Chapter 5 - Mole Concept and Stoichiometry

Exercise 5(A)

Solution 1.

(a) Gay-Lussac's law states that when gases react, they do so in volumes which bear a simple ratio to one another, and to the volume of the gaseous product, provided that all the volumes are measured at the same temperature and pressure.

(b) Avogadro's law states that equal volumes of all gases under similar conditions of temperature and pressure contain the same number of molecules.

Solution 2.

a) The number of atoms in a molecule of an element is called its atomicity. Atomicity of Hydrogen is 2, phosphorus is 4 and sulphur is 8.

b) N_2means 1 molecule of nitrogen and 2N means two atoms of nitrogen.
N_2 can exist independently but 2N cannot exist independently.

Solution 3.

(a) This is due to Avogadros Law which states Equal volumes of all gases under similar conditions of temperature and pressure contain the same number of molecules.
Now volume of hydrogen gas =volume of helium gas
n molecules of hydrogen =n molecules of helium gas
nH_2=nHe
1 mol. of hydrogen has 2 atoms of hydrogen and I molecule of helium has 1 atom of helium
Therefore 2H=He
Therefore atoms in hydrogen is double the atoms of helium.

(b) For a given volume of gas under given temperature and pressure, a change in any one of the variable i.e., pressure or temperature changes the volume.

(c) Inflating a balloon seems violating Boyles law as volume is increasing with increase in pressure. Since the mass of gas is also increasing.

Solution 4.

$2H_2 + O_2 \rightarrow 2H_2O$
2 V 1V 2V

From the equation, 2V of hydrogen reacts with 1V of oxygen
so 200cm^3 of Hydrogen reacts with = 200/2= 100 cm^3
Hence, the unreacted oxygen is 150 – 100 = 50cm^3 of oxygen.

Solution 5.

$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$
1 V 2 V 1 V
From equation,1V of CH_4 reacts with = 2 V of O_2
so, 80 cm^3 CH_4 reacts with = 80 × 2 = 160cm^3 O_2
Remaining O_2 is 200-160 = 40cm^3
From equation, 1V of methane gives 1 V of CO_2
So, 80 cm^3 gives 80cm^3 CO_2 and H_2O is negligible.

Solution 6.

$2C_2H_2 + 5O_2 \rightarrow 4CO_2 + 2H_2O\ (l)$
2 V 5 V 4 V
From equation, 2 V of C_2H_2 requires = 5 V of O_2
So, for 400ml C_2H_2, O_2 required = 400 × 5/2 =1000 ml
Similarly, 2 V of C_2H_2 gives = 4 V of CO_2
So, 400ml of C_2H_2 gives CO_2 = 400 × 4/2 = 800ml

Solution 7.

Balanced chemical equation:
$H_2S_{(g)} + Cl_{2(g)} \rightarrow 2HCl_{(g)} + S_{(s)}$
1mole 1mole 2moles 1mol
112cm^3 120cm^3
(i)At STP, 1 mole gas occupies 22.4 L.
As 1 mole H_2S gas produces 2 moles HCl gas,
22.4 L H_2S gas produces 22.4 × 2 = 44.8 L HCl gas.
Hence, 112 cm^3 H_2S gas will produce 112 × 2 = 224 cm^3 HCl gas.
(ii) 1 mole H_2S gas consumes 1 mole Cl_2 gas.
This means 22.4 L H_2S gas consumes 22.4 L Cl_2 gas at STP.
Hence, 112 cm^3 H_2S gas consumes 112 cm^3 Cl_2 gas.
120 cm^3 - 112 cm^3 = 8 cm^3 Cl_2 gas remains unreacted.
Thus, the composition of the resulting mixture is 224 cm^3 HCl gas + 8 cm^3 Cl_2 gas.

Solution 8.

$2C_2H_6 + 7O_2 \rightarrow 4CO_2 + 6H_2O$
2 V 7 V 4 V
Now from equation, 2V of ethane reacts with = 7 V of oxygen
So, 600cc of ethane reacts with= 600 $\times$ 7/2 = 2100cc
Hence, unused O_2 is = 2500 - 2100 = 400 cc
From 2V of ethane = 4 V of CO_2 is produced
So, 600cc of ethane will produce = 4 $\times$ 600/2 =1200cc CO_2

Solution 9.

$C_2H_4 + 3O_2 \rightarrow 2CO_2 + 2H_2O$
1V 3V
11litre 33 litre

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

$$V_2 = \frac{P_1V_1T_2}{P_2T_1} = \frac{380 \times 33 \times 273}{549 \times 760} = 8.25 \text{ litres}$$

Solution 10.

$CH_4 + 2Cl_2 \rightarrow CH_2Cl_2 + 2HCl$
1 V 2 V 1 V 2 V
From equation, 1V of CH_4 gives = 2 V HCl
so, 40 ml of methane gives = 80 ml HCl
For 1V of methane = 2V of Cl_2 required
So, for 40ml of methane = 40 $\times$ 2 = 80 ml of Cl_2

Solution 11.

$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$
1 V 5 V 3 V

From equation, 5 V of O_2 required = 1V of propane
so, 100 cm^3 of O_2 will require = 20 cm^3 of propane

Solution 12.

$2NO + O_2 \rightarrow 2NO_2$

2 V 1 V 2 V

From equation, 1V of O_2 reacts with = 2 V of NO

200cm^3 oxygen will react with = 200 $\times$ 2 =400 cm^3 NO

Hence, remaining NO is 450 - 400 = 50 cm^3

NO_2 produced = 400cm^3 because 1V oxygen gives 2 V NO_2

Total mixture = 400 + 50 = 450 cm^3

Solution 13.

$2CO + O_2 \rightarrow 2CO_2$
2 V 1 V 2 V

2 V of CO requires = 1V of O_2
so, 100 litres of CO requires = 50 litre of O_2

Solution 14.

$4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$

4 V 5 V 4 V

9 litres of reactants gives 4 litres of NO

So, 27 litres of reactants will give = 27 $\times$ 4/9 = 12 litres of NO

Solution 15.

$H_2 + Cl_2 \rightarrow 2HCl$
1V 1V 2 V

Since 1 V hydrogen requires 1 V of oxygen and 4cm^3 of H_2 remained behind so the mixture had com”>16 cm^3 hydrogen and 16 cm^3 chlorine.
Therefore Resulting mixture is H_2 =4cm^3,HCl=32cm^3

Solution 16.

$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$
1 V 2 V 1 V

$2C_2H_2 + 5O_2 \rightarrow 4CO_2 + 2H_2O$
2 V 5 V 4 V

From the equations, we can see that
1V CH_4 requires oxygen = 2 V O_2
So, 10cm^3 CH_4 will require =20 cm^3 O_2
Similarly 2 V C_2H_2 requires = 5 V O_2
So, 10 cm^3 C_2H_2 will require = 25 cm^3 O_2
Now, 20 V O_2 will be present in 100 V air and 25 V O_2 will be present in 125 V air ,so the volume of air required is 225cm^3

Solution 17.

$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$
$2C_4H_{10} + 13O_2 \rightarrow 8CO_2 + 10H_2O$
60 ml of propane (C_3H_8) gives 3 $\times$ 60 = 180 ml CO_2
40 ml of butane (C_4H_{10}) gives = 8 $\times$ 40/2 = 160 ml of CO_2
Total carbon dioxide produced = 340 ml
So, when 10 litres of the mixture is burnt = 34 litres of CO_2 is produced.

Solution 18.

$2C_2H_2(g) + 5O_2(g) \rightarrow 4CO_2(g) + 2H_2O(g)$
4 V CO_2 is collected with 2 V C_2H_2
So, 200cm^3 CO_2 will be collected with = 100cm^3 C_2H_2
Similarly, 4V of CO_2 is produced by 5 V of O_2
So, 200cm^3 CO^2 will be produced by = 250 ml of O_2

Solution 19.

This experiment supports Gay lussac's law of combining volumes.
Since the unchanged or remaining O_2 is 58 cc so, used oxygen 106 – 58 = 48cc
According to Gay lussac's law, the volumes of gases reacting should be in a simple ratio.

$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$
1 V 2 V
24 cc 48 cc
i.e. methane and oxygen react in a 1:2 ratio.

Solution 19.

According to Avogadro's law, equal volumes of gases contain equal no. of molecules under similar conditions of temperature and pressure. This means more volume will contain more molecules and least volume will contain least molecules.
So,
(a) 5 litres of hydrogen has greatest no. of molecules with the maximum volume.
(b) 1 litre of SO_2 contains the least number of molecules since it has the smallest volume.

Solution 20.

Gas	Volume (in litres)	Number of molecules
Chlorine	10	x/2
Nitrogen	20	x
Ammonia	20	X
Sulphur dioxide	5	x/4

Solution 21.

100 cm^3 of oxygen contains = Y molecules
Applying Avogadro's law,

$$50\ cm^3 \text{ of nitrogen contains} = \frac{50\ Y}{100} = \frac{Y}{2}$$

Exercise 5(B)

Solution 1.

a) This statement means one atom of chlorine is 35.5 times heavier than 1/12 time of the mass of an atom C-12.
b) The value of avogadro's number is 6.023×10^{23}
c) The molar volume of a gas at STP is 22.4 dm^3 at STP

Solution 2.

(a) The vapour density is the ratio between the masses of equal volumes of gas and hydrogen under the conditions of standard temperature and pressure.

(b) Molar volume is the volume occupied by one mole of the gas at STP. It is equal to 22.4 dm^3.

(c) The relative atomic mass of an element is the number of times one atom of the element is heavier than 1/12 times of the mass of an atom of carbon-12.

(d) The relative molecular mass of an compound is the number that represents how many times one moleculae of the substance is heavier than 1/12 of the mass of an atom of carbon-12.

(e) The number of atoms present in 12g (gram atomic mass) of C-12 isotope, i.e. 6.023 $x10^{23}$ atoms.

(f) The quantity of the element which weighs equal to its gram atomic mass is called one gram atom of that element.

(g) Mole is the amount of a substance containing elementary particles like atoms, molecules or ions in 12 g of carbon-12.

Solution 3.

(a) Applications of Avogadro's Law :

1. It explains Gay-Lussac's law.
2. It determines atomicity of the gases.
3. It determines the molecular formula of a gas.
4. It determines the relation between molecular mass and vapour density.
5. It gives the relationship between gram molecular mass and gram molecular volume.

(b) According to Avogadro's law under the same conditions of temperature and pressure, equal volumes of different gases have the same number of molecules.

Since substances react in simple ratio by number of molecules, volumes of the gaseous reactants and products will also bear a simple ratio to one another.This what Gay Lussac's Law says.

$H_2 + Cl_2 \rightarrow 2HCl$
1V 1V 2V (By Gay-Lussacs law)
n molecules n molecules 2n molecules (By Avogadros law)

Solution 4.

(a) (2N)28 + (8H)8 + (Pt)195 + (6Cl)35.5 x 6 = 444
(b) $KClO_3$ = (K)39 + (Cl)35.5 + (3O)48 = 122.5
(c) (Cu)63.5 + (S)32 + (4O)64 + ($5H_2O$)5 x 18 = 249.5
(d) (2N)28 + (8H)8 + (S)32 + (4O)64 = 132
(e) (C)12 + (3H)3 + (C)12 + (2O)32 + (Na)23 = 82
(f) (C)12 + (H)1+ (3Cl)3 x 35.5 = 119.5
(g) (2N)28 + (8H)8 + (2Cr)2 x 51.9+ (7O)7 x 16 = 252

Solution 5.

(a) No. of molecules in 73 g HCl = $6.023 \times 10^{23} \times 73/36.5$(mol. mass of HCl)
= 12.04×10^{23}

(b) Weight of 0.5 mole of O_2 is = 32(mol. Mass of O_2) x 0.5=16 g

(c) No. of molecules in 1.8 g H_2O = $6.023 \times 10^{23} \times 1.8/18$
= 6.023×10^{22}

(d) No. of moles in 10g of $CaCO_3$ = 10/100(mol. Mass $CaCO_3$)
= 0.1 mole

(e) Weight of 0.2 mole H_2 gas = 2(Mol. Mass) x 0.2 = 0.4 g

(f) No. of molecules in 3.2 g of SO_2 = 6.023×10^{23} x 3.2/64
= 3.023×10^{22}

Solution 6.

Molecular mass of H_2O is 18, CO_2 is 44, NH_3 is 17 and CO is 28
So, the weight of 1 mole of CO_2 is more than the other three.

Solution 7.

4g of NH_3 having minimum molecular mass contain maximum molecules.

Solution 8.

a) No. of particles in s1 mole = 6.023×10^{23}
So, particles in 0.1 mole = $6.023 \times 10^{23} \times 0.1 = 6.023 \times 10^{22}$

b) 1 mole of H_2SO_4 contains =2 x 6.023×10^{23}
So, 0.1 mole of H_2SO_4 contains =2 x 6.023×10^{23} x0.1
= 1.2×10^{23} atoms of hydrogen

c) 111g $CaCl_2$ contains = 6.023×10^{23} molecules
So, 1000 g contains = 5.42×10^{24} molecules

Solution 9.

(a) 1 mole of aluminium has mass = 27 g
So, 0.2 mole of aluminium has mass = 0.2 x 27 = 5.4 g
(b) 0.1 mole of HCl has mass = 0.1 x 36.5 (mass of 1 mole)
= 3.65 g
(c) 0.2 mole of H_2O has mass = 0.2 x 18 = 3.6 g
(d) 0.1 mole of CO_2 has mass = 0.1 x 44 = 4.4 g

Solution 10.

(a) 5.6 litres of gas at STP has mass = 12 g
So, 22.4 litre (molar volume) has mass =12 x 22.4/5.6
= 48g(molar mass)
(b) 1 mole of SO_2 has volume = 22.4 litres
So, 2 moles will have = 22.4 x 2 = 44.8 litre

Solution 11.

(a) 1 mole of CO_2 contains O_2 = 32g
So, CO_2 having 8 gm of O_2 has no. of moles = 8/32 = 0.25 moles
(b) 16 g of methane has no. of moles = 1
So, 0.80 g of methane has no. of moles = 0.8/16 = 0.05 moles

Solution 12.

(a) 6.023 x 10^{23} atoms of oxygen has mass = 16 g
So, 1 atom has mass = 16/6.023 x 10^{23} = 2.656 x 10^{-23} g
(b) 1 atom of Hydrogen has mass = 1/6.023 x 10^{23} = 1.666 x 10^{-24}
(c) 1 molecule of NH_3 has mass = 17/6.023 x10^{23} = 2.82 x 10^{-23} g
(d) 1 atom of silver has mass = 108/6.023 x 10^{23} =1.701 x 10^{-22}
(e) 1 molecule of O_2 has mass = 32/6.023 x 10^{23} = 5.314 x 10^{-23} g
(f) 0.25 gram atom of calcium has mass = 0.25 x 40 = 10g

Solution 13.

(a) 0.1 mole of $CaCO_3$ has mass =100(molar mass) x 0.1=10 g
(b) 0.1 mole of $Na_2SO_4.10H_2O$ has mass = 322 x 0.1 = 32.2 g
(c) 0.1 mole of $CaCl_2$ has mass = 111 x 0.1 = 11.1g
(d) 0.1 mole of Mg has mass = 24 x 0.1 = 2.4 g

Solution 14.

1molecule of $Na_2CO_3.10H_2O$ contains oxygen atoms = 13
So, 6.023 x10^{23} molecules (1mole) has atoms=13 x 6.023 x 10^{23}
So, 0.1 mole will have atoms = 0.1 x 13 x 6.023 x 10^{23} =7.8 x 10^{23}

Solution 15.

3.2 g of S has number of atoms = 6.023 x10^{23} x 3.2 /32
= 0.6023 x 10^{23}

So, 0.6023 x 10^{23} atoms of Ca has mass=40 x0.6023×10^{23}/6.023 x 10^{23}
= 4g

Solution 16.

(a) No. of atoms = 52 x 6.023 x10^{23} = 3.131 x 10^{25}
(b) 4 amu = 1 atom of He
so, 52 amu = 13 atoms of He
(c) 4 g of He has atoms = 6.023 x10^{23}
So, 52 g will have = 6.023 x 10^{23} x 52/4 = 7.828 x10^{24} atoms

Solution 17.

Molecular mass of Na_2CO_3 = 106 g
106 g has 2 x 6.023 x10^{23} atoms of Na
So, 5.3g will have = 2 x 6.023 x10^{23}x 5.3/106=6.022 x10^{22} atoms
Number of atoms of C = 6.023 x10^{23} x 5.3/106 = 3.01 x 10^{22} atoms
And atoms of O = 3 x 6.023 x 10^{23} x 5.3/106= 9.03 x10^{22} atoms

Solution 18.

(a) 60 g urea has mass of nitrogen(N_2) = 28 g
So, 5000 g urea will have mass = 28 x 5000/60 = 2.33 kg
(b) 64 g has volume = 22.4 litre
So, 320 g will have volume = 22.4 x 320/64=112 litres

Solution 19.

(a) Vapour density of carbon dioxide is 22, it means that 1 molecule of carbon dioxide is 22 heavier than 1 molecule of hydrogen.
(b) Vapour density of Chlorine atom is 35.5.

Solution 20.

22400 cm^3 of CO has mass = 28 g
So, 56 cm^3 will have mass = 56 x 28/22400 = 0.07 g

Solution 21.

18 g of water has number of molecules = 6.023 x 10^{23}
So, 0.09 g of water will have no. of molecules = 6.023 x 10^{23} x 0.09/18 = 3.01 x 10^{21} molecules

Solution 22.

(a) No. of moles in 256 g S_8 = 1 mole
So, no. of moles in 5.12 g = 5.12/256 = 0.02 moles

(b) No. of molecules = 0.02 x 6.023 x 10^{23} = 1.2 x 10^{22} molecules
No. of atoms in 1 molecule of S = 8
So, no. of atoms in 1.2 x 10^{22} molecules = 1.2 x 10^{22} x 8
= 9.635x 10^{22} molecules

Solution 23.

Atomic mass of phosphorus P = 30.97 g
Hence, molar mass of P_4 = 123.88 g
If phosphorus is considered as P_4 molecules,
then 1 mole P_4 ≡ 123.88 g
Therefore, 100 g of P_4 = 0.807 g

Solution 24.

(a) 308 cm^3 of chlorine weighs = 0.979 g
So, 22400 cm^3 will weigh = gram molecular mass
= 0.979 x 22400/308 =71.2 g
(b) 2 g(molar mass) H_2 at 1 atm has volume = 22.4 litres
So, 4 g H_2 at 1 atm will have volume = 44.8 litres
Now, at 1 atm(P_1) 4 g H_2 has volume (V_1) = 44.8 litres
So, at 4 atm(P_2) the volume(V_2) will be = $\frac{P_1V_1}{P_2} = \frac{1 \times 44.8}{4}$ = 11.2 litres
(c) Mass of oxygen in 22.4 litres = 32 g(molar mass)
So, mass of oxygen in 2.2 litres = 2.2 x 32/22.4=3.14 g

Solution 25.

No. of atoms in 12 g C = 6.023 x10^{23}
So, no. of carbon atoms in 10^{-12} g = 10^{-12} x 6.023 x10^{23}/12
= 5.019 x 10^{10} atoms

Solution 26.

Given:
P= 1140 mm Hg
Density = D = 2.4 g / L

T = 273 ^{0}C = 273+273 = 546 K
M = ?

We know that, at STP, the volume of one mole of any gas is 22.4 L
Hence we have to find out the volume of the unknown gas at STP.

First apply Charle's law.
We have to find out the volume of one liter of unknown gas at standard temperature 273 K.

V_1= 1 L T_1 = 546 K
V_2=? T_2 = 273 K
$V_1/T_1 = V_2/ T_2$
$V_2 = (V_1 \times T_2)/T_1$
= (1 L x 273 K)/546 K
= 0.5 L

We have found out the volume at standard temperature. Now we have to find out the volume at standard pressure.

Apply Boyle's law.
P_1 = 1140 mm Hg V_1 = 0.5 L
P_2 = 760 mm Hg V_2 = ?
$P_1 \times V_1 = P_2 \times V_2$
$V_2 = (P_1 \times V_1)/P_2$
= (1140 mm Hg x 0.5 L)/760 mm Hg
= 0.75 L

Now, 22.4 L is the volume of 1 mole of any gas at STP, then 0.75 L is the volume of X moles at STP
X moles = 0.75 L / 22.4 L
= 0.0335 moles
The original mass is 2.4 g
n = m / M
0.0335 moles = 2.4 g / M
M = 2.4 g / 0.0335 moles
M= 71.6 g / mole
Hence, the gram molecular mass of the unknown gas is 71.6 g

Solution 27.

1000 g of sugar costs = Rs. 40
So, 342g(molar mass) of sugar will cost=342×40/1000=Rs. 13.68

Solution 28.

(a) Weight of 1 g atom N = 14 g
So, weight of 2 g atom of N = 28 g
(b) 6.023×10^{23} atoms of C weigh = 12 g
So, 3×10^{25} atoms will weigh = $\frac{12 \times 3 \times 10^{25}}{6.023 \times 10^{23}} = 597.7$ g
(c) 1 mole of sulphur weighs = 32 g
(d) 7 g of silver
So, 7 grams of silver weighs least.

Solution 29.

40 g of NaOH contains 6.023×10^{23} molecules
So, 4 g of NaOH contains = $6.02 \times 10^{23} \times 4/40$
= 6.02×10^{22} molecules

Solution 30.

The number of molecules in 18 g of ammonia= 6.02×10^{23}
So, no. of molecules in 4.25 g of ammonia = $6.02 \times 10^{23} \times 4.25/18$
= 1.5×10^{23}

Solution 31.

(a) One mole of chlorine contains 6.023×10^{23} atoms of chlorine.
(b) Under similar conditions of temperature and pressure, two volumes of hydrogen combined with one volume of oxygen will give two volumes of water vapour.
(c) Relative atomic mass of an element is the number of times one atom of an element is heavier than 1/12 the mass of an atom of carbon-12.
(d) Under similar conditions of temperature and pressure, equal volumes of all gases contain the same number of molecules.

Exercise 5(C)

Solution 1.

Information conveyed by H_2O

1. That H_2O contains 2 volumes of hydrogen and 1 volume of oxygen.
2. That ratio by weight of hydrogen and oxygen is 1:8.
3. That molecular weight of H_2O is 18g.

Solution 2.

The empirical formula is the simplest formula, which gives the simplest ratio in whole numbers of atoms of different elements present in one molecule of the compound.
The molecular formula of a compound denotes the actual number of atoms of different elements present in one molecule of a compound.

Solution 3.

(a) CH (b) CH_2O (c) CH (d) CH_2O

Solution 4.

Relative mol. mass of $CuSO_4.5H_2O$=63.5+32+(16x4)+5(1x2+16)
= 249.5 g
249.5 g of $CuSO_4.5H_2O$ contains water of crystallization = 90 g
So, 100 g will contain = $\frac{90 \times 100}{249.5} = 36.07$ g
So, % of H_2O = 36.07 $\times$ 100 = 36.07 %

Solution 5.

(a) Molecular mass of $Ca(H_2PO_4)_2$ = 234
So, % of P = 2 $\times$ 31 $\times$ 100/234 = 26.5%
(b) Molecular mass of $Ca_3(PO_4)_2$ = 310
% of P = 2 $\times$ 31 $\times$ 100/310 = 20%

Solution 6.

Molecular mass of $KClO_3$ = 122.5 g
% of K = 39 /122.5 = 31.8%
% of Cl = 35.5/122.5 = 28.98%
% of O = 3 x 16/122.5 = 39.18%

Solution 7.

Element % At. mass Atomic ratio Simple ratio

Pb 62.5 207 $\frac{62.5}{207} = 0.3019$ 1

N 8.5 14 $\frac{8.5}{14} = 0.6071$ 2

O 29.0 16 $\frac{29.0}{16} = 1.81$ 6

So, $Pb(NO_3)_2$ is the empirical formula.

Solution 8.

In Fe_2O_3, Fe = 56 and O = 16

Molecular mass of $Fe_2O_3 = 2 \times 56 + 3 \times 16 = 160$ g

Iron present in 80% of $Fe_2O_3 = \frac{112}{160} \times 80 = 56$ g

So, mass of iron in 100 g of ore = 56 g

$\therefore$ mass of Fe in 10000 g of ore = $56 \times 10000/100$

= 5.6 kg

Solution 9.

For acetylene, molecular mass = $2 \times$ V.D = $2 \times 13 = 26$ g

The empirical mass = 12(C) + 1(H) = 13 g

$n = \frac{\text{Molecular formula mass}}{\text{Empirical formula weight}} = \frac{26}{13} = 2$

Molecular formula of acetylene = $2 \times$ Empirical formula = C_2H_2

Similarly, for benzene molecular mass= $2 \times$ V.D = $2 \times 39 = 78$

n = 78/13=6

So, the molecular formula = C_6H_6

Solution 10.

Element % At. mass Atomic ratio Simple ratio

H 17.7 1 $\frac{17.7}{1} = 17.7$ $\frac{17.7}{5.87} = 3$

N 82.3 14 $\frac{82.3}{14} = 5.87$ $\frac{5.87}{5.87} = 1$

So, the empirical formula = NH_3

Solution 11.

Element	%	at. mass	atomic ratio	simple ratio
C	54.54	12	$\frac{54.54}{12} = 4.55$	2
H	9.09	1	$\frac{9.09}{1} = 9.09$	4
O	36.36	16	$\frac{36.36}{16} = 2.27$	1

(a) So, its empirical formula = C_2H_4O

(b) empirical formula mass = 44

Since, vapour density = 44

So, molecular mass = 2 $\times$ V.D = 88

Or n = 2

so, molecular formula = $(C_2H_4O)_2 = C_4H_8O_2$

Solution 12.

Element	%	at. mass	atomic ratio	simple ratio
C	26.59	12	$\frac{26.59}{12} = 2.21$	1
H	2.22	1	$\frac{2.22}{1} = 2.22$	1
O	71.19	16	$\frac{71.19}{16} = 4.44$	2

(a) its empirical formula = CHO_2

(b) empirical formula mass = 45

Vapour density = 45

So, molecular mass = V.D $\times$ 2 = 90

so, molecular formula = $C_2H_2O_4$

Solution 13.

Element	%	at. mass	atomic ratio	simple ratio
Cl	71.65	35.5	$\frac{71.65}{35.5} = 2.01$	1
H	4.07	1	$\frac{4.07}{1} = 4.07$	2
C	24.28	12	$\frac{24.28}{12} = 2.02$	1

(a) its empirical formula = CH_2Cl

(b) empirical formula mass = 49.5

Since, molecular mass = 98.96

so, molecular formula = $(CH_2Cl)_2 = C_2H_4Cl_2$

Solution 14.

(a) The g atom of carbon = 4.8/12 = 0.4 and g atom of hydrogen = 1/1=1
(b) Element Given mass At. mass Gram atom Ratio
C 4.8 12 0.4 1 2
H 1 1 1 2.5 5
So, the empirical formula = C_2H_5
(c) Empirical formula mass = 29
Molecular mass = V.D $\times$ 2 = 29 $\times$ 2 = 58
So, molecular formula = C_4H_{10}

Solution 15.

Since, g atom of Si = given mass/mol. Mass
so, given mass = 0.2 $\times$ 28 = 5.6 g
Element mass At. mass Gram atom Ratio
Si 5.6 28 0.2 1
Cl 21.3 35.5 $\frac{21.3}{35.5} = 0.6$ 3
Empirical formula = $SiCl_3$

Solution 16.

Element % at. mass atomic ratio simple ratio
C 92.3 12 $\frac{92.3}{12} = 7.7$ 1
H 7.7 1 $\frac{7.7}{1} = 7.7$ 1
So, empirical formula is CH
Empirical formula mass = 13
Since molecular mass = 78
So, n = 6
$\therefore$ molecular formula is C_6H_6

Solution 17.

(a) G atoms of magnesium = 18/24 = 0.75 or g- atom of Mg
(b) G atoms of nitrogen = 7/14 = 0.5 or 1/2 g- atoms of N
(c) Ratio of gram-atoms of N and Mg = 1:1.5 or 2:3
So, the formula is Mg_3N_2

Solution 18.

Barium chloride = $BaCl_2.x\ H_2O$
$Ba + 2Cl + x[H_2 + O]$
$= 137 + 235.5 + x\ [2+16]$
$= [208 + 18x]$ contains water = 14.8% water in $BaCl_2.x\ H_2O$
$= [208 + 18\ x]\ 14.8/100 = 18x$
$= [104 + 9x]\ 2148 = 18000x$
$= [104+9x]\ 37 = 250x$
$= 3848 + 333x = 2250x$
$1917x = 3848$
x = 2molecules of water

Solution 19.

Molar mass of urea; CON_2H_4 = 60 g
So, % of Nitrogen = 28 × 100/60 = 46.66%

Solution 20.

Element % At. mass Atomic ratio Simple ratio
C 42.1 12 3.5 1
H 6.48 1 6.48 2
O 51.42 16 3.2 1
The empirical formula is CH_2O
Since the compound has 12 atoms of carbon, so the formula is
$C_{12}\ H_{24}\ O_{12}$.

Solution 21.

(a) Now since the empirical formula is equal to vapour density and we know that vapour density is half of the molecular mass i.e. we have n=2 so, molecular formula is A_2B_4.

(b) Since molecular mass is 2 times the vapour density, so Mol. Mass = 2 V.D
Empirical formula weight = V.D/3
So, n = molecular mass/ Empirical formula weight = 6
Hence, the molecular formula is A_6B_6

Solution 22.

Atomic ratio of N = 87.5/14 = 6.25
Atomic ratio of H= 12.5/1 = 12.5

This gives us the simplest ratio as 1:2
So, the molecular formula is NH_2

Solution 23.

Element % at. mass atomic ratio simple ratio
Zn 22.65 65 0.348 1
H 4.88 1 4.88 14
S 11.15 32 0.348 1
O 61.32 16 3.83 11
Empirical formula of the given compound =$ZnSH_{14}O_{11}$
Empiricala formula mass = 65.37+32+141+11+16=287.37
Molecular mass = 287
n = Molecular mass/Empirical formula mass = 287/287=1
Molecular formula = $ZnSO_{11}H_{14}$
= $ZnSO_4.7H_2O$

Exercise 5(D)

Solution 1.

(a) Moles:1 mole + 2 mole $\rightarrow$ 1 mole + 2 mole
(b) Grams: 42g + 36g $\rightarrow$ 74g + 4 g
(c) Molecules = $6.02 \times 10^{23} + 12.046 \times 10^{23} \rightarrow 6.02 \times 10^{23} + 12.046 \times 10^{23}$

Solution 2.

(a) 100 g of $CaCO_3$ produces = 164 g of $Ca(NO_3)_2$
So, 15 g $CaCO_3$ will produce = 164 $\times$ 15/100 = 24.6 g $Ca(NO_3)_2$
(b) 1 V of $CaCO_3$ produces 1 V of CO_2
100 g of $CaCO_3$ has volume = 22.4 litres
So, 15 g will have volume = 22.4 $\times$ 15/100 = 3.36 litres CO_2

Solution 3.

$2NH_3 + H_2SO_4 \rightarrow (NH_4)_2SO_4$
66 g

(a) $2NH_3 + H_2SO_4 \rightarrow (NH_4)_2SO_4$
34 g98 g132 g

For 132 g $(NH_4)_2SO_4$ = 34 g of NH_3 is required
So, for 66 g $(NH_4)_2SO_4$ = 66 × 32/132 = 17 g of NH_3 is required
(b) 17g of NH_3 requires volume = 22.4 litres
(c) Mass of acid required, for producing 132g $(NH_4)_2SO_4$ = 98g
So, Mass of acid required, for 66g $(NH_4)_2SO_4$ = 66 × 98/132 = 49g

Solution 4.

(a) Molecular mass of Pb_3O_4 = 3 × 207.2 + 4 × 16 = 685 g
685 g of Pb_3O_4 gives = 834 g of $PbCl_2$
Hence, 6.85 g of Pb_3O_4 will give = 6.85 × 834/685 = 8.34 g

(b) 685g of Pb_3O_4 gives = 71g of Cl_2
Hence, 6.85 g of Pb_3O_4 will give = 6.85 × 71/685 = 0.71 g Cl_2

(c) 1 V Pb_3O_4 produces 1 V Cl_2
685g of Pb_3O_4 has volume = 22.4 litres = volume of Cl_2 produced
So, 6.85 Pb_3O_4 will produce = 6.85 × 22.4/685 = 0.224 litres of Cl_2

Solution 5.

Molecular mass of KNO_3 = 101 g
63 g of HNO_3 is formed by = 101 g of KNO_3
So, 126000 g of HNO_3 is formed by = 126000 x 101/63 = 202 kg
Similarly,126 g of HNO_3 is formed by 170 kg of $NaNO_3$
So, smaller mass of $NaNO_3$ is required.

Solution 6.

$CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2$

100g73g22.4L

(a)V_1 =2 litresV_2 =?

T_1 = (273+27)=300KT_2=273K

$V_1/T_1=V_2/T_2$

$V_2=V_1T_2/T_1= \left[\frac{2 \times 273}{300}\right]L$

Now at STP 22.4 litres of CO_2 are produced using $CaCO_3$ =100g

So, $\left[\frac{2 \times 273}{300}\right]$ litres are produced by =100/22.4 2274/300 =.125g

(b)22.4 litres are CO_2 are prepared from acid =73g

$\left[\frac{2 \times 273}{300}\right]$ litres are prepared from = 73/22.4 2273/300=5.9g

Solution 7.

$2H_2O \rightarrow 2H_2 + O_2$

2 V2 V1 V

2 moles of H_2O gives = 1 mole of O_2

So, 1 mole of H_2O will give = 0.5 moles of O_2

so, mass of O_2 = no. of moles x molecular mass

= 0.5 $\times$ 32 = 16 g of O_2

and 1 mole of O_2 occupies volume =22.4 litre

so, 0.5 moles will occupy = 22.4 $\times$ 0.5 = 11.2 litres at S.T.P.

Solution 8.

$2Na_2O_2 + 2H_2O \rightarrow 4NaOH + O_2$

2 V4 V1 V

(a) Mol. Mass of Na_2O_2 = 2 $\times$ 23 + 2 $\times$ 16 = 78 g

Mass of $2Na_2O_2$= 156 g

156 g Na_2O_2 gives = 160 g of NaOH (4 $\times$ 40 g)

So, 1.56 Na_2O_2 will give = 160 $\times$ 1.56/156 = 1.6 g

(b) 156 g Na_2O_2 gives = 22.4 litres of oxygen

So, 1.56 g will give = 22.4 $\times$ 1.56/156 = 0.224 litres

= 224 cm^3

(c)156 g Na_2O_2 gives = 32 g O_2

So, 1.56 g Na_2O_2 will give = 32 $\times$ 1.56/156

= 32/100 = 0.32 g

Solution 9.

$2NH_4Cl + Ca(OH)_2 \rightarrow CaCl_2 + 2H_2O + 2NH_3$

2 V1 V1 V2 V

Mol. Mass of $2NH_4Cl$ = 2[14 + (1 $\times$ 4) + 35.5] = 2[53.5] = 107 g

(a) 107 g NH_4Cl gives = 34 g NH_3

So, 21.4 g NH_4Cl will give = 21.4 $\times$ 34/107 = 6.8 g NH_3

(b) The volume of 17 g NH_3 is 22.4 litre

So, volume of 6.8 g will be = 6.8 $\times$ 22.4/17 = 8.96 litre

Solution 10.

$Al_4C_3 + 12\ H_2O \rightarrow 3CH_4 + 4Al(OH)_3$

1 V3 V4 V

144g3 $\times$ 22.4 *l* volume

Now, since 144 g of Al_4C_3 gives = 3 $\times$ 22.4 litre of CH_4

So, 14.4 g of Al_4C_3 willgive =3 $\times$ 22.4 $\times$ 14.4 /144 = 6.72 litres CH_4

Solution 11.

$MnO_2 + 4HCl \rightarrow MnCl_2 + 2H_2O + Cl_2$

1 V4 V1 V1 V

(a) 1 mole of MnO_2 weighs = 87 g (mol. Mass)

So, 0.02 mole will weigh = 87 $\times$ 0.02 = 1.74 g MnO_2

(b) 1 mole MnO_2 gives = 1 mole of $MnCl_2$

So, 0.02 mole MnO_2will give =0.02 mole of $MnCl_2$

(c) 1 mole $MnCl_2$ weighs = 126 g(mol mass)

So, 0.02 mole $MnCl_2$ will weigh = 126 $\times$ 0.02 g = 2.52 g

(d) 0.02 mole MnO_2will form =0.02 mole of Cl_2

(e) 1 mole of Cl_2 weighs = 35.5 g

So, 0.02 mole will weigh = 71 $\times$ 0.02 = 1.42 g of Cl_2

(f) 1 mole of chlorine gas has volume = 22.4 litres

So, 0.02 mole will have volume = 22.4 $\times$ 0.02 = 0.448 litre

(g) 1 mole MnO_2requires HCl = 4 mole

So, 0.02 mole MnO_2 will require =4 $\times$ 0.02 = 0.08 mole

(h) For 1 mole MnO_2, acid required = 4 mole of HCl

So, for 0.02 mole, acid required = 4 $\times$ 0.02 =0.08 mole

Mass of HCl = 0.08 x 36.5 = 2.92 g

Solution 12.

$N_2 + 3H_2 \rightarrow 2NH_3$
28g 6g 34g
28g of nitrogen requires hydrogen = 6g
2000g of nitrogen requires hydrogen = 6/28 $\times$ 2000=3000/7g
So mass of hydrogen left unreacted =1000-3000/7=571.4g of H_2
(b)28g of nitrogen forms NH_3 = 34g
2000g of N_2 forms NH_3
= 34/28 $\times$ 2000
=2428.6g

Miscellaneous Exercise

Solution 1.

From equation: $2H_2 + O_2 \rightarrow 2H_2O$
1 mole of Oxygen gives = 2 moles of steam
so, 0.5 mole oxygen will give = 2 $\times$ 0.5 = 1mole of steam

Solution 2.

$3Cu + 8HNO_3 \rightarrow 3Cu\ (NO_3)_2 + 4H_2O + 2NO$
1 V 8 V 3 V 2 V
Mol. Mass of $8HNO_3$ = 8 $\times$ 63 = 504 g
(a) For 504 g HNO_3, Cu required is = 192 g
So, for 63g HNO_3 Cu required = 192 $\times$ 63/504 = 24g
(b) 504 g of HNO_3 gives = 2 $\times$ 22.4 litre volume of NO
So, 63g of HNO_3 gives =2 $\times$ 22.4 $\times$ 63/504 =5.6 litre of NO

Solution 3.

(a) 28g of nitrogen = 1mole
So, 7g of nitrogen = 1/28 $\times$ 7= 0.25 moless
(b) Volume of 71 g of Cl2 at STP =22.4 litres
Volume of 7.1 g chlorine =22.4 $\times$ 7.1/71=2.24 litre
(c) 22400cm^3 volume have mass =28 g of CO(molar mass)
So, 56cm^3 volume will have mass =28 $\times$ 56/22400= 0.07 g

Solution 4.

% of N in $NaNO_3$= $\frac{14}{85} \times 100 = 16.47\%$

% of N in $(NH_4)_2SO_4$ = $\frac{14}{132} \times 100 = 21.21\%$

% of N in $CO(NH_2)_2$ = $\frac{14}{60} \times 100 = 46.66\%$

So, highest percentage of N is in urea.

Solution 5.

$2H_2O \rightarrow 2H_2 + O_2$

2 V 2 V 1 V

(a) From equation, 2 V of water gives 2 V of H_2 and 1 V of O_2

where 2 V = 2500 cm^3

so, volume of O_2 liberated = 2V/V = 1250 cm^3

(b)

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

$$\frac{P_1V_1}{T_1} = \frac{7P_1 \times V_2}{2 \times T_1}$$

$$V_2 = \frac{2500 \times 2}{7}$$

$$V_2 = \frac{5000}{7} cm^3$$

(c)

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

$$\frac{5000}{7 \times 2500} = \frac{T_1}{T_2}$$

$$T_2 = 3.5\ T_1$$

i.e. temperature should be increased by 3.5 times.

Solution 6.

Molecular mass of urea=12 + 16+2(14+2) =60g
60g of urea contains nitrogen =28g
So, in 50g of urea, nitrogen present =23.33 g
50 kg of urea contains nitrogen=23.33kg

Solution 7.

(a) 80% C and 20% H

So, atomic ratio of C and H are: $C = \frac{80}{12} = 6.66\ ;\ H = \frac{20}{1} = 20$

Simple ratio of C:H = 1 : 3

So, empirical formula is CH_3

(b) Empirical formula mass = 12+(3x1) = 15 g

Vapour density = 15

So, the molecular mass = 15(V.D) x 2 = 30 g

Hence, n= 2 so the molecular formula is C_2H_6

Solution 8.

22400cm^3 CO_2 has mass = 44g

so, 224 cm^3 CO_2 will have mass= 0.44 g

Now since CO_2 is being formed and X is a hydrocarbon so it contains C and H.

In 0.44g CO_2, mass of carbon=0.44-0.32=0.12g=0.01g atom

So, mass of Hydrogen in X = 0.145-0.12 = 0.025g

= 0.025g atom

Now the ratio of C:H is C=1: H=2.5 or C=2 : H=5

i.e. the formula of hydrocarbon is C_2H_5

(a) C and H

(b) Copper (II) oxide was used for reduction of the hydrocarbon.

(c)

(i) no. of moles of CO_2= 0.44/44 = 0.01 moles

(ii) mass of C = 0.12 g

(iii) mass of H = 0.025 g

(iv) The empirical formula of X = C_2H_5

Solution 9.

Mass of X in the given compound =24g

Mass of oxygen in the given compound =64g

So total mass of the compound =24+64=88g

% of X in the compound = 24/88 100 = 27.3%

% of oxygen in the compound=64/88 100 =72.7%

Element % At. Mass Atomic ratio Simplest ratio

X 27.3 12 27.3/12=2.27 1

O 72.7 16 72.2/16=4.54 2

So simplest formula = XO_2

Solution 10.

(a) $V.D = \dfrac{\text{mass of gas at STP}}{\text{mass of equal volume of } H_2} = \dfrac{85}{5} = 17$

(b) Molecular mass = 17(V.D) x 2= 34g

Solution 11.

(a) $CO_2 + C \rightarrow 2CO$

1 V 1 V 2 V

12 g of C gives = 44.8 litre volume of CO

So, 3 g of C will give = 11.2 litre of CO

(b) $2CO + O_2 \rightarrow 2CO_2$

2 V 1 V 2 V

(i) 2 V CO requires oxygen = 1 V

so, 24 cm^3 CO will require = 24/2 =12 cm^3

(ii) 2 x 22400 cm^3 CO gives = 2 x 22400 cm^3 CO_2

so, 24cm^3 CO will give = 24 cm^3 CO_2

Solution 12.

$2Ca(NO_3)_2 \rightarrow 2CaO + 4NO_2 + O_2$

2 V 2 V 4 V 1 V

(a) 56 g of CaO is obtained with NO_2 = 2 $\times$ 22.4 litre of NO_2

So, 5.6g of CaO is obtained with NO_2=2 $\times$ 22.4 $\times$ 5.6/56

= 4.48 litre

(b) 56 g of CaO is obtained by = 164 g $Ca(NO_3)_2$

So, 5.6 g CaO is obtained by = 5.6 $\times$ 56/164 g $Ca(NO_3)_2$

= 16.4 g of $Ca(NO_3)_2$ is heated.

Solution 13.

(a) Number of molecules in 100cm^3 of oxygen=Y
According to Avogadros law, Equal volumes of all gases under similar conditions of temperature and pressure contain equal number of molecules.Therefore ,number of molecules in 100 cm^3 of nitrogen under the same conditions of temperature and pressure = Y
So, number of molecules in 50 cm^3 of nitrogen under the same conditions of temperature and pressure =Y/100 50=Y/2

(b) (i) Empirical formula is the formula which tells about the simplest ratio of combining capacity of elements present in a compound.
(ii) The empirical formula is CH_3
(iii) The empirical formula mass for CH_2O = 30
V.D = 30
Molecular formula mass = V.D 2 = 60
Hence, n =mol. Formula mass/empirical formula mass= 2
So, molecular formula = $(CH_2O)_2$ = $C_2H_4O_2$

Solution 14.

The relative atomic mass of Cl = (35 x 3 + 1 x 37)/4=35.5 amu

Solution 15.

Mass of silicon in the given compound =5.6g
Mass of the chlorine in the given compound=21.3g
Total mass of the compound=5.6g+21.3g=26.9g
% of silicon in the compound = 56/26.9 $\times$ 100 = 20.82%
% of chlorine in the compound = 21.2/26.9 $\times$ 100 = 79.18%
Element % At. Mass At. Ratio Simplest ratio
Si 20.82 28 20.82/28=0.74 1
Cl 79.18 35.5 79.18/35.5=2.23 3
So the empirical formula of the given compound =$SiCl_3$

Solution 16.

% composition Atomic ratio Simple ratio
P = 38.27% 38.27/31 =1.23 1
H = 2.47% 2.47/1 = 2.47 2
O = 59.26% 59.26/16 = 3.70 3
So, empirical formula is PH_2O_3 or H_2PO_3
Empirical formula mass = 31+ 2 $\times$ 1 + 3 $\times$ 16 = 81
The molecular formula is = $H_4P_2O_6$, because n = 162/81=2

Solution 17.

V_1 = 10 litres V_2=?
T_1= 27+ 273 = 300K T_2=273K
P_1=700 mm P_2 = 760 mm
Using the gas equation

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

$$V_2 = \frac{P_1V_1T_2}{T_1P_2} = \frac{700 \times 10 \times 273}{300 \times 760}$$

Molecular weight A = 60
So, weight of 22.4 litres of A at STP =60 g
Weight of = $\frac{700 \times 10 \times 273}{300 \times 760}$ litres of A at STP

$$= \frac{60}{22.4} \times \frac{700 \times 10 \times 273}{300 \times 760} \text{ g or } 22.45\text{g}$$

Solution 18.

(a) Molecular mass of CO_2 = 12+ 2x16 = 44 g
So, vapour density (V.D) = mol. Mass/2 = 44/2 = 22

$$V.D = \frac{\text{mass of certain amount of } CO_2}{\text{mass of equal volume of hydrogen}} = \frac{m}{1}$$

$$22 = \frac{m}{1}$$

So, mass of CO_2 = 22 kg
(b) According to Avogadros law ,equal volumes of all gases under similar conditions of temperature and pressure contain equal number of molecules.
So, number of molecules of carbon dioxide in the cylinder =number of molecules of hydrogen in the cylinder=X

Solution 19.

(a) The volume occupied by 1 mole of chlorine = 22.4 litre
(b) Since PV=constant so, if pressure is doubled; the volume will become half i.e. 11.2 litres.
(c) $V_1/V_2 = T_1/T_2$
$22.4/V_2$ =273/546
V_2 = 44.8 litres
(d) Mass of 1 mole Cl_2 gas =35.5 x 2 =71 g

Solution 20.

(a) Total molar mass of hydrated $CaSO_4.xH_2O$ = 136+18x

Since 21% is water of crystallization, so

$$\frac{18x}{136+18x} = \frac{21}{100}$$

So, x = 2 i.e. water of crystallization is 2.

(b) For 18 g water, vol. of hydrogen needed = 22.4 litre
So, for 1.8 g, vol. of H_2 needed= 1.8 x 22.4/18 = 2.24 litre
Now 2 vols. of water = 1 vol. of oxygen
1 vol. of water =1/2 vol. of O_2 =22.4/2=11.2 lit.
18 g of water = 11.2 lit. of O_2
1.8 g of water = 11.2/18 18/10=1.12 lit.
(c) 32g of dry oxygen at STP = 22400cc
2g will occupy = 224002/32=1400cc
P_1=760mm P_2 =740mm
V_1=1400cc V_2 =?
T_1 =273 K, T_2 = 27 +73 = 300K

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

$\times$

$$V_2 = \frac{P_1V_1T_2}{T_1P_2} = \frac{760 \times 1400 \times 300}{273 \quad 740} = 1580 \text{ cc}$$

$$= 1580/1000 = 1.58 l$$

(d) P_1= 750mm P_2=760mm
V_1= 44lit. V_2=?
T_1= 298K T_2=273K

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

$\times$

$$V_2 = \frac{P_1V_1T_2}{T_1P_2} = \frac{750 \times 44 \times 273}{298 \times 760} = 39.78 \text{ lit.}$$

22.4 lit. of CO2 at STP has mass= 44g
39.78 lit. of CO2 at STP has masss $= \frac{44 \times 39.78}{22.4}$
$= 78.14$ g

(e) Since 143.5g of AgCl is produced from =58.5 g of NaCl
so, 1.435 g of AgCl is formed by =0.585 g of NaCl
% of NaCl =0.585 x100 = 58.5%

Solution 21.

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

$$\frac{P_1 \times 22.4}{273} = \frac{2P_2 V_2}{546}$$

$$V_2 = 22.4 \text{ litre}$$

Solution 22.

(a) The molecular mass of $(Mg(NO_3)_2.6H_2O$ = 256.4 g
% of Oxygen = 12 x 16/256
= 75%

(b) The molecular mass of boron in $Na_2B_4O_7.10H_2O$ = 382 g
% of B = 4 x 11/382 = 11.5%

Solution 23.

$$V \times \frac{760}{273} = \frac{360 \times 380}{360}$$

$$V = \frac{360 \times 380 \times 273}{760 \quad 360} = 136.5 cm^3$$

$136.5 cm^3$ of the gas weigh = 0.546

22400 cm^3 of the gas weight = $\frac{0.546 \times 22400}{136.5}$ = 89.6 a.m.u

Relative molecular mass= 89.6a.m.u

Solution 24.

(a) 252 g of solid ammonium dichromate decomposes to give 152 g of solid chromium oxide, so the loss in mass in terms of solid formed = 100 g
Now, if 63 g ammonium dichromate is decomposed, the loss in mass would be = 100 x 63/252 = 25 g

(b) If 252 g of ammonium dichromate produces Cr_2O_3 = 152 g
So, 63 g ammonium dichromate will produce = 63 x 152/252
= 38 g

Solution 25.

$2H_2S + 3O_2 \rightarrow 2H_2O + 2SO_2$

2 V 3 V 2 V

128 g of SO_2 gives = 2 $\times$ 22.4 litres volume

So, 12.8 g of SO_2 gives = 2 $\times$ 22.4 $\times$ 12.8/128

= 4.48 litre volume

Or one can say 4.48 litres of hydrogen sulphide.

2 $\times$ 22.4 litre H_2S requires oxygen = 3 $\times$ 22.4 litre

So, 4.48 litres H_2S will require = 6.72 litre of oxygen

Solution 26.

From equation, $2NH_3 + 2O_2 \rightarrow 2NO + 3H_2O$

When 60 g NO is formed, mass of steam produced = 54 g

So, 1.5 g NO is formed, mass of steam produced = 54 $\times$ 1.5/60

=1.35 g

Solution 27.

In 1 hectare of soil, N_2 removed = 20 kg

So, in 10 hectare N_2 removed = 200 kg

The molecular mass of $Ca(NO_3)_2$ =164

Now, 28 g N_2 present in fertilizer = 164 g $Ca(NO_3)_2$

So, 200000 g of N_2 is present in = 164 $\times$ 200000/28

= 1171.42 kg

Solution 28.

(a) 1 mole of phosphorus atom = 31 g of phosphorus
31 g of P =1 mole of P

6.2g of P = $\frac{6.2 \times 1}{31}$ =0.2 mole of P

(b) 31 g P reacts with HNO_3 = 315 g

so, 6.2 g P will react with HNO_3 = 315 × 6.2/31 = 63 g

(c)

Moles of steam formed from 31g phosphorus = 18g/18g = 1mol

Moles of steam formed from 6.2 g phosphorus = 1mol/31g6.2=0.2 mol

Volume of steam produced at STP =0.2 × 22.4 l/MOL=4.48 litre

Since the pressure (760mm) remains constant , but the temperature (273+273)=546 is double, the volume of the steam also gets doubled
So,Volume of steam produced at 760mm Hg and 273°C = 4.48 × 2 = 8.96litre

Solution 29.

(a) 1 mole of gas occupies volume = 22.4 litre

(b) 112cm^3 of gaseous fluoride has mass = 0.63 g

so, 22400cm^3 will have mass = 0.63 × 22400/112

= 126 g

The molecular mass = At mass P + At. mass of F

126 = 31 + At. Mass of F

So, At. Mass of F = 95 g

But, at. mass of F = 19 so 95/19 = 5

Hence, there are 5 atoms of F so the molecular formula = PF_5

Solution 30.

$Na_2CO_3.10H_2O \rightarrow Na_2CO_3 + 10H_2O$

286 g 106 g

So, for 57.2 g $Na_2CO_3.10H_2O$ = 106 $\times$ 57.2/286 = 21.2 g Na_2CO_3

Solution 31.

(a) The molecular mass of $Ca(H_2PO_4)_2$ = 234
The % of P = 2 $\times$ 31/234 = 26.49 %

(b) Simple ratio of M = 34.5/56 = 0.616 = 1
Simple ratio of Cl = 65.5/35.5 = 1.845 = 3

Empirical formula = MCl_3

Empirical formula mass = 162.5, Molecular mass = 2 $\times$ V.D = 325

So, n = 2

So, molecular formula = M_2Cl_6

Solution 32.

$V_1/V_2 = n_1/n_2$
So, no. of moles of Cl = x/2 (since V is directly proportional to n)
No. of moles of NH_3 = x
No. of moles of SO_2 = x/4

This is because of Avogadros law which states Equal volumes of all gases, under similar conditions of temperature and pressure, contain equal number of molecules.

So, 20 litre nitrogen contains x molecules
So, 10 litre of chlorine will contain = x × 10/20=x/2 mols.
And 20 litre of ammonia will also contain =x molecules
And 5 litre of sulphur dioxide will contain = x × 5/20 = x/4 mols.

Solution 33.

$4N_2O + CH_4 \rightarrow CO_2 + 2H_2O + 4N_2$

4 V 1 V 1 V 2 V 4 V

2 x 22400 litre steam is produced by N_2O = 4 x 22400 cm^3

So, 150 cm^3 steam will be produced by= 4 $\times$ 22400 $\times$ 150/2 x 22400

= 300 cm^3 N_2O

Solution 34.

(a) Volume of O_2 = V
Since O_2 and N_2 have same no. of molecules = x
so, the volume of N_2 = V
(b) 3x molecules means 3V volume of CO
(c) 32 g oxygen is contained in = 44 g of CO_2
So, 8 g oxygen is contained in = 44 x 8/32 = 11 g
(d) Avogadro's law is used in the above questions.

Solution 35.

(a) 444 g is the molecular formula of $(NH_4)_2PtCl_6$
% of Pt = (195/444) x 100 = 43.91% or 44%

(b) simple ratio of Na = 42.1/23 = 1.83 = 3
simple ratio of P = 18.9/31 = 0.609 = 1
simple ratio of O = 39/16 = 2.43 = 4
So, the empirical formula is Na_3PO_4

Solution 36.

$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$

1 V 2 V 1 V 2 V

From equation:

22.4 litres of methane requires oxygen = 44.8 litres O_2

$2H_2 + O_2 \rightarrow 2H_2O$

2 V 1 V 2 V

From equation,

44.8 litres hydrogen requires oxygen = 22.4 litres O_2

So, 11.2 litres will require = 22.4 x 11.2/44.8 = 5.6 litres

Total volume = 44.8 + 5.6 = 50.4 litres

Solution 37.

According to Avogadros law:
Equal volumes of all gases, under similar conditions of temperature and pressure ,contain equal number of molecules.

So, 1 mole of each gas contains = 6.02×10^{23} molecules

Mol. Mass of H_2 (2),O_2(32) ,CO_2(44),SO_2(64),Cl_2(71)

(1)Now 2 g of hydrogen contains molecules =6.02×10^{23}

So, 8g of hydrogen contains molecules = $8/2 \times 6.02 \times 10^{23}$

=$4 \times 6.02 \times 10^{23}$ = 4M molecules

(2)32g of oxygen contains molecules = $8/32 \times 6.02 \times 10^{23}$=M/4

(3)44g of carbon dioxide contains molecules = 8/44 6.02 10^{23}=2M/11

(4)64g of sulphur dioxide contains molecules =6.02×10^{23}

So, 8g of sulphur dioxide molecules = $8/64 \times 6.02 \times 10^{23}$= M/8

(5)71 g of chlorine contains molecules =6.02×10^{23}

So, 8g of chlorine molecules = $8/72 \times 6.02 \times 10^{23}$ = 8M/71

Since 8M/71<M/8<2M/11<M/4<4M

Thus Cl_2<SO_2<CO_2<O_2<H_2

(i)Least number of molecules in Cl_2

(ii)Most number of molecules in H_2

Solution 38.

$Na_2SO_4 + BaCl_2 \rightarrow BaSO_4 + 2NaCl$

Molecular mass of $BaSO_4$ = 233 g

Now, 233 g of $BaSO_4$ is produced by Na_2SO_4 = 142 g

So, 6.99 g $BaSO_4$ will be produced by = 6.99 $\times$ 142/233 = 4.26

The percentage of Na_2SO_4 in original mixture = 4.26 $\times$ 100/10

= 42.6%

Solution 39.

(a) 1 litre of oxygen has mass = 1.32 g
So, 24 litres (molar vol. at room temp.) will have mass = 1.32 x 24

= 31.6 or 32 g

(b) $2KMnO_4 \rightarrow K_2MnO_4 + MnO_2 + O_2$

316 g of $KMnO_4$ gives oxygen = 24 litres

So, 15.8 g of $KMnO_4$ will give = 24 $\times$ 316/15.8 = 1.2 litres

Solution 40.

(a)
(i) The no. of moles of SO_2 = 3.2/64 = 0.05 moles
(ii) In 1 mole of SO_2, no. of molecules present = 6.02×10^{23}
So, in 0.05 moles, no. of molecules = $6.02 \times 10^{23} \times 0.05$

= 3.0×10^{22}

(iii) The volume occupied by 64 g of SO_2 = 22.4 dm^3

3.2 g of SO_2 will be occupied by volume = 22.4 $\times$ 3.2/64 =1.12 dm^3

(b) Gram atoms of Pb = 6.21/207=0.03 = 1

Gram atoms of Cl = 4.26/35.5 = 0.12 = 4

So, the empirical formula = $PbCl_4$

Solution 41.

(i) D contains the maximum number of molecules because volume is directly proportional to the number of molecules.

(ii) The volume will become double because volume is directly proportional to the no. of molecules at constant temperature and pressure.
$V_1/V_2 = n_1/n_2$
$V_1/V_2 = n_1/2n_1$
So, $V_2 = 2V_1$

(iii) Gay lussac's law of combining volume is being observed.

(iv) The volume of D = 5.6 4 = 22.4 dm^3, so the number of molecules = 6 x 10^{23} because according to mole concept 22.4 litre volume at STP has = 6 x 10^{23} molecules

(v) No. of moles of D = 1 because volume is 22.4 litre
so, mass of N_2O = 1 44 = 44 g

Solution 42.

(a) $NaCl + NH_3 + CO_2 + H_2O \rightarrow NaHCO_3 + NH_4Cl$
$2NaHCO_3 \rightarrow Na_2CO_3 + H_2O + CO_2$

From equation:

106 g of Na_2CO_3 is produced by = 168 g of $NaHCO_3$

So, 21.2 g of Na_2CO_3 will be produced by = 168 × 21.2/106

= 33.6 g of $NaHCO_3$

(b) For 84 g of $NaHCO_3$, required volume of CO_2 = 22.4 litre

So, for 33.6 g of $NaHCO_3$, required volume of CO_2 = 22.4 x 33.6/84

= 8.96 litre

Solution 43.

(a) $NH_4NO_3 \rightarrow N_2O + 2H_2O$
1mole 1mole 2mole
1 V 1 V 2 V
44.8 litres of water produced by = 22.4 litres of NH_4NO_3
So, 8.96 litres will be produced by = 22.4 x 8.96/44.8
= 4.48 litres of NH_4NO_3
So, 4.48 litres of N_2O is produced.
(i) 44.8 litre H_2O is produced by = 80 g of NH_4NO_3
So, 8.96 litre H_2O will be produced by = 80 x 8.96/44.8
= 16g NH_4NO_3
(iii) % of O in NH_4NO_3 = 3x16/80 = 60%

Solution 44.

(a) Element % Atomic mass Atomic ratio Simple ratio
K 47.9 39 1.22 2
Be 5.5 9 0.6 1
F 46.6 19 2.45 4
so, empirical formula is K_2BeF_4

(b) $3CuO + 2NH_3 \rightarrow 3Cu + 3H_2O + N_2$
3 V 2 V 3 V 1V
3 x 80 g of CuO reacts with = 2 x 22.4 litre of NH_3
so, 120 g of CuO will react with = 2x 22.4 x 120/80 x 3
= 22.4 litres

Solution 45.

(a) The molecular mass of ethylene(C_2H_4) is 28 g
No. of moles = 1.4/28 = 0.05 moles
No. of molecules = 6.023 $x10^{23}$ x 0.05 = 3 x 10^{22} molecules
Volume = 22.4 x 0.05 = 1.12 litres

(b) Molecular mass = 2 X V.D
S0, V.D = 28/2 = 14

Solution 46.

(a) Molecular mass of Na_3AlF_6 = 210
So, Percentage of Na = 3x23x100/210 = 32.85%
(b) $2CO + O_2 \rightarrow 2CO_2$
2 V 1 V 2 V
1 mole of O_2 has volume = 22400 ml
Volume of oxygen used by 2 x 22400 ml CO = 22400 ml
So, Vol. of O_2 used by 560 ml CO =22400 x 560/(2 x 22400)

= 280 ml

So, Volume of CO_2 formed is 560 ml.

Solution 47.

a. Mass of gas X =10g
Mass of hydrogen gas= 2
Relative vapour density

$$= \frac{\text{Mass of volume of gas X under similar conditions}}{\text{Mass of volume of hydogen gas under similar conditions}} = \frac{10}{2} = 5$$

Relative molecular mass of the gas= 2×relative vapour

density = 2×5

=10
b.

i. The combustion reaction $2C_2H_2(g) + 5O_{2(g)} \rightarrow 4CO_{2(g)} + 2H_2O_{(g)}$
According to Gay-Lussac's law,
2 volume of acetylene requires 5 volume of oxygen to burn it

∴ 1 volume of acetylene requires 2.5 volume of oxygen to burn it

∴ 200cm^3 requires 2.5×200=500 cm^3 of oxygen
2 volume of acetylene on combustion gives $4CO_2$

∴ 1 volume of acetylene on combustion gives $2CO_2$

∴ 200cc of acetylene on combustion will give 200×2=400cc of CO_2
ii. Hydrogen = 12.5%
∴ Nitrogen= 100-12.5= 87.5%

Element	% Weight	Atomic Weight	Atomic Ratio	Simplest Ratio
N	87.5	14	87.5/14=6.25	6.25/6.25=1
H	12.5	1	12.5/1=12.5	12.5/6.25=2

The Empirical formula of the compound is NH_2
Empirical formula weight =14+2=16
Relative molecular mass =37

$$N = \frac{\text{Relative molecular mass}}{\text{Empirical Weight}} = \frac{37}{16} = 2.3 \approx 2$$

Molecular formula = n x empirical formula = 2 x NH_2
$=N_2H_4$

c.

i. Molecules of nitrogen gas in a cylinder = 24 x 10^{24}
Avogadro's number = 6 x 10^{23}

1. Mass of nitrogen in a cylinder = $\frac{24 \times 10^{24} \times 28}{6 \times 10^{23}}$
=1120g

2. Volume of nitrogen at stp

Volume of 28 g of N_2 = 22.4dm^3

Volume of 1120g of N_2 = $\frac{1120 \times 22.4}{28}$ dm^3
=896 dm^3

Solution 48.

a.

i. 10 litres of LPG contains

Propane $= \frac{60}{100} \times 10 = 6 \text{ litres}$

Butane $= \frac{40}{100} \times 10 = 4 \text{ litres}$

$$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$$

1 vol. — 3 vol.

6L — 18L

$$2C_4H_{10} + 13O_2 \rightarrow 8CO_2 + 10H_2O$$

2 vol. — 8 vol.

4L — 16L

18+16=34 L

ii. Molecular mass of $NH_4(NO_3)$ =80
H=1, N=14, O=16
% of Nitrogen
As 80 g of NH4(NO3) contains 28 g of nitrogen

∴ 100 g of of $NH_4(NO_3)$ will contain $\frac{28 \times 100}{80}$
= 35%

% of Oxygen
As,80 g of NH4(NO3) contains 48 g of oxygen

∴ 100 g of of $NH_4(NO_3)$ will contain $\frac{100 \times 48}{80}$
= 60%

b.

i. Equation for reaction of calcium carbonate with dilute hydrochloric acid:

$$CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2 \uparrow$$

ii. Relative molecular mass of calcium carbonate=100
Mass of 4.5 moles of calcium carbonate
= No. of moles× Relative molecular mass
= 4.5×100
= 450g

iii. $CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2 \uparrow$
As, 100g of calcium carbonate gives 22.4dm^3 of CO_2

∴ 450 g of calcium carbonate will give $\frac{450 \times 22.4}{100}$

=100.8 L
iii. Molecular mass of calcium carbonate =100
Relative molecular mass of calcium chloride =111
As 100 g of calcium carbonate gives 111g of calcium chloride

∴ 450 g of calcium carbonate will give $\frac{450 \times 111}{100}$
=499.5 g
iv.
Molecular mass of HCl=36.5
Molecular mass of calcium carbonate =100
As 100 g of calcium carbonate gives (2×36.5)= 73g of HCl

∴ 450 g of calcium carbonate will give $\frac{450 \times 73}{100}$
=328.5g

Number of moles of HCl= $\frac{\text{Weight of HCl}}{\text{Molecular weight of HCl}}$

= $\frac{328.5}{36.5}$
= 9 moles

Solution 49.

a.

i. Atomic mass: S = 32 and O = 16

Molecular mass of SO_2=32+(2×16)

=64g

As 64 g of SO_2 = 22.4dm^3

Then, 320 g of SO_2 = $\frac{320 \times 22.4}{64}$

=112 L

ii. Gay-Lussac's law Gay-Lussac's Law states "When gases react, they do so in volumes which bear a simple ratio to one another and to the volume of the gaseous product, if all the volumes are measured at the same temperature and pressure."

iii. $C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$

Molar mass of propane = 44

44 g of propane requires 5 × 22.4 litres of oxygen at STP.

8.8 g of propane requires $\frac{5 \times 22.4 \times 8.8}{44}$ = 22.4 litres

b.

i.

Element	Relative atomic mass	%Compound	Atomic ratio	Simplest ratio
H	1	2.13	2.13/1=2.13	2
C	12	12.67	12.67/12=1.055	2
Br	80	85.11	85.11/80=1	1

Empirical formula = CH_2Br

n(Empirical formula mass of CH_2Br) = Molecular mass (2 × VD)

n(12 + 2 + 80) = 94 × 2

n = 2

Molecular formula = Empirical formula × 2

= (CH_2Br) × 2

= $C_2H_4Br_2$

ii. 10^{22} atoms of sulphur

6.022 × 10^{23} atoms of sulphur will have mass = 32 g

10^{22} atoms of sulphur will have mass = $\frac{32 \times 10^{22}}{6.022 \times 10^{23}}$

= 0.533 g

iii. 0.1 mole of carbon dioxide

1 mole of carbon dioxide will have mass = 44 g

0.1 mole of carbon dioxide will have mass = 4.4 g

Solution 50.

a. $P + 5HNO_{3(conc.)} \rightarrow H_3PO_4 + H_2O + 5NO_2$

i. Number of moles of phosphorus taken = $\frac{9.3}{31}$
= 0.3 mol

ii. 1 mole of phosphorus gives 98 gm of phosphoric acid.
So, 0.3 mole of phosphorus gives (0.3 × 98) gm of phosphoric acid
= 29.4 gm of phosphoric acid

iii. 1 mole of phosphorus gives 112 L of NO_2 gas at STP.
So, 0.3 mole of phosphorus gives (112 × 0.3) L of

NO_2 gas at STP.

= 33.6 L of NO_2 gas at STP

b.
i. According to the equation

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

3 volumes of hydrogen produce 2 volumes of ammonia

67.2 litres of hydrogen produce $\frac{2 \times 67.2}{3}$ = 44.8 L

3 volumes of hydrogen combine with 1 volume of ammonia.

67.2 litres of hydrogen combine with $\frac{1 \times 67.2}{3}$ =22.4L Nitrogen left = 44.8 - 22.4 = 22.4 litres

ii. 5.6 dm^3 of gas weighs 12 g
1 dm^3 of gas weighs = (12/56) gm
22.4 dm^3 of gas weighs = (12/56 × 22.2) gm = 48g
Therefore, the relative molecular mass of gas = 48 gm.

iii. Molar mass of $Mg(NO_3)_2.6H_2O$
= 24 × (14 × 2) + (16 × 12) + (1 × 12) = 256 g

Mass percent of magnesium = $\frac{24 \times 100}{256} = 9.37\%$

Solution 51.

a.

$$2C_4H_{10} + 13O_2 \rightarrow 8CO_2 + 10H_2O$$

i. $2V \quad 13V$

2 vols. of butane requires O_2 = 13 vols

90 dm^3 of butane will require O_2 = $\frac{13}{2} \times 90$

= 585 dm^3

ii. Molecular mass = 2 × Vapour density

So, molecular mass of gas = 2 × 8 = 16 g

As we know, molecular mass or molar mass occupies 22.4 litres.

That is,

16 g of gas occupies volume = 22.4 litres

So, 24 g of gas will occupy volume

$= \frac{22.4}{16} \times 24 = 33.6$ litres

iii. According to Avogadro's law, equal volumes of all gases under similar conditions of temperature and pressure contain the same number of molecules.

So, molecules of nitrogen gas present in the same vessel = X

b.

$$2KClO_3 \xrightarrow{MnO_2} 2KCl + 3O_2$$

i. $2V \quad\quad 2V \quad 3V$

3 vols. of oxygen require $KClO_3$ = 2 vols.

So, 1 vol. of oxygen will require $KClO_3$ = $\frac{2}{3}$ vols.

So, 6.72 litres of oxygen will require $KClO_3$

So, 1 vol. of oxygen will require $KClO_3$ = $\frac{2}{3}$ vols.

So, 6.72 litres of oxygen will require $KClO_3$

$= \frac{2}{3} \times 6.72 = 4.48$ litres

22.4 litres of $KClO_3$ has mass = 122.5 g

So, 4.48 litres of $KClO_3$ will have mass

$= \frac{122.5}{22.4} \times 4.48 = 24.5$ g

ii. 22.4 litres of oxygen = 1 mole

So, 6.72 litres of oxygen = $\frac{6.72}{22.4}$ = 0.3 moles

No. of molecules present in 1 mole of O_2

= 6.023×10^{23}

So, no. of molecules present in 0.3 mole of O_2

= $6.023 \times 10^{23} \times 0.3$

= 1.806×10^{23}

iii. Volume occupied by 1 mole of CO_2 at STP = 22.4 litres

So, volume occupied by 0.01 mole of CO_2 at STP = 22.4 × 0.01= 0.224 litres

Solution 52.

a.

i. $2C_2H_2 + 5O_2 \rightarrow 4CO_2 + 2H_2O$

2 moles of C_2H_2=4moles of CO_2
x dm^3 of C_2H_2 =8.4 dm^3 of CO_2

$$x = \frac{2 \times 8.4}{4}$$

=4.2 dm^3 of C_2H_2

ii. Empirical formula= X_2Y
Atomic weight (X)= 10
Atomic weight (Y)= 5
Empirical formula weight = (2 × 10) + 5
=25

$$n = \frac{\text{Molecular weight}}{\text{Empirical formula weight}}$$

$$= \frac{2 \times V.D}{\text{Empirical formula weight}}$$

$$= \frac{2 \times 25}{25}$$

= 2
So, molecular formula = $X_2Y \times 2$
= X_4Y_2

b.

i. A cylinder contains 68 g of ammonia gas at STP.
Molecular weight of ammonia = 17 g/mole
68 g of ammonia gas at STP =?
1 mole = 22.4 dm^3
∴ 4 mole = 22.4 × 4 = 89.6 dm^3
ii. 4 moles of ammonia gas is present in the cylinder.
iii. 1 mole = 6.023×10^{23} molecules
4 moles = 24.092×10^{23} molecules

Solution 42.

The formula of aluminium nitride is AlN.

The molecular mass = 41

So, the percentage of N = 14 × 100/41 = 34.146 %

Solution 48.

(i) Element % atomic mass atomic ratio simple ratio

C 4.8 12 $\frac{4.8}{12} = 0.4$ 1

Br 95.2 80 $\frac{95.2}{80} = 1.2$ 3

So, empirical formula is CBr_3

(ii) Empirical formula mass = 12 + 3 $\times$ 80 = 252 g

molecular formula mass = 2 $\times$ 252(V.D) = 504 g

n= 504/252 = 2

so, molecular formula = C_2Br_6

Solution 49.

$2C_8H_{18} + 25O_2 \rightarrow 16CO_2 + 18H_2O$

2 V 25 V 16 V 18 V

(i) 2 moles of octane gives = 16 moles of CO_2

so, 1 mole octane will give = 8 moles of CO_2

(ii) 1 mole CO_2 occupies volume = 22.4 litre

so, 8 moles will occupy volume = 8 $\times$ 22.4 = 179.2 litre

(iii) 1 mole CO_2 has mass = 44 g

so, 16 moles will have mass = 44 $\times$ 16 = 704 g

(iv) Empirical formula is C_4H_9.

Solution 50.

(a) (i) element % atomic mass at. ratio simple ratio

C 14.4 12 1.2 1

H 1.2 1 1.2 1

Cl 84.5 35.5 2.38 2

Empirical formula = $CHCl_2$

(ii) Empirical formula mass = 12+1+71= 84 g

Since molecular mass = 168 so, n = 2

so, molecular formula = $(CHCl_2)_2 = C_2H_2Cl_4$

(b) (i) $C + 2H_2SO_4 \rightarrow CO_2 + 2H_2O + 2SO_2$

1 V 2 V 1 V 2 V

196 g of H_2SO_4 is required to oxidized = 12 g C

So, 49 g will be required to oxidise = 49 x 12/196 = 3 g

(ii) 196 g of H_2SO_4 occupies volume = 2 x 22.4 litres

So, 49 g H_2SO_4 will occupy = 2 x 22.4 x 49/196 = 11.2 litre

i.e. volume of SO_2 = 11.2 litre