of crystallization

The molecular mass of ($CaCl_2$) = (35.5 x2) + 40 = 111gram

1.11 gram $CaCl_2$ bind with ⟶ 0.36 gram water of crystallization

111 gram $CaCl_2$ bind with ⟶ (X) gram water of crystallization

X (mass of water of crystallization) = (111 x 0.36) ÷ 1.11 = 36 gram

The molecular mass of (H_2O)= 16 + (2x1) = 18 gram

The number of molecules of water of crystallization in the molecule

of hydrate $CaCl_2$ = 36 ÷ 18

= 2 molecules

13- Calculate the equilibrium constant (K_p) of the reaction :

$$N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)} \qquad \Delta H = -92 \text{ KJ}$$

The pressures of gases are 2.3 atmosphere for N_2 , 7.1 atmosphere for H_2 and 0.6 atmosphere for NH_3. Comment on the value of (K_p)

$$KP = \frac{P_2[NH_3]}{P[N_2] \times P_3[H_2]} = \frac{(0.6)2}{2.3 \times (7.1)3} = 4.4 \times 10^{-4}$$

The small value of K_p indicating the small amount of resulting ammonia .

14- Calculate the equilibrium constant for the reaction :

$$1_2 + H_2 \rightleftharpoons 2HI$$

Provided that concentrations of iodine , hydrogen and hydrogen iodide at equilibrium are 0.1105.0.1105 and 0.7815 mole / liter respectively .

$$Kc = \frac{[HI]^2}{[H_2]\,[I_2]} = \frac{[0.781]^2}{[0.1105][0.1105]} = 50.018$$

15- If the equilibrium constant for the following reaction is 15.75

$$Cl_2 + PCl_3 \rightleftharpoons PCl_5$$

And the concentrations of chlorine and phosphorus trichloride were 0.3 and 0.84 mole / liter respectively. Calculate the concentration of phosphorous pentachloride.

$$\text{Equilibrium constant } K_c = \frac{[PCl_5]}{[Cl_2][PCl_3]} \longrightarrow 15.75 = \frac{[PCl_5]}{[0.3][0.84]} \longrightarrow 15.75 = \frac{[PCl_5]}{0.252}$$

The concentration of $PCl_5 = 15.75 \times 0.252 = 3.969$ mole / liter

16- Calculate the degree of dissociation in 0.1 molar hydrocyanic acid (HCN) solution at 25°C. Providing that the equilibrium constant of the acid $K_a = 7.20 \times 10^{-10}$

$$HCN + H_2O \rightleftharpoons H_3O^+ + CN^-$$

Applying Ostwald law : $Ka = a^2 \times C$

$$7.2 \times 10^{-10} = a^2 \times 0.1$$

$$a^2 = \frac{7.2 \times 10^{-10}}{0.1} = 72 \times 10^{-10}$$

$$a = \sqrt{72 \times 10^{-10}} = 8.5 \times 10^{-5}$$

The degree of dissociation of hydrogen ion = 8.5×10^{-5}

17- Calculate the concentration of hydronium ions (H_3O^+) in a 0.2 molar solution of acetic acid at 25°C given that equilibrium constant of the acid is (1.8×10^{-5})

$$[H_3O^+] = \sqrt{K_a \times X_\alpha}$$

$$[H_3O^+] = \sqrt{1.8 \times 10^{-5} \times 0.} = 1.897 \times 10^{-3} \text{ molar}$$

18- Calcium fluoride has K_{sp} of 3.9×10^{-11} . What is the fluoride ion concentration at equilibrium ?

$$CaF_2\ (s) \rightleftharpoons Ca^{-2}\ (aq) + 2F^-_{(aq)}$$

(X) (X) (2x)

$$Ksp = [Ca^{-2}] \times [2f]^2$$

$$3.9 \times 10^{-11} = (X) \times (2x)^2$$

$$3.9 \times 10^{-11} = 4\ x^3$$

$$x^3 = \frac{3.9 \times 10^{-11}}{4} \qquad \therefore\ x = 2.1 \times 10^{-4} \text{ mole / liter}$$

19- Calculate the solubility product. (K_{sp}) of calcium phosphate $Ca_3(PO)_4$ which is sparingly soluble in water , given that the concentration of calcium ions is (1×10^{-4}) mole / litre.

$$Ca_3(PO_4)_2 \rightleftharpoons 3Ca^{2+} + 2PO_4^{3-}$$

$$K_{sp} = [Ca^{2+}]^3\ [PO_4^{3-}]^2$$

$$= [1 \times 10^{-8}]^3\ [0.5 \times 10^{-3}]^2 = 2.5 \times 10^{-31}$$

20- Two metals A and B their standard oxidation potentials are – 0.3 and 0.7 volts respectively, each of them is divalent :

1- **Using a diagram how can you represent the cell which can be formed from these two metals?**
2- **Calculate the electromotive force of this cell.**
3- **Does this cell produce an electric current ? Why ?**

Electro Chemistry

1- $B \mid B^{+2} \parallel A^{+2} \mid A$

2- e.m.f = standard oxidation potential of anode – standard oxidation potential of cathode e.m.f = 0.7 – (-0.3) = 1 volt

3- An electric current is produced because the e.m.f is positive value and the reaction inside the cell is spontaneous .

21- What is the number of faradays required to precipitate gram/atom of copper according to the following reaction :

$$Cu^{2-} + 2e^{-} \longrightarrow Cu \text{ (at cathode)}$$

2 Faradays

22- Calculate the electric current intensity required for passing 3.7 Faraday through an electrolyte for 40 minutes.

The quantity of electricity = current strength × time

$3.7 \times 96500 = I \times 40 \times 60$

$I = (3.7 \times 96500) + (40 \times 60) = 148.7$ ampere

23- What is the quantity of electricity (coulomb) necessary to separate 5.6 grams of iron from solution of Iron (III) chloride ? Where the cathode reaction is :

$$Fe^{3-} + 3e^{-} \longrightarrow Fe^{0} \qquad (Fe = 55.86)$$

Equivalent mass of iron $= \dfrac{\text{Atomic mass}}{\text{Valence}} = \dfrac{55.86}{3} = 18.62$ grams

Quantity of electricity (coulomb) $= \dfrac{\text{Mass of deposited substance} \times 96500}{\text{Equivalent mass}}$

$$= \frac{5.6 \times 6500}{18.62} = 29022.5 \text{ coulomb}$$

24- Aluminum metal is produced from electrolysis of molten aluminum oxide. Calculate the number of aluminum moles produced when an electric current of intensity 9.6 amperes is passed for 5 minutes . the cathode reaction equation is : $Al^{3} + 3e^{-} \longrightarrow Al^{0}$ (Al = 27)

Quantity of electricity = electric current intensity intensity × time

$= 9.65 \times 5 \times 60 = 2895$ coulombs

Equivalent mass of Al = atomic mass / valency = = 27 / 3 = 9 gram

96500 coulombs $\longrightarrow$ 9 grams Al

285 coulombs $\longrightarrow$ (X) grams AI

$$X = \frac{2895 \times 9}{96500} = 0.27 \text{ gram}$$

27 grams Al $\longrightarrow$ 1 mole Al

0.27 gram Al $\longrightarrow$ (X) mole Al

$$(X) \frac{0.27 \times 1}{27} = 0.01 \text{ mole Al}$$