Unit-1

SOME BASIC CONCEPTS OF CHEMISTRY

1. Question based on significant numbers, Precision, Accuracy, ScientificNotation, laws of chemical combinations, SI units

1.1 What are the SI unit of mass, length & time?

1.2 Match the following prefixes with their multiples:

Prefixes	Multiples
(i) micro	10^{6}
(ii) deca	10^{9}
(iii)mega	10^{-6}
(iv) giga	10^{-15}
(v)femto	10
(vi) pico	10^{-12}

1.3 (a) What do you mean by significant figures? What are rules for determining the number of significant figures?

(b)Explain the terms: Precision and Accuracy

1.4 Express the following in the scientific notation: (i) 0.0048 (ii) 234,000 (iii) 8008 (iv) 500.0 (v) 6.0012

1.5 How many significant figures are present in the following? (i) 0.0025 (ii) 208 (iii) 5005 (iv) 126,000 (v) 500.0 (vi) 2.0034

1.6 Round up the following upto three significant figures: (i) 34.216 (ii) 10.4107 (iii) 0.04597 (iv) 2808

1.7 The following data are obtained when dinitrogen and dioxygen react together to form different compounds :

S.No	Mass of dinitrogen	Mass of dioxygen
1	14 g	16 g

2	14 g	32 g
3	28 g	32 g
4	28 g	80 g

(a) Which law of chemical combination is obeyed by the above experimental data? Give its statement.

1.8 Convert the following into basic units: (i) 28.7 pm (ii) 15.15 pm (iii) 25365 mg

1.9 How many significant figures should be present in the answer of the following calculations?

(i) $\frac{0.02856 \times 298.15 \times 0.112}{0.5785}$ (ii) 5×5.364

(iii) $0.0125 + 0.7864 + 0.0215$

1.10. State and illustrate the law of constant proportions.

1.11 State and explain the law of multiple proportions.

2. Question based on atomic and molecular masses Atomic Mass Average Atomic Mass, Molecular Mass, Formula Mass, mole concept and molar Masses, percentage composition, Empirical Formula for Molecular Formula, Limiting Reagent.

2.1 Calculate the molecular mass of the following: (i) H_2O (ii) CO_2 (iii) CH_4(iv) $C_6H_{12}O_6$

2.2 Calculate the mass per cent of different elements present in sodium sulphate (Na_2SO_4).

2.3 Determine the empirical formula of an oxide of iron which has 69.9% iron and 30.1% Dioxygen by mass.

2.4 How much copper can be obtained from 100 g of copper sulphate ($CuSO_4$)?

2.5 In a reaction $A + B_2 \rightarrow$ [redacted]$_2$ Identify the limiting reagent, if any, in the following reaction mixtures.

(i) 300 atoms of A + 200 molecules of B (ii) 2 mol A + 3 mol B

(iii) 100 atoms of A + 100 molecules of B (iv) 5 mol A + 2.5 mol B (v) 2.5 mol A + 5 mol B

2.5 Determine the molecular formula of an oxide of iron in which the mass per cent of iron and oxygen are 69.9 and 30.1 respectively.

2.6 Calculate the atomic mass (average) of chlorine using the following data:

Isotope	% Natural Abundance	Molar Mass
^{35}Cl	75.77	34.9689
^{37}Cl	24.23	36.9659

2.7 In three moles of ethane (C_2H_6), calculate the following: (i) Number of moles of carbon atoms. (ii) Number of moles of hydrogen atoms. (iii) Number of molecules of ethane.

2.8 If ten volumes of dihydrogen gas reacts with five volumes of dioxygen gas, how many volumes of water vapour would be produced?

2.9A welding fuel gas contains carbon and hydrogen only. Burning a small sample of it in oxygen gives 3.38 g carbon dioxide , 0.690 g of water and no other products. A volume of 10.0 L (measured at STP) of this welding gas is found to weigh 11.6 g. Calculate (i) empirical formula, (ii) molar mass of the gas, and (iii) molecular formula.

2.10 Calculate the amount of water (g) produced by the combustion of 16 g of methane. reaction.

2.11 How many moles of methane are required to produce 22 g CO_2 (g) after combustion?

2.12 A compound contains 4.07 % hydrogen,24.27 % carbon and 71.65 % chlorine.
Its molar mass is 98.96 g. What are its empirical and molecular formulas ?

3. Question based on Mass per cent, Molarity, Mole fraction, Molality

3.1(i) Define the following terms. (Write the mathematical formulas related to terms)(a) Mass percent (b) Molarity (c) Molality (d) Mole-fraction (e) Mass percent

(ii)Calculate the mass of sodium acetate (CH_3COONa) required to make 500 mL of 0.375 molar aqueous solution. (Molar mass of sodium acetate is 82.0245 g mol^{-1}).

3.2 Calculate the concentration of nitric acid in moles per litre in a sample which has a density, 1.41 g mL^{-1} and the mass per cent of nitric acid in it being 69%.

3.3 What is the concentration of sugar ($C_{12}H_{22}O_{11}$) in mol L^{-1} if its 20 g are dissolved in enough water to make a final volume up to 2L?

3.4 If the density of methanol is 0.793 kg L^{-1}, what is its volume needed for making 2.5 L of its 0.25 M solution?

3.5 A sample of drinking water was found to be severely contaminated with chloroform, $CHCl_3$, supposed to be carcinogenic in nature. The level of contamination was 15 ppm (by mass).

(i) Express this in percent by mass. (ii) Determine the molality of chloroform in the water sample.

3.6 The density of 3 M solution of NaCl is 1.25 g mL^{-1}. Calculate molality of the solution.

3.7 How are 0.50 mol Na_2CO_3 and 0.50 M Na_2CO_3 different?

3.8 Which one of the following will have largest number of atoms?

(i) 1 g Au (s) (ii) 1 g Na (s) (iii) 1 g Li (s)(iv) 1 g of Cl_2(g)

3.9 Calculate the molarity of a solution of ethanol in water in which the mole fraction of ethanol is 0.040 (assume the density of water to be one).

3.10 Calculate the number of atoms in each of the following (i) 52 moles of Ar (ii) 52 u of He (iii) 52 g of He.

3.11Calculate the molarity of NaOH in the solution prepared by dissolving its 4 g in enough water to form 250 mL of the solution.

3.12 A solution is prepared by adding 2 g of a substance A to 18 g of water. Calculate the mass per cent of the solute.

3.13 How does molality & Molarity depend on temperature? Out of molality & Molarity which one is better way to express concentration?

ANSWERS

2.1 Calculate the molecular mass of the following:

Ans: (i) H_2O = 18 (ii) CO_2=44 (iii) CH_4 =16 (iv) $C_6H_{12}O_6$ = 180

2.2 Calculate the mass per cent of different elements present in sodium sulphate (Na_2SO_4).

Ans % Na= 46 X100/142=32.4, %S= 32 X100/142= 22.53, %O = 64X100/142= 45.1

2.3 Determine the empirical formula of an oxide of iron which has 69.9% iron and 30.1% Dioxygen by mass.

Ans: no of moles of Fe: 69.9/56= 1.248

no of moles of O =30.1/ 16= 1.881

whole number ratio between the number of moles = 1: 1.5= 2: 3.

Hence empirical formula is Fe_2O_3

2.4 How much copper can be obtained from 100 g of copper sulphate ($CuSO_4$)?

Ans: 63.5g of Cu in 159.5g of $CuSO_4$.

63.5X100/159.5g = 39.81g of Cu in 100g of $CuSO_4$

2.5 In a reaction A + B_2 → [redacted]$_2$ Identify the limiting reagent, if any, in the following reaction mixtures.

(i) 300 atoms of A + 200 molecules of B Ans:B is limiting

(ii) 2 mol A + 3 mol B Ans: A is limiting

(iii) 100 atoms of A + 100 molecules of B Ans: reactants totally consumed

(iv) 5 mol A + 2.5 mol B Ans: B is limiting

(v) 2.5 mol A + 5 mol B Ans: A is limiting

2.6 Calculate the atomic mass (average) of chlorine using the following data:

Isotope	% Natural Abundance	Molar Mass
^{35}Cl	75.77	34.9689
^{37}Cl	24.23	36.9659

Ans: (34.9689 X75.77) + (36.9659 X24.23)/100 = 35.48

2.7 In three moles of ethane (C_2H_6), calculate the following:

(i) Number of moles of carbon atoms. Ans: 3X2= 6

(ii) Number of moles of hydrogen atoms. Ans: 3X6= 18

(iii) Number of molecules of ethane. Ans: 3X $6.023X10^{23}$=$18.069X10^{23}$

2.8 If ten volumes of dihydrogen gas reacts with five volumes of dioxygen gas, how many volumes of water vapour would be produced?

Ans: $2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(g);}$ 10 volumes of water vapour

2.9A welding fuel gas contains carbon and hydrogen only. Burning a small sample of it in oxygen gives 3.38 g carbon dioxide, 0.690 g of water and no other products. A volume of 10.0 L (measured at STP) of this welding gas is found to weigh 11.6 g. Calculate (i) empirical formula, (ii) molar mass of the gas, and (iii) molecular formula.

Ans:

i. 12g of C in 44g of CO_2 =>(12/44)X3.38g of C in 3.38g of CO_2= 0.922
   2g of H in 18g of H_2O => (2/18) X 0.690 of H in 0.690g of H_2O=0.077
   No of Moles of C= 0.922/12= 0.077
   No of moles of H =0.077
   The empirical formula =CH

ii. 22.4L at STP =1 molar mass
   10L at STP weighs11.6g;
   22.4L will weigh (11.6/10)X22.4= 26

iii. Empirical formula mass= 13
   Molecular mass=26
   The ratio of molecular mass: empirical formula mass=2
   Hence molecular formula is C_2H_2

2.10 Calculate the amount of water (g) produced by the combustion of 16 g of methane.

Ans: $CH_4 + 2O_2 \rightarrow 2H_2O + CO_2$, 16g CH_4 is 1mole. From the stoichiometric equation we get 1mole of methane gives 2moles of H_2O. ie is 18X2 =36g of water.

2.11 How many moles of methane are required to produce 22 g CO_2 (g) after combustion?

Ans: 22g of CO_2 is 22/44 moles ie 0.5 moles; 1mole of CH_4 produces 1mole of CO_2. Hence 0.5 moles of methane is required.

2.12 A compound contains 4.07 % hydrogen,24.27 % carbon and 71.65 % chlorine.

Its molar mass is 98.96 g. What are its empirical and molecular formulas ?

Ans: no of moles of H =4.07; C=24.27/12= 2.02; 71.65/35.5= 2.02

Simplest whole number ratio H: C:O= 2:1:1

Hence empirical formula is CH_2O

3. Question based on Mass per cent, Molarity, Mole fraction, Molality

3.1

(ii)Calculate the mass of sodium acetate (CH_3COONa) required to make 500 mL of 0.375 molar aqueous solution. (Molar mass of sodium acetate is 82.0245 g mol^{-1}).

Ans: no of moles of sodium acetate (CH_3COONa) required = (0.375/1000) X500=0.1875,ie 0.1875X82.0245 g = 15.38g

3.2 Calculate the concentration of nitric acid in moles per litre in a sample which has a density, 1.41 g mL^{-1} and the mass per cent of nitric acid in it being 69%.

Ans: 69g of HNO_3 in 100g of sample. => 69/63=1.095moles in 100g of sample. => 1.095 moles in 100/1.41ml of acid i.e 70.92ml.

No of moles of HNO_3 in 1000ml= (1.095/70.92)X1000= 15.44M

3.3 What is the concentration of sugar ($C_{12}H_{22}O_{11}$) in mol L^{-1} if its 20 g are dissolved in enough water to make a final volume up to 2L?

Ans: 20g in 2lit➔ 10g in 1 lit; 10/342=0.02924moles /lit

3.4 If the density of methanol is 0.793 kg L^{-1}, what is its volume needed for making 2.5 L of its 0.25 M solution?

Ans: moles of methanol required to prepare 2.5L of 0.25M methanol solution =2.5X0.25= 0.625➔ 0.625X32g=20g of methanol.

793g of methanol is present in 1000ml. => 20g is present in (1000/793) X 20 ml of methanol sample. 25.22ml of methanol is used to prepare 2.5lit of 0.25M methanol.

3.5 A sample of drinking water was found to be severely contaminated with chloroform, $CHCl_3$, supposed to be carcinogenic in nature. The level of contamination was 15 ppm (by mass).

(i) Express this in percent by mass. Ans: $(15/10^6)$X 100= $15X10^{-4}$% by mass

(ii) Determine the molality of chloroform in the water sample. Ans: Mass of solute in 1kg of solvent is$15X10^{-3}$g. => $15X10^{-3}/119.5 = 1.26X\ 10^{-4}$molal.

3.6 The density of 3 M solution of NaCl is 1.25 g mL^{-1}. Calculate molality of the solution.

Ans: 1.25g/ml➔ 1250g/lit. Mass of 1 litre solution is 1250g of which 3X58.5g= 175.5g is solute. Mass of solvent = 1250- 175.5= 1074.5 g.

3moles of solute in 1.074kg of solvent➔ 3/1.074 moles in 1kg of solvent. Hence molality=2.79moles/kg

3.8 Which one of the following will have largest number of atoms?

(i) 1 g Au (s) (ii) 1 g Na (s) (iii) 1 g Li (s)(iv) 1 g of Cl_2(g)

Ans: iii) 1 g Li, because it has the least atomic mass among the given ones.

3.9 Calculate the molarity of a solution of ethanol in water in which the mole fraction of ethanol is 0.040 (assume the density of water to be one).

Ans: we have to calculate no of moles per litre. Let no of moles of ethanol be X. let 1 litre of water = 1kg of water. Then:

X/(X + 55.56)= 0.04 ;let X << 55.56 then X/55.56=0.04 ; X = 2.22,

Hence molarity is 2.22moles /lit

3.10 Calculate the number of atoms in each of the following

(i) 52 moles of Ar; Ans: 52 X $6.022X10^{23}$=313.144X 10^{23}=3.13 X 10^{25} atoms

(ii) 52 u of He; Ans: 52/4= 13 atoms

(iii) 52 g of He; Ans: (52/4) X $6.022X10^{23}$ =78.286 X 10^{23} atoms of He.

3.11Calculate the molarity of NaOH in the solution prepared by dissolving its 4 g in enough water to form 250 mL of the solution.

Ans: 4g in 250ml ➔ 16g in 1 lit. ➔ 16/40moles/lit= 0.4moles /lit= 0.4M

3.12 A solution is prepared by adding 2 g of a substance A to 18 g of water. Calculate the mass per cent of the solute.

Ans: (2/18) X 100 is the mass percent.