Chapter – 1 (Some basic concepts of Chemistry)

Exercise Questions:

Question: 1 Calculate the molar mass of the following:

i.) H_2O

ii.) CO_2

iii.) CH_4

Answer:

i.) H_2O

The molecular mass of water

= (2 x atomic mass of hydrogen) + (1 x atomic mass of oxygen)

= [2(1.0084) + 1(16.00u)]

= 2.016 u + 16.00u

= 18.016 u

= 18.02 u

ii.) CO_2

The molecular mass of carbon dioxide

= (1 x atomic mass of carbon) + (2 x atomic mass of oxygen)

= [1(12.011u) + 2(16.00 u)

= 12.011 u + 32.00 u

= 44.01 u

iii.) CH_4

= The molecular mass of methane

= (1 x atomic mass of carbon) + (4 x atomic mass of hydrogen)

= [1(12.011 u) + 4(1.0084 u)

= 12.011 u + 4.032 u

= 16.043 u

Question: 2 Calculate the mass percent of different elements present in sodium sulphate (Na_2SO_4).

Answer:

The molecular formula of the sodium sulphate is Na2SO4

Molar mass of Na2SO4 = [(2 x 23.0) + (32.066) + 4(16.00)]

= 142.066 g

Mass percentage = Mass of that element in the compound x 100 / Molar mass of the compound

:Mass percent of the sodium:

= 46.0g x 100 / 142.066g
= 32.37 g
= 32.4%
: Mass percent of sulphur:
= 32.066 g x 100 / 142.066g
= 22.57

= 22. 6%
Mass percent of oxygen:
= 64.0 g x 2100 / 142.066 g
= 45.049
= 45.05%

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

Answer:
% of iron by mass 69.9%
% 0f oxygen by mass 30.1%
Relative moles of iron in iron oxide:
= % of iron by mass / Atomic mass of iron
= 69.9 / 55.85
= 1.25
Relative moles of oxygen in iron oxide:
= % of oxygen by mass / Atomic mass of oxygen
= 30.1 / 16.00
= 1.88
Simplest molar ratio of iron to oxygen:
= 1.25 : 1.88
= 1 : 1.5
= 2 : 3
: The empirical formula of iron oxide is Fe2O3.

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

- **i.) 1 mole of carbon is burnt in air.**
- **ii.) 1 mole of carbon is burnt in 16g of dioxygen.**
- **iii.) 2 moles of carbon are burnt in 16g of dioxygen.**

Answer:
The balanced reaction of combustion of carbon can be written as:

$C + O_2 \rightarrow CO_2$

i.) As per the balanced equation, 1 mole of carbon burns in 1 mole of dioxygen to produce 1 mole of carbon dioxide.

ii.) According to the equation, only 16 g dioxygen is available. Hence, it will react with 0.5 mole of carbon to give 22 g of carbon dioxide. Hence, it is a limiting reagent.

iii.) According to the question, only 16 g dioxygen is available. It is a limiting reagent. Thus, 16 g of dioxygen can combine with only 0.5 mole of carbon to give 22 g of carbon dioxide.

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

Answer:

0.375 M aqueous solution of sodium acetate

= 1000 mL of solution containing 0.375 moles of sodium acetate

: Number of moles of sodium acetate in 500 Ml

= 0.375 x 500 / 1000

= 0.1875 mole

Molar mass of sodium acetate = 82.0245 g mole^{-1} (given)

: Required mass of sodium acetate = 82.0245 g mole^{-1}(0.1875 mole)

= 15.38 g

Question: 6 Calculate the concentration of nitric acid in moles per litre in a sample which has a density. 1.41 g mol^{-1} and the mass percent of nitric acid in it being 69%.

Answer:

Mass percent of nitric acid is the sample = 69%

The 100g 0f nitric acid contains 60 g of nitric acid by mass

Molar mass of nitric acid (HNO3)

= {1 + 14 + 3(16)} gmol^{-1}

= 1 + 14 + 18

= 63 g mol^{-1}

: Number of moles in 69 g of HNO3

= 69 g / 63 g mol^{-1}

= 1.095 mol

Volume of 100g of nitric acid solution

= Mass of solution / density of solution

= 100g / 1.41 gmL^{-1}

= 70.92 Ml = 70.92 x 10^{-3}

= 15.44mol/L

Concentration of nitric acid = 15.44 mol/L

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

Answer:

1 mole of $CuSO_4$ contains 1 mole of copper

Molar mass of $CuSO_4$ = (63.5) + (32.00) + 4(16)

= 159.5 g

159.5 g of $CuSO_4$ contains 63.5 g of copper

= 100 g of $CuSO_4$ will contains 63.5 x 100g / 159.5 of copper

= Amount of copper that can be obtained from 100g of $CuSO_4$ = 63.5 x 100 / 159.5

= 39.81 g

Question: 8 Determine the molecular formula of an oxide of iron in which the mass percent of iron and oxygen are 69.9 and 30.1 respectively.

Answer:

From the available data Percentage of iron = 69.9

Percentage of oxygen= 30.1

Total percentage of iron & oxygen= 69.9+30.1= 100%

Step 1 calculation of simplest whole number ratios of the elements

Element	Percentage	Atomic mass	Atomic ratio	Simplest ratio	Simplest whole ratio
F = 1e	69.9	55.84	69.9 / 55.84 = 1.25	1.25	2
O	30.1	16	30.1 / 16 = 1.88	1.88 = 1.5	3

Step 2 Writing the empirical formula of the compound

The empirical formula of the compound = Fe2 O3

Step 3 determination of molecular formula of the compound

Empirical formula mass = 2 X69.9 + 3 X16=187.8 amu

Molecular mass of oxide= 159.69g/mol(given)

Now we know molecular formula = n x Empirical formula

And n= molecular mass / empirical formula mass= 159.69/187.8 = 0.85 = approx 1

Therefore molecular formula = n x empirical formula

=1 x(Fe2O3) = Fe2O3

The molecular formula of the oxide is Fe2O3

Question: 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**

Answer:

The average atomic mass of chlorine

= (Fractional abundance of ^{35}Cl) + (Molar mass of ^{36}Cl) + (Fractional abundance of ^{37}Cl)

= [{75.77 / 100}(34.9689 u)} + {(24.23 / 100)(36.9659)}[]

= 35.4527 u.

Question: 10 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.

Answer:

i.) 1 mole of C2H6 contains 2 moles of carbon atoms

: Number of moles of carbon atoms in 3 moles of C2H6

= 3 x 6 = 18

ii.) 1 mole of C2H6 contains 6.023 x 10^{23} molecules of ethane

:Number of molecules in 3 moles of C2H6

= 3 x 6.022 x 10^{23} = 18.069 x 10^{23}

Question: 11 What is the concentration of sugar in $molL^{-1}$. If its 20 g are dissolved in enough water to make a final volume up to 2L?

Answer:

Molarity of a solution is given by:

= Number of moles of solute / Volume of solution in Litres

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

$$= \frac{20\text{ g} / [(12 \times 12) + (1 \times 22) + (11 \times 16)]\text{g}}{2\text{ L}}$$

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

= 0.0585 mol / 2L
= : Molar concentration of sugar = 0.02925 mol /L

Question:12 If the density of methanol is 0.793 kg L^{-1}, what is its volume needed for making 2.5 L of its 0.25M solution?

Answer:
Molar mass of methanol(CH2OH) = (1 x 12) + (4 x 1) + (1 x 16)
= 32 g mol^{-1}
= 0.032 kg mol^{-1}
Molarity of the methanol solution = 0.793kg L^{-1} / 0.032 kg mol^{-1}
= 24.78 mol L^{-1}
(Since density is mass per unit volume)
Applying, M1V1 = M2V2
(Given solution)(Solution to be prepared)
V1 = 0.0252 L
V1 = 25.22Ml

Question:13 Pressure is determined as force per unit area of the surface. The SI unit of pressure, pascal is as shown below:
1 Pa = 1 N m^{-2}
If mass of air at sea level is 1034 g cm^{-2}, calculate the pressure in pascal.

Answer:
Pressure is defined as force acting per unit area of the surface.
P = F / A
$= \frac{1034g \times 9.8ms^{-1}}{Cm^2} \times \frac{1kg}{1000g} \times \frac{(100)^2cm^2}{1\ m^2}$
= 1.01332 x 10^6kg $m^{-1}s^{-2}$
We know,
1N = 1kg ms^{-2}
Then,
1 Pa = 1Nm^{-2} 1Kg $m^{-1}s^{-2}$
: Pressure = 1.01332 x 10^6 Pa

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

Answer:
The SI unit of mass is kilogram (kg). 1 kilogram is defined as the mass equal to the mass of international prototype of kilogram.

Question: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**

Answer:

Prefixes	Multiples
micro	10^{-6}
Deca	10
Mega	10^6
Giga	10^9
Femto	10^{-15}

Question:16 What do you mean by significant figures?

Answer:
Significant figures are those meaningful digits that are known with certainty. They indicate uncertainty in an experiment or calculated value. For example, if 15.6 mL is the result of an experiment, tyhen 15 is certain while 6 is uncertain and the total number of significant figures are 3.
Hence, significant figures are defined as the total number of digits in a number including the last digit that represents the uncertainity of the result.

Question: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.

Answer:

i.) 1 ppm is equivalent ti 1 part out of 1 million ($10^6$0 parts.

: Mass percent of 15 ppm chloroform in water

$= 15 \times 100 / 10^6$

$= 15 \times 10^{-3}\%$

ii.) 100 g of the sample contains 1.5×10^{-3}g of CHCl3

= 1000 g of the sample contains 1.5×10^{-2} g of CHCl3

Molality of chloroform in water

$= 1.5 \times 10^{-2}$ g / Molar mass of CHCl3

Molar mass of CHCl3 = 12.00 + 1.00 + 3(35.5)

= 119.5 g / mol

Molality of chjloroform in water = 0.0125×10^{-2}m

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

Question:18 Express the following in scientific notation:

i.) 0.0048

ii.) 234,000

iii.) 8008

iv.) 500.0

v.) 6.0012

Answer:

i.) $0.0048 = 4.8 \times 10^{-3}$

ii.) $234{,}000 = 2.34 \times 10^5$

iii.) $8008 = 8.008 \times 10^3$

iv.) $500.0 = 5.000 \times 10^2$

v.) $6.0012 = 6.0012 \times 10^0$

Question:19 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

Answer:

i.) 0.0025

There are two significant figures.

ii.) 208

There are 3 significant figures

iii.) 5005

There are 4 significant figures

iv.) 126.000

There are 3 significant figures

v.) 500.0

There are 4 significant figures

vi.) 2.0034

There are 5 significant figures.

Question:20 Round up the following upto three significant figures:

i.) 34.216

ii.) 10.4107

iii.) 0.04597

iv.) 2808

Answer:

i.) 34.216

ii.) 10.4107

iii.) 0.04597

iv.) 2808

Question:21 The following data obtained when dinitrogen and dioxygen react together to form different compound:

Mass of dinitrogen	**Mass of dioxygen**
14 g	**16 g**
14 g	**32 g**
28 g	**32 g**
28 g	**80 g**

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

b.) Fill in the blanks in the following conversions:

i.) 1 km = ---------mm = ………….. pm

ii.) 1 mg = ………..kg = ……………ng

iii.) 1 ml = ………..L = ……………..dm^3

Answer:
Let us fix 14 parts by weight of nitrogen as fixed weight.
Now let us calculate the weights of oxygen which combine with 14 parts by weight of nitrogen

S No	No. of parts by weight of nitrogen	No. of parts by weight of oxygen	14 parts of nitrogen as fixed weight	No. of parts by weight of oxygen which combine with 14 parts by weight of nitrogen
1	14 g	16 g	14 g	16
2	14 g	32 g	14 g	32
3	28 g	32 g	14 g	32
4	28 g	80 g	14 g	80

(a) If we fix the mass of dinitrogen at 14 g, then the masses of dioxygen that will combine with the fixed mass of dinitrogen are 16 g, 32 g, 32 g, and 80 g.
The masses of dioxygen bear a whole number ratio of 1:2:2:5. Hence, the given experimental data obeys the law of multiple proportions.

This law was given by Dalton in 1804. The law states that if two elements combine to form 2 or more compound, then the weight of one element which combines a fixed weight of other element in these compounds, bears a simple whole number ratio by weight.

(b) (i) We know 1km=1000m
Or 1m = 1000 mm
Therefore 1km = 1000x 1000mm= 106 mm
1 km = 1 km × 1000 m / 1 km x 1 pm / 10^{-12} m
1 km = 10^{15} pm
Hence, 1 km = 10^{6} mm = 10^{15} pm

(ii) We know 1kg = 1000mg
Or 1000mg= 1kg
Or 1mg= 1/1000* 1= 0.01 kg
1 mg = 1 mg × 1g / 1000mg x 1 ng / 10^{-9}g
⇒ 1 mg = 106 ng
1 mg = 10^{-6} kg = 10^{6} ng

(iii) We know 1000 ml=l L
Or 1ml=1/1000*1= 0.01L
1 mL = 1 cm^3 = 1 cm^3
⇒ 1 mL = 10^{-3} dm^3
1 mL = 10^{-3} L = 10^{-3} dm^3

Question:22 If the speed of light is 3.0 x 10^8m s^{-1}. Calculate the distance covered by light in 2.00ns.

Answer:

According to the equation:

Time taken to cover the distance = 2.00 ns

= 2.00 x 10^{-9}s

Speed of light = 3 x $10^8$$ms^{-1}$

Distance travelled by light in 2.00 ns

= Speed of light x time taken

= (3.0 x 10^8 ms^{-1}) (2.00 x 10^{-9})

= 6.00 x 10^{-1} m

0.600 m

Question:23 In a reaction

$A + B_2 \rightarrow AB_2$

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 atom of A + 100 molecules of B**
- **iv.) 5 mol A + 2.5 mol B**
- **v.) 2.5 mol A + 5 mol B**

Answer:

A limiting reagent determines the extentof a reaction. It is the reactant which is the first to get consumed during a reaction, thereby causing the reaction to stop and limiting tha amount of product formed.

(i) According to the given reaction, 1 atom of A reacts with 1 molecule of B. Thus, 200 molecules of B will react with 200 atoms of A, thereby leaving 100 atoms of A unused. Hence, B is the limiting reagent. Here atom B is in lesser amount(200).

(ii) According to the reaction, 1 mol of A reacts with 1 mol of B. Thus, 2 mol of A will react with only 2 mol of B. As a result, 1 mol of A will not be consumed. Hence, A is the limiting reagent.

(iii) According to the given reaction, 1 atom of A combines with 1 molecule of B. Thus, all 100 atoms of A will combine with all 100 molecules of B. Hence, the mixture is stoichiometric where no limiting reagent is present.

(iv) 1 mol of atom A combines with 1 mol of molecule B. Thus, 2.5 mol of B will combine with only 2.5 mol of A. As a result, 2.5 mol of A will be left as such. Hence, B is the limiting reagent because B is less as compared to A

(v) According to the reaction, 1 mol of atom A combines with 1 mol of molecule B. Thus, 2.5 mol of A will combine with only 2.5 mol of B and the remaining 2.5 mol of B will be left as such. Hence, A is the limiting reagent

Question:24 Dinitrogen and dihydrogen react with each other to produce ammonia according to the following chemical equation:

$N_2(g) + H_2(g) \rightarrow 2NH_3\ (g)$

- **i.) Calculate the mass of ammonia produced if 2.00 x 10^3g dinitrogen reacts with 1.00 x 10^3 g of hydrogen.**
- **ii.) Will any of the reactants remain unreacted?**
- **iii.) If yes, which one and what would be its mass?**

Answere:

(i) Balancing the given chemical equation,

$N_2(g) + H_2(g) \rightarrow 2NH_3\ (g)$

Total mass of Ammonia = 2((14) +3(1)) = 34 g

From the chemical equation, we can write

28gm of N2 reacts with 6gm of H2 to produce ammonia= 34g

Or 1 gm of N2 reacts with 1gm of H2 to produce ammonia= 34/28*1

Or when 2.00 x 10^3 g of N2 reacts with 1.00 x 10^3 gm of H2 to produce ammonia

=34/28 *2.00 x 10^3 = 2428.57g

Hence 2.00 × 103 g of dinitrogen will react with 1.00 x 10^3 g of dihydrogen to give 2428.57 g of ammonia

Given, Amount of dihydrogen = 1.00 × 10^3 g

Hence, N2 is the limiting reagent.

(ii) N2 is the limiting reagent and H2 is the excess reagent. Hence, H2 will remain unreacted.

(iii) Mass of dihydrogen left unreacted = 1.00 × 10^3 g – 428.6 g

= 571.4 g

Question:25 How are 0.50 mol Na_2CO_3 and 0.50 M Na_2CO_3 different?

Answer:

Molar mass of Na2CO3 = (2 x 23) + 12.00 + (3 x 6)

= 106 g mol^{-1}
Now, 1 mole of Na2CO3 means 106 g of Na2CO3
: 0.5 mol of Na2CO3 = 106 g x 0.5 mol / 1 mole
= 53 g Na2CO3
= 0.50 M of Na2CO3 = 0.50 mol / L Na2CO3
Hence, 0.50 mol of Na2CO3 is present in 1 L of water or 53 g Na2CO3 is present in 1 L of water.

Question: 26 If ten volumes of dihydrogen gas reacts with five volume of dioxygen gas, how many volumes of water vapour would be produced?

Answer:
Reaction of dihydrogen with dioxygen can be written as:
$2H_{2(g)} + O_{29g)} \rightarrow 2H_2O(g)$
Now, two volumes of dihydrogen react with one volume of dihydrogen to produce two volumes of water vapour
Hence, ten volumes of dihydrogen will react with five volumes of dioxygen to produce ten volumes of water vapour.

Question:27 Convert the following in basic units:

- **i.) 28.7 pm**
- **ii.) 15.15 pm**
- **iii.) 25365 mg**

Answer:
(i) 28.7 pm:
1 pm = 10^{-12} m
28.7 pm = 28.7 × 10^{-12} m
= 2.87 × 10^{-11} m

(ii) 15.15 pm:
1 pm = 10^{-12} m
15.15 pm = 15.15 × 10^{-12} m
= 1.515 × 10^{-12} m

(iii) 25365 mg:
1 mg = 0.01 kg
Therefore 25365 mg = 0.01/1 x 25365= 253.65 kg

Question:28 Which one of the following will have largest no. of atoms:

i.) **1 g Au (s)**

ii.) **1 g Na (s)**

iii.) **1 g Li (s)**

iv.) **1 g Cl_2 (g)**

Answer:

(i) Gram atomic mass of Au= 197 g

Or

197g of Au contains = 6.022×10^{23}

Therefore 1gm of Au contains = $6.022 \times 10^{23}/197*1 = 3.06 \times 10^{21}$ atoms

(ii) Gram atomic mass of Na = 23 g

Or

23 g of Na contains atoms = 6.022×10^{23}

Or

1gm of Na contains atoms = 6.022×10^{23} /23 *1 = 26.2×10^{21} atoms

(iii) Gram atomic mass of Li = 7

Or

7g of Li contains atoms = 6.022×10^{23}

Or

1g of Li contains atoms = $6.022 \times 10^{23}/7$ *1= 86.0×10^{21} atoms

(iv) Gram atomic mass of Cl = 71 Or 71g of Cl contains atoms = 6.022×10^{23}

Or

1 g of Cl contains atoms = 6.022×10^{23} /71 * 1= 8.48×10^{21} atoms

Hence, 1 g of Li (s) will have the largest number of atoms

Question:29 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).

Answer:

Mole fraction of C2H5OH= Number of moles of C2H5OH / Number of moles of solution

Let the moles of C2H5OH= X

Now density of water = 1 (given)

And the weight of 1000ml of water = volume * density (from density = mass/volume)

= 1000 x 1=1000g

Therefore moles of water = 1000/18 = 55.55 mol (18g is molecular mass of water)

Also mole fraction of C2H5OH= 0.040 (given)
Putting the values in equation 1,we get
= 0.040 = X/X + 55.55
=0.040X + 2.222 = X
OR
X= 2.3145 mol
Molarity of solution = 2.314 M

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

Answer:
1 mole of carbon atoms = 6.022×10^{23} atoms of carbon
= 12 g of carbon
: Mass of one ^{12}C atom = $12g / 6.022 \times 10^{23}$
= 1.993×10^{-23}g

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

i.) $\dfrac{0.02856 \times 298.15 \times 0.112}{0.5785}$

ii.) **5 x 5.364**

iii.) **0.0125 + 0.7864 + 0.0215**

Answer:
(i) Least precise term i.e. 0.112 is having 3 significant digits.
∴ There will be 3 significant figures in the calculation.
(ii) 5.364 is having 4 significant figures.
∴ There will be 4 significant figures in the calculation.
(iii) Least number of decimal places in each term is 4.
∴ There will be 4 significant figures

Question:32 Use the data given in the following table to calculate the molar mass of naturally occurring argon isotopes:

Isotope	Isotopic molar mass	Abundance
^{36}Ar	35.96755 g mol^{-1}	0.337%

^{38}Ar	**37.96272 g mol^{-1}**	**0.063%**
^{40}Ar	**39.9624 g mol^{-1}**	**99.600%**

Answer:

Molar mass of argon

= [(35.96755 x 0.337/100) + (37.96272 x 0.063/100) + (39.9624 x 90.60/100)] g mol^{-1}

= [0.121 + 0.0024 + 39.802] $gmol^{-1}$

= 39.947 $gmol^{-1}$

Question:33 Calculate the no. of atoms in each of the following :

i.) 52 moles of Ar

ii.) 52 u of He

iii.) 52 g of He

Answer:

(i) 1 mole of Ar = 6.022×10^{23} atoms of Ar

52 mol of Ar = $52 \times 6.022 \times 10^{23}$ atoms of Ar

= 3.131×10^{25} atoms of Ar

(ii) Atomic mass of He = 4amu

Or

4amu is the mass of He atoms = 1

Therefore 52 amu is the mass of He atoms= ¼*52 = 13 atoms of He

(iii) Gram atomic mass of He = 4g

Or

4g of He contains = 6.022x 10^{23} atoms

Therefore 52 g of He contains = 6.022x 10^{23} /4 * 52 = 7.83 x 10^{24} atoms

Question:34 A 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

iii.) Molecular formula

Answer:

(i) Mass of carbon in 3.38 g of CO_2 = 3.38 g/44 x 12 = 0.922 g

Mass of hydrogen in 0.690 g of H2O = 0.690 g/18 x 2 = 0.077 g
Total mass of the sample burnt = 0.922 g + 0.077 g = 0.999 g
Percentage of carbon in the fuel = {0.922}/{0.999 g} x 100 = 92.29%
Percentage of hydrogen in the fuel = {0.077 g}/{0.999 g} x 100 = 7.71%

Element	Mass percent	Atomic mass	Relative no. of atoms	Simple atomic ratio
Carbon (C)	92.29	12.0	92.29 / 12.0 = 7.69	7.69 / 7.69 = 1
Hydrogen	7.71	1.0	7.71 / 1.0 = 7.71	7.71 / 7.69 = 1

Therefore, empirical formula of the compound = CH

(ii) Volume of the gaseous fuel = 11.6 g
Molar mass of the fuel = {11.6 g}/{10.0 L} x 22.4 L/ml = 26.0 g mol-1

(iii) Empirical formula mass of the fuel = (12 + 1) g mol-1 = 13 g mol-1
Molar mass of the fuel = 26.0 g mol-1 n = {26.0 g mol-1}/{13 g mol-1} = 2
Molecular formula of the fuel = 2 x Empirical formula = 2 x CH = C_2H_2

Question:35 Calcium carbonate reacts with aqueous HCl to give $CaCl_2$ and CO_2 according to the reaction, $CaCO_3$ (s) + 2 HCl (aq) → $CaCl_2$(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?

Answer:
0.75 M of HCl = 0.75 mol of HCl are present in 1 L of water
= [(0.75 mol) x (36.5 g mol^{-1})] HCl is present in 1 L of water
= 27.375 g of HCl is present in 1 L of water
Thus, 1000 mL of solution
= 27.375g x 25mL / 1000 Ml
= 0.6844 g
From the given chemical equation
$CaCO_{2(s)}$ + 2HCl(aq) → $CaCl_{2(aq)}$ + $CO_{2(g)}$ + H2O(l)
2 mol of HCl (2 x 36.5 = 71 g) react wuth 1 mol of CaCO3 (100g).
: Amount of CaCO3 that will react with 0.6844 g = 100 x 0.6844 g / 71
= 0.9639 g

Question:36 Chlorine is prepared in the laboratory by treating manganese dioxide (MnO_2) with aqueous hydrochloric acid according to the reaction

4HCl(aq) + MnO_2(s) → $2H_2O$(l) + $MnCl_2$(aq) + Cl_2(g)

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

Answer:
1 mol [55 + 2 x 16 = 87 g] MnO2 reacts completely with 4 mol[4 x 36.5 = 146 g] of HCl
: 50 g of MnO2 will react with
= 146g x 5.0 g / 87 g
= 8.4 g of HCl
Hence, 8.4 g of HCl will react with 5.0 g of manganese dioxide.