Some Basic Concepts of Chemistry

1 Chapter

1. Calculate the molecular mass of the following:

i. H_2O

Ans: The molecular mass of water, H_2O, can be calculated by the following steps given below:

= (2 × Atomic mass of hydrogen element) + (1 × Atomic mass of oxygen element)

= [(2 × 1.0084 u) + (1 × 16.00 u)]

= 2.016 u + 16.00 u

= 18.016 u or 18.02 u

ii. CO_2

Ans: The molecular mass of carbon dioxide, CO_2, is calculated below:

= (1 × Atomic mass of carbon) + (2 × Atomic mass of oxygen)

= [(1× 12.011 u) + (2 × 16.00 u)]

= 12.011 u + 32.00 u

= 44.01 u

iii. CH_4

Ans: The molecular mass of methane, CH_4, is calculated below in step by step manner:

= (1 × Atomic mass of carbon) + (4 × Atomic mass of hydrogen)

= [(1 × 12.011 u) + (4 × 1.008 u)]

= 12.011 u +4.032 u

= 16.043 u

2. Calculate the mass percent of different elements present in sodium sulphate $\left(Na_2SO_4\right)$.

Ans: The given compound in the question is sodium sulphate and its formula is Na_2SO_4. Its molecular formula is calculated below:

$Na_2SO_4 = [(2\times23.0)+(32.066)+4(16.00)]$

= 142.066 g

Now, let us find the mass percentage of each element in the given compound using the formula given below:

$$\text{Mass percent of an element} = \frac{\text{Mass of that element in the compound}}{\text{Molar mass of the compound}} \times 100$$

$\therefore$ Mass percent of sodium:

$$= \frac{46.0 \text{ g}}{142.066 \text{ g}} \times 100$$

= 32.379

= 32.4%

Now, let us find the mass percentage of sulphur:

$$= \frac{32.066 \text{ g}}{142.066 \text{ g}} \times 100$$

= 22.57

= 22.6%

Now, the mass percentage of oxygen:

$$= \frac{64.0 \text{ g}}{142.066 \text{ g}} \times 100$$

= 45.049

= 45.05%

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

Ans: We are given that the percentage of iron by mass is 69.9% and the percentage of oxygen by mass is 30.1%.

Now, we can calculate the relative moles of iron by using the formula given below:

$$= \frac{\text{\% of iron by mass}}{\text{Atomic mass of iron}}$$

$$= \frac{69.9}{55.85}$$

= 1.25

In the same way we can calculate the relative moles of oxygen:

$= \dfrac{\text{\% of oxygen by mass}}{\text{Atomic mass of oxygen}}$

$= \dfrac{30.1}{16.00}$

$= 1.88$

Since we have relative moles of both the elements so, we can calculate the simpler molar ratio.

$= 1.25: 1.88$

$= 1: 1.5$

$= 2: 3$

So, now we can write the empirical formula of iron oxide as Fe_2O_3.

4. Calculate the amount of carbon dioxide that could be produced when

Ans: It is possible to express the balanced response of carb on combustion as follows:

$C+O_2 \rightarrow CO_2$

i. 1mole of carbon is burnt in air.

Ans: Carbon dioxide is produced when one mole of carbon is burned in one mole of dioxygen (air) using the balancing equation.

ii. 1mole of carbon is burnt in 16 g of dioxygen.

Ans: There is only 16 g of dioxygen accessible, as stated in the question. In this case, it will react with 0.5 moles of carbon to produce 22 g of CO_2. In this sense, it is a limiter.

iii. 2moles of carbon are burnt in 16 g of dioxygen.

Ans: It appears that just 16 g of dioxygen are accessible. In other words, it's a reaction-suppressing agent. This means that with just half as much carbon as dioxygen, 22 g of carbon dioxide may be produced.

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

Ans: 0.375 M aqueous Ans of sodium acetate means 1000 ml of Ans contains 0.375 moles of sodium acetate.

So, we can calculate the number of moles of sodium acetate in 500 ml. This is given below:

$$=\frac{0.375}{1000}\times 500$$

= 0.1875 mole

We are also given the molar mass of sodium acetate is $82.0245\text{ g mole}^{-1}$.

Required mass of sodium acetate can be calculated as:

$$=\left(82.0245\text{ g mol}^{-1}\right)\left(0.1875\text{ mole}\right)$$

= 15.38 g

6. 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 percent of nitric acid in it being 69%.

Ans: We are given the mass percentage of nitric acid in the sample as 69%.

So, we can say that 100 g of nitric acid contains 69 g of nitric acid by mass.

Molar mass of nitric acid (HNO_3) is calculated as below:

= [1 + 14 + (3 × 16)]

= 1 + 14 + 48

$= 63\text{ g mol}^{-1}$

As we have the molar mass of nitric acid so, we can find the number of moles in 69 g of nitric acid as given below:

$$=\frac{69\text{ g}}{63\text{ g mol}^{-1}}$$

= 1.095 mol

Volume of 100 g of nitric acid Ans can be calculated as:

$$=\frac{\text{Mass of solution}}{\text{density of solution}}$$

$$=\frac{100\text{ g}}{1.41\text{ g mL}^{-1}}$$

=70.92 mL

$=70.92\times 10^{-3}\text{ L}$

Now, we can calculate the concentration of nitric acid as:

$$=\frac{1.095\text{ mole}}{70.92\times 10^{-3}\text{ L}}$$

= 15.44 mol/ L

Therefore, concentration of nitric acid is 15.44 mol/L

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

Ans: In copper sulphate we can see that there is one atom of copper so, we can say that 1 mole of $CuSO_4$ will have 1 mole of copper.

The molar mass of copper sulphate is calculated below:

$CuSO_4 = 63.5 + 32 + (4 \times 16)$

= 63.5 + 32.0 + 64.0

= 159.5 g

We can say that 159.5 g of $CuSO_4$ will have 63.5 g of copper.

$\Rightarrow$ 100 g of $CuSO_4$ will contain $\frac{63.5 \times 100\text{ g}}{159.5}$ of copper.

So, the amount of copper that can be obtained from 100 g of $CuSO_4 = \frac{63.5 \times 100\text{ g}}{159.5}$

= 39.81 g

8. Determine the molecular formula of an oxide of iron in which the mass percent of iron andoxygen are 69.9 and 30.1 respectively. Given that the molar mass of the oxide is 159.69 g mol^{-1}

Ans: We are given the mass percentage of iron (Fe) as 69.9% and the percentage of oxygen (O) as 30.1%.

We know the atomic mass of iron is 55.85.

Number of moles of iron present in the oxide will be $= \frac{69.90}{55.85}$

$= 1.25$

We the atomic mass of oxygen is 16.

Number of moles of oxygen present in the oxide will be $= \frac{30.1}{16.0}$

$= 1.88$

The ratio of iron to the oxygen in the oxide is calculated below:

= 1.25: 1.88

$= \frac{1.25}{1.25} : \frac{1.88}{1.25}$

= 1: 1.5

= 2: 3

According to the ratio the formula of the oxide will be Fe_2O_3.

Empirical formula mass of Fe_2O_3 = [(2 × 55.85) + (3 × 16.00)] = 159.7 g/ mol

Given molar mass of Fe_2O_3 = 159.69 g/ mol

Multiplying the empirical formula by n gives the molecular formula for the molecule. This is calculated below:

$$n = \frac{\text{Molar mass}}{\text{Empirical formula mass}} = \frac{159.69\text{ g}}{159.7\text{ g}}$$

= 0.999 = 1

So, the empirical formula of the oxide is Fe_2O_3 and the value of n is 1. Therefore, the molecular formula of the oxide is Fe_2O_3.

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

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

Ans: The average atomic mass of chlorine is calculated below:

$$= \left[\left(\text{Fractional abundance of } ^{35}\text{Cl}\right)\left(\text{Molar mass of } ^{35}\text{Cl}\right) + \left(\text{Fractional abundance of } ^{37}\text{Cl}\right)\left(\text{Molar m}\right.\right.$$

$$= \left[\left\{\left(\frac{75.77}{100}\right)(34.9689\text{u})\right\} + \left\{\left(\frac{24.23}{100}\right)(36.9659\text{u})\right\}\right]$$

= 26.4959 + 8.9568

= 35.4527 u

So, the average atomic mass of chlorine is 35.4527 u.

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

i. Number of moles of carbon atoms.

Ans: 2 Moles of carbon atoms are present in each mole of C_2H_6.

Therefore, number of moles of carbon atoms in3 moles of C_2H_6.

= 2 × 3 = 6

ii. Number of moles of hydrogen atoms.

Ans: 6 moles of hydrogen atoms are present in each mole of C_2H_6.

Therefore, number of moles of carbon atoms in 3 moles of C_2H_6.

= 3 × 6 = 18

iii. Number of molecules of ethane.

Ans: 6.023×10^{23} molecules of ethane are present in each mole of C_2H_6.

Therefore, number of molecules in 3 moles of C_2H_6.

$= 3 \times 6.023 \times 10^{23} = 18.069 \times 10^{23}$

11. What is the concentration of sugar $\left(C_{12}H_{22}O_{11}\right)$ in mol L^{-1} if its 20 g are dissolved in enoughwater to make a final volume up t o 2 L?

Ans: Molarity (M) of the Ans can be calculated by the formula given below:

$$= \frac{\text{Number of moles of solute}}{\text{Volume of solution in Litres}}$$

This can be further written as

$$= \frac{\text{Mass of sugar / molar mass of sugar}}{2\text{ L}}$$

Putting the values, we get:

$$= \frac{20\text{ g}/\left[(12\times12)+(1\times22)+(11\times16)\right]\text{ g}}{2\text{ L}}$$

$$= \frac{20\text{ g}/\ 342\text{ g}}{2\text{ L}}$$

$$= \frac{0.0585\text{mol}}{2\text{L}}$$

$=0.02925\text{ mol L}^{-1}$

So, the molar concentration of sugar is $=0.02925\text{ mol L}^{-1}$.

12. 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 Ans?

Ans: The molar mass of methanol is calculated below:

$(CH_3OH) = (1\times12)+(4\times1)+(1\times16)$

$=32\text{ g mol}^{-1}$

$=0.032\text{ kg mol}^{-1}$

Molarity of methanol Ans will be $= \dfrac{0.793\text{ kg L}^{-1}}{0.032\text{ kg mol}^{-1}}$

$= 24.78\text{ mol L}^{-1}$

(Since density is mass per unit volume)

Now, to find the volume we have to write the formula,

$M_1V_1=M_2V_2$

1 is for the given Ans and 2 is for the Ans to be prepared.

Putting the values, we get:

$\left(24.78\text{ mol L}^{-1}\right)V_1 = (2.5\text{L})\left(0.25\text{ mol L}^{-1}\right)$

$V_1 = 0.0252\text{ L}$

$V_1 = 25.22\text{ mL}$

13. Pressure is determined as force per unit area of surface. The SI unit of pressure, Pascal is as shown below:

$1\ Pa = 1\ Nm^{-2}$

If mass of air at sea level is 1034 g cm^{-2}, calculate the pressure in Pascal.

Ans: Force per unit area of a surface is described as pressure. This is calculated below:

$$P = \frac{F}{A}$$

$$= \frac{1034g \times 9.8\ ms^{-2}}{cm^2} \times \frac{1\ kg}{1000\ g} \times \frac{(100)^2\ cm^2}{1m^2}$$

$$= 1.01332 \times 10^5\ kg\ m^{-1}\ s^{-2}$$

We know the relation of force can be written as:

$1\ N = 1\ kg\ m\ s^{-2}$

Then we can write,

$1\ Pa = 1\ Nm^{-2} = 1\ kg\ m^{-2}\ s^{-2}$

$1\ Pa = 1\ kg\ m^{-1}\ s^{-2}$

$\text{Pressure} = 1.01332 \times 10^5\ Pa$

14. What is the SI unit of mass? How is it defined?

Ans: The kilogram is the SI unit of mass in the SI system (kg). An international kilogram prototype is defined as one kilogram.

15. 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**

Ans: The multiples are matched with their prefixes in the table given below:

	Prefixes	Multiples
i).	Micro	10^{-6}
ii).	Deca	10
iii).	Mega	10^6
iv).	Giga	10^9
v).	Femto	10^{-15}

16. What do you mean by significant figures?

Ans: Significant figures are those digits that have meaning and are recognized to be assured of their value.

They are used to show uncertainty in an experiment or a computed number.

For example, if 18.2 mL is theresult of an experiment, then 18is certain while 2 is uncertain, and the total number ofsignificant figures are 3.

Since the final digit signifies uncertainty, significant figures are defined as the sum of all of a number's decimal places.

17. 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.

Ans: i). 1 part out of 1 million $\left(10^6\right)$ parts is equal to 1 ppm.

Therefore, mass percent of 15 ppm chloroform in water will be

$$=\frac{15}{10^6}\times 100$$

$$\simeq 1.5\times 10^{-3}\%$$

ii). 100 g of the sample will have 1.5×10^{-3} of $CHCl_3$.

So 1000 g of the sample contains will have 1.5×10^{-2} of $CHCl_3$.

Therefore, molality of chloroform in water is calculated as:

$$=\frac{1.5\times 10^{-2}\text{ g}}{\text{Molar mass of }CHCl_3}$$

For we want molar mass of chloroform.

Molar mass of $CHCl_3 = 12.00 + 1.00 + 3\left(35.5\right) = 119.5\text{ g mol}^{-1}$

$\therefore$ Molality of chloroform in water $= 0.0125\times 10^{-2}\text{m}$

$= 1.25\times 10^{-4}\text{m}$

18. Express the following in the scientific notation:

Ans: If we want to express the numbers in scientific notation, we must first put the number in decimal form and multiply it by 10 with some power. These are given below:

1. 0.00048

Ans: $0.0048 = 4.8 \times 10^{-3}$

2. 234,000

Ans: $234,000 = 2.34 \times 10^{5}$

3. 80008

Ans: $8008 = 8.008 \times 10^{3}$

4. 500.0

Ans: $500.0 = 5.000 \times 10^{2}$

5. 6.0012

Ans: $6.0012 = 6.0012 \times 10^{0}$

19. How many significant figures are present in the following?

Ans: There are some rules to find the number of significant figures and by following the rules the significant figures are given below:

1. 0.0025

Ans: There are 2 significant figures.

2. 208

Ans: There are 3 significant figures.

3. 5005

Ans: There r are 4 significant figures.

4. 126,000

Ans: There are 3 significant figures.

5. 500.0

Ans: There are 4 significant figures.

6. 2.0034

Ans: There are 5 significant figures.

20. Round up the following up to three significant figures.

Ans: These can be written as:

1. 34.216

Ans: 34.216 = 34.2

2. 10.4107

Ans: 10.4107 = 10.4

3. 0.04597

Ans: 0.04597 = 0.0460

4. 2808

Ans: 2808 = 2810

21. The following data are obtained when dinitrogen and dioxygen react together to form differentcompounds:

	Mass of dinitrogen	**Mass of dioxygen**
i).	**14 g**	**16 g**
ii).	**14 g**	**32 g**
iii).	**28 g**	**32 g**
iv).	**28 g**	**80 g**

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

Ans: The masses of dioxygen that will combine with the fixed dinitrogen mass are 32 g, 64 g, 32 g, and 80 g, respectively. The mass ratios of dioxygen are 1: 2: 1: 5. In light of this fact, the supplied experimental data is in accordance with the law of multiple proportions. One element's mass multiplied by the fixed mass of another element must be small whole numbers if two elements combine to produce more than one compound, according to this rule.

b) Fill in the blanks in the following conversions:

i. 1 km = …………….. mm …………..pm

Ans: $1 \text{ km} = 1 \text{ km} \times \dfrac{1000 \text{ m}}{1 \text{ km}} \times \dfrac{100 \text{ cm}}{1 \text{ m}} \times \dfrac{10 \text{ mm}}{1 \text{ cm}}$

$1\text{km} = 10^{6} \text{ mm}$

$1 \text{ km} = 1 \text{ km} \times \dfrac{1000 \text{ m}}{1 \text{ km}} \times \dfrac{1 \text{ pm}}{10^{-12} \text{ m}}$

$1\text{km}=10^{15}\text{pm}$

Hence, $1 \text{ km} = 10^{6} \text{ mm} = 10^{15} \text{ pm}$

ii. 1 mg = ……………... kg …………… ng

Ans: $1 \text{ mg} = 1 \text{ mg} \times \dfrac{1 \text{ g}}{1000 \text{ mg}} \times \dfrac{1 \text{ kg}}{1000 \text{ g}}$

$1\text{mg} = 10^{6} \text{ kg}$

Hence, $1\text{mg} = 10^{-6} \text{ kg} = 10^{6} \text{ ng}$

iii. 1 mL = ……………. L ……………… dm^3

Ans: $1 \text{ mL} = 1 \text{ mL} \times \dfrac{1 \text{ L}}{1000 \text{ mL}}$

$1 \text{ mg} = 10^{-3} \text{ L}$

$1 \text{ mL} = 1 \text{ cm}^3 = 1 \text{ cm}^3 \times \dfrac{1 \text{ dm} \times 1 \text{ dm} \times 1 \text{ dm}}{10 \text{ cm} \times 10 \text{ cm} \times 10 \text{ cm}}$

$1 \text{ mL} = 10^{-3} \text{ dm}^3$

Hence, $1 \text{ mL} = 10^{-3} \text{ L} = 10^{-3} \text{ dm}^3$

22. If the speed of light is 3.0×10^{8} ms^{-1}, calculate the distance covered by light in 2.00 ns.

Ans: From the question we can see that time taken to cover the distance is 2.00ns.

This can be written as:

$=2.00\times10^{-9}\text{s}$

We know the speed of light $= 3.0\times10^{8} \text{ ms}^{-1}$

So, the distance travelled by light in 2.00ns will be:

$=$ Speed of light $\times$ Time taken

$=\left(3.0\times10^{8}\text{ms}^{-1}\right)\left(2.00\times10^{-9}\text{s}\right)$

$=6.00\times10^{-1}\text{m}$

$= 0.600 \text{ m}$

23. In a reaction

$A + B_2 \rightarrow AB_2$

Identify the limiting reagent, if any in the following reaction mixtures.

Ans: Reactants that serve as limiting agents restrict the amount of a response. An initial reaction product is consumed before any more products are created, which stops the reaction and limits the quantity of products that are formed.

(i) 300 atoms of A + 200 molecules of B

Ans: It is shown that 1 atom of A interacts with 1 molecule of B in the given reaction. In other words, 200 molecules of B will react with 200 atoms of A, leaving 100 atoms of A unusable as a result. B is, thus, the limiting reagent in the reaction.

(ii) 2 mol A + 3 mol B

Ans: It is shown that 1 atom of A interacts with 1 molecule of B in the given reaction. In other words, 2 moles of A will react with just 2 moles of B. Consequently, 1 mol of A will not be used up in the process. This means that A is considered to be the limitative reagent.

(iii) 100 atoms of A + 100 molecules of B

Ans: According to the given reaction, 1 atom of A reacts with 1 molecule of B . The mixture is stoichiometric where no limiting reagent is present.

(iv) 5 mol A + 2.5 mol B

Ans: It is shown that 1 atom of A interacts with 1 molecule of B in the given reaction. Because of this, only 2.5 mol of B may be combined with 2.5 mol of A. There will be 2.5 mol of a remaining. B is, thus, the limiting reagent in this reaction.

(v) 2.5 mol A + 5 mol B

Ans: It is shown that 1 atom of A interacts with 1 molecule of B in the given reaction. Because of this, only 2.5 mol of A may be combined with 2.5 mol of B. There will be 2.5 mol of a remaining. A is, thus, the limiting reagent in this reaction.

24. Dinitrogen and dihydrogen react with each other to produce ammonia according to thefollowing chemical equation:

$\mathbf{N_{2(g)} + H_{2(g)} \rightarrow 2NH_{3(g)}}$

(i) Calculate the mass of ammonia produced if $2.00 \times 10^3 g$ dinitrogen reacts with $1.00 \times 10^3 g$ of dihydrogen.

Ans: First, we have to balance the given chemical equation.

$N_{2(g)} + 3H_{2(g)} \rightarrow 2NH_{3(g)}$

From this equation we can say, 1 mole (28g) of dinitrogen reacts with 3 mole (6g) of dihydrogen to give 2 mole (34g)of ammonia.

$= 2.00 \times 10^3$ g of dinitrogen will react with $\frac{6\text{ g}}{28\text{ g}} \times 2.00 \times 10^3$ g dihydrogen.

$= 2.00 \times 10^3$g of dinitrogen will react with 428.6 gof dihydrogen.

We are given the amount of dihydrogen = 1.00×10^3 g

Therefore, N_2 is the limiting reagent.

We can say that 28 g of N_2 will produce 34 g of NH_3.

Hence, mass of ammonia produced by 2000 g of $N_2 = \frac{34\text{ g}}{28\text{ g}} \times 2000$ g

= 2428.57 g

(ii) Will any of the two reactants remain unreacted?

Ans: N_2 is the limiting reagent while H_2 is the excess reagent. So, hydrogen will be left unreacted.

(iii) If yes, which one and what would be its mass?

Ans: Mass of dihydrogen left unreacted can be calculated as

$= 1.00 \times 10^3$g - 428.6g

= 571.4 g

25. How are0.50 mol Na_2CO_3 and 0.50 M Na_2CO_3 different?

Ans: The molar mass of Na_2CO_3 is given below:

Na_2CO_3 = (2 × 23) + 12.00 + (3 × 16)

= 106 g/mol

So, 1 mole of Na_2CO_3 means 106 g of Na_2CO_3.

Therefore, for 0.5 mol of Na_2CO_3 can be calculated as:

0.5 mol of $Na_2CO_3 = \frac{106\text{ g}}{1\text{ mole}} \times 0.5$ mol Na_2CO_3

$=53g\ Na_2CO_3$

$= 0.50\ M\ Na_2CO_3 = 0.50 mol/L\ Na_2CO_3$

Hence, 0.50 mol Na_2CO_3 is present in 1 L of water or 53g Na_2CO_3 is present in 1 L of water.

26. If ten volumes of dihydrogen gas react with five volumes of dioxygen gas, how many volumesof water vapour would be produced?

Ans: Let us first write the reaction between dihydrogen and dioxygen. The reaction will be:

$$2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(g)}$$

Dioxygen reacts with two volumes of dihydrogen to generate two volumes of water vapour.

As a result, ten volumes of dihydrogen will react with five volumes of dioxygen to generate ten volumes of water Vapours.

27. Convert the following into basic un its:

Ans: To convert the given numbers into basic units we have to convert it into meters and kilograms. All the numbers are converted into meters and kilograms, and are written below:

(i) 28.7 pm

Ans: $1pm = 10^{-12}m$

$28.7pm = 28.7 \times 10^{-12}m$

$= 2.87 \times 10^{-11}m$

(ii) 15.15 pm

Ans: $1pm = 10^{-12}m$

$15.15pm = 15.15 \times 10^{-12}m$

$= 1.515 \times 10^{-12}m$

(iii) 25365 mg

Ans: $1mg = 10^{-3}g$

$25365mg = 2.53657 \times 10^{4} \times 10^{-3}g$

Since,

$1g = 10^{-3}kg$

$2.5365 \times 10^{1}g = 2.5365 \times 10^{-1} \times 10^{-3}kg$

$25365mg = 2.5365 \times 10^{-2}kg$

28. Which one of the following will have largest number of atoms?

Ans: As we can see that all the atoms are given in grams so, by counting the number of atoms in each element we can find the answer. These are solved step by step and written below:

(i) 1 g Au (s)

Ans: $1\text{g of Au (s)} = \frac{1}{197}\text{mol of Au (s)}$

$= \frac{6.022\times10^{23}}{197}\text{ atoms of Au (s)}$

$= 3.06\times10^{21}\text{ atoms of Au (s)}$

(ii) 1 g Na (s)

Ans: $1\text{g of Na (s)} = \frac{1}{23}\text{mol of Na (s)}$

$= \frac{6.022\times10^{23}}{23}\text{ atoms of Na (s)}$

$= 0.262\times10^{23}\text{ atoms of Na (s)}$

$= 26.2\times10^{21}\text{ atoms of Na (s)}$

(iii) 1 g Li (s)

Ans: $1\text{g of Li (s)} = \frac{1}{7}\text{mol of Li (s)}$

$= \frac{6.022\times10^{23}}{7}\text{ atoms of Li (s)}$

$= 0.86\times10^{23}\text{ atoms of Li (s)}$

$= 86.0\times10^{21}\text{ atoms of Li (s)}$

(iv) 1 g of Cl_2 (g)

Ans: $1\text{g of } Cl_2\text{ (g)} = \frac{1}{71}\text{mol of } Cl_2\text{ (g)}$

Molar mass of Cl_2 is 71 (2×35.5)

$= \frac{6.022\times10^{23}}{71}\text{ atoms of } Cl_2\text{ (g)}$

$= 0.0848\times10^{23}\text{ atoms of } Cl_2\text{ (g)}$

$= 8.48\times10^{21}\text{ atoms of } Cl_2\text{ (g)}$

Hence, 1 g of Li (s) has the largest number of atoms.

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

Ans: First we have to find the mole fraction of ethanol.

$$\text{Mole fraction of } C_2H_5OH = \frac{\text{Number of moles } C_2H_5OH}{\text{Number of moles of solution}}$$

$$0.40 = \frac{n_{C_2H_5OH}}{n_{C_2H_5OH} + n_{H_2O}} \qquad \text{.................(1)}$$

Number of moles present in 1 L water:

$$n_{H_2O} = \frac{1000\ g}{18\ g\ mol^{-1}}$$

$$n_{H_2O} = 55.55 mol$$

Substituting the value of n_{H_2O} in equation (1),

$$\frac{n_{C_2H_5OH}}{n_{C_2H_5OH} + 55.55} = 0.040$$

$$n_{C_2H_5OH} = 0.040 n_{C_2H_5OH} + (0.040)(55.55)$$

$$0.96 n_{C_2H_5OH} = 2.222 mole$$

$$n_{C_2H_5OH} = 2.314 mole$$

$$\text{Molarity of solution} = \frac{2.314\ mol}{1\ L}$$

So, the molarity of the Ans is 2.314 M.

30. What will be the mass of one ^{12}C atom in g?

Ans: We know that 1 mole of carbon means 12 gram of carbon is there and in terms of number of atoms, there are 6.023×10^{23} atoms in 1mole of carbon. This can be written as:

1 mole = 12 g = 6.023×10^{23}

$$\text{So, mass of one } {}^{12}C \text{ atom} = \frac{12g}{6.022 \times 10^{23}}$$

$$= 1.993 \times 10^{-23} g$$

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

Ans: First we have to find the least precise number to find the significant figures.

$$\textbf{(i)}\ \frac{\mathbf{0.2856 \times 298.15 \times 0.112}}{\mathbf{0.5785}}$$

Ans: Least precise number of calculation = 0.112

Therefore, number of significant figures in the answer

Number of significant figures in the least precise number = 3

(ii) 5×5.364

Ans: Least precise number of calculations = 5.364

Therefore, number of significant figures in the answer will be

Number of significant figures in 5.364 = 4

(iii) 0.0125+0.7864+0.0215

Ans: Since the least number of decimal places in each term in four, the number of significant figures in the answer will also be 4.

32. Use the data given in the following table to calculate the molar mass of naturally occurringargon isotopes:

Isotope	Isotopic molar mass	Abundance
^{36}**Ar**	**35.96755g mol^{-1}**	**0.337%**
^{38}**Ar**	**37.96272 g mol^{-1}**	**0.063%**
^{40}**Ar**	**39.9624 g mol^{-1}**	**99.600%**

Ans: Molar mass of argon is calculated by step by step manner.

$$=\left[\left(35.96755\times\frac{0.337}{100}\right)+\left(37.96272\times\frac{0.063}{100}\right)+\left(39.9624\times\frac{90.60}{100}\right)\right]\text{g mol}^{-1}$$

$$=\left[0.121+0.024+39.802\right]\text{g mol}^{-1}$$

$$=39.947\text{ g mol}^{-1}$$

So, the molar mass of argon is 39.947 g/ mol.

33. Calculate the number of atoms in each of the following

Ans: All the options are given in different forms so, we have to convert it into number of atoms. These are given below:

(i)52 moles of Ar

Ans: 1 mole of Ar = 6.022×10^{23} atoms of Ar

Therefore,

52 mole of Ar = $52\times6.022\times10^{23}$ atoms of Ar

$=3.131\times10^{25}$ atoms of Ar

(ii) 52 u of He

Ans: 1 atom of He = 4u of the He

Or this can be written as, 4 u of He = 1 atom of He

1u of He = $\frac{1}{4}$ atom of He

52of He = $\frac{52}{4}$ atom of He

= 13 atoms of He.

(iii)52 g of He

Ans: 4g of He = 6.022×10^{23} atoms of He

Therefore, we can write:

52g of He = $\frac{6.022\times10^{23}\times52}{4}$ atoms of He

= 7.8286×10^{24} atoms of He

34. A welding fuel gas contains carbon and hydrogen only.Burning a small sample of it in oxygengives 3.38 gcarbon dioxide 0.690 g 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

Ans: 1 mole (44 g) of CO_2 will have 12 gcarbon.

So, 3.38 g of CO_2 will have carbon = $\frac{12g}{44g} \times 3.38g$

= 0.9217 g

18 g of water will have 2 g of hydrogen.

So, 0.690 g of water contain hydrogen = $\frac{2g}{18g} \times 0.690$

= 0.0767 g

Since carbon and hydrogen are the only constituents of the compound, the total mass of thecompound is:

= 0.9217 g + 0.0767 g

=0.9984 g

So, the percentage of Carbon in the compound = $\frac{0.9217}{0.9984} \times 100 = 92.32\%$

Now, percentage of Hydrogen in the compound = $\frac{0.0767}{0.9984} \times 100 = 7.68\%$

Moles of carbon in the compound = $\frac{92.32}{12} = 7.69$

Moles of hydrogen in the compound = $\frac{7.68}{1} = 7.68$

Since, we have the number of moles of both the elements, the ratio of carbon to hydrogen will be:

7.69: 7.68 = 1: 1

This is in the whole number, so the empirical formula will be CH.

ii. Molar mass of the gas

Ans: We are given,

Weight of 10.0 L of the gas (at S.T.P) = 11.6 g

Weight of 22.4L of gas at STP = $\frac{11.6\text{g}}{10.0\text{L}} \times 22.4\text{L}$

$= 25.984\text{g}$

$\approx 26\text{g}$

Hence, the molar mass of the gas is 26 g.

iii. Molecular formula.

Ans: Empirical formula mass of CH = 12 + 1 = 13

Now, we can find the value of n. This is given below:

n = $\frac{\text{Molar mass of gas}}{\text{Empirical formula mass of gas}}$

$= \frac{26\text{g}}{13\text{g}}$

n = 2

Therefore,

Molecular formula of gas $= (\text{CH})_n$

$= C_2H_2$

35. Calcium carbonate reacts with aqueous HCl to given $CaCl_2$ and CO_2 according to the reaction,

$CaCO_{3(s)} + 2HCl_{(aq)} \rightarrow CaCl_{2(aq)} + CO_{2(g)} + H_2O_{(l)}$

What mass of $CaCO_3$ is required to react completely with 25 mL of 0.75 M HCl?

Ans: We are given the molarity as 0.75 M which means in 1 L of Ans there are 0.75 moles of HCl. This can be converted into grams as:

$= \left[(0.75 \text{mol}) \times (36.5 \text{gmol}^{-1})\right]$ HCl is present in 1L of water

=27.375g of HCl is present in 1L of water

Thus, 1000 mL of Ans contains 27.375 g of HCl.

So, the amount of HCl present in 25 mL of Ans

$= \frac{27.375\text{g}}{1000\text{mL}} \times 25\text{mL}$

= 0.6844 g

The chemical reaction given in the question is:

$CaCO_{3(s)} + 2HCl_{(aq)} \rightarrow CaCl_{2(aq)} + CO_{2(g)} + H_2O_{(l)}$

2 mol of HCl $(2 \times 36.5 = 73\text{g})$ reacts with 1 mol of $CaCO_3\,(100\text{g})$.

So, the amount of $CaCO_3$ that will react with $0.6844\text{g} = \frac{100}{71} \times 0.6844\text{g}$

= 0.9639 g

36. Chlorine is prepared in the laboratory by treating manganese dioxide (MnO_2) with aqueoushydrochloric acid according to the reaction

$4HCl_{(aq)} + MnO_{2(l)} \rightarrow MnCl_{2(aq)} + Cl_{2(g)}$

How many grams of HCl react with 5.0 gof manganese dioxide?

Ans: 1 mol of MnO_2 reacts with 4 mol of HCl.

As the molar mass of MnO_2 is 87g and molar mass of HCl is 36.5 g. For 4 moles of HCl, the mass will be 146 g.

So, for 5.0 g of MnO_2 will react with:

$= \frac{146}{87} \times 5 = 8.4$ g

Therefore, 8.4 g of HCl will completely react with 5 g of MnO_2.