Book Name: Selina Concise

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_2 means 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:

$2H_2 + O_2 \longrightarrow 2H_2O$
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:

$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$
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:

$2C_2H_2 + 5O_2 \longrightarrow 4CO_2 + 2H_2O\ (l)$
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:
$H_2S_{(g)} + CI_{2(g)} \longrightarrow 2HCI_{(g)} + S_{(g)}$
1 mole 1 mole 2 moles 1mole
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^3HCl gas + 8 cm^3 Cl_2 gas

Solution 8:

$2C_2H_6 + 7O_2 \longrightarrow 4CO_2 + 6H_2O$
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 × 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 = 4 600/2 = 1200cc CO_2

Solution 9:

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

$\frac{p_1 v_1}{T_1} = \frac{p_2 v_2}{T_2}$

$V_2 = \frac{p_1 v_1 T_2}{P_2 T_1} = \frac{380 \times 33 \times 273}{549 \times 760} = 8.25$ liters

Solution 10:

$CH_4 + 2Cl_2 \longrightarrow CH_2Cl_2 + 2HCl$
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 × 2 = 80 ml of Cl_2

Solution 11:

$C_3H_8 + 5O_2 \longrightarrow CO_2 + 4H_2O$
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:

$2NO + O_2 \longrightarrow 2NO_2$
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 × 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:

$2CO + O_2 \longrightarrow 2CO_2$
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:

$4NH_3 + 5O_2 \longrightarrow 4NO + 6H_2O$
4 V 5 V 4 V
9 litres of reactants gives 4 litres of NO
So, 27 litres of reactants will give = 27 × 4/9 = 12 litres of NO

Solution 15:

$H_2 + Cl_2 \longrightarrow 2HCl$
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:

$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$
1 V 2 V 1 V
$2C_2H_2 + 5O_2 \longrightarrow 4CO_2 + 2H_2O$
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:

$C_3H_8 + 5O_2 \longrightarrow 3CO_2 + 4H_2O$
$2C_4H_{10} + 13O_2 \longrightarrow 8CO_2 + 10H_2O$
60 ml of propane (C_3H_8) gives 3 × 60 = 180 ml CO_2
40 ml of butane (C_4H_{10}) gives = 8 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:

$2C_2H_2(g) + 5O_2(g) \longrightarrow 4CO_2(g) + 2H_2O(g)$
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.
$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$
1 V 2 V
24 cc 48 cc
i.e. methane and oxygen react in a 1:2 ratio.

Solution 20:

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.

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 molecule 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.
$H_2 + Cl_2$? 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 × 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 × 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 × 35.5 = 119.5
(g) (2N)28 + (8H)8 + (2Cr)2 × 51.9 + (7O)7 × 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)
$= 12.04 \times 10^{23}$

(b) Weight of 0.5 mole of O_2 is = 32(mol. Mass of O_2) × 0.5=16 g
(c) No. of molecules in 1.8 g H_2O = $6.023 \times 10^{23} \times 1.8/18$
$= 6.023 \times 10^{22}$
(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) × 0.2 = 0.4 g
(f) No. of molecules in 3.2 g of SO_2 = $6.023 \times 10^{23} \times 3.2/64$
$= 3.023 \times 10^{22}$

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 = $2 \times 6.023 \times 10^{23} \times 0.1$
$= 1.2 \times 10^{23}$ 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 × 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 × 18 = 3.6 g
(d) 0.1 mole of CO_2 has mass = 0.1 × 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 × 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 × 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) 6.023×10^{23} atoms of oxygen has mass = 16 g
So, 1 atom has mass = $16/6.023 \times 10^{23} = 2.656 \text{ x } 10^{-23}$ g
(b) 1 atom of Hydrogen has mass = $1/6.023 \times 10^{23} = 1.666 \times 10^{-24}$
(c) 1 molecule of NH_3 has mass = $17/6.023 \times 10^{23} = 2.82 \times 10^{-23}$ g
(d) 1 atom of silver has mass = $108/6.023 \times 10^{23} = 1.701 \times 10^{-22}$
(e) 1 molecule of O_2 has mass = $32/6.023 \times 10^{23} = 5.314 \times 10^{-23}$ g
(f) 0.25 gram atom of calcium has mass = 0.25 × 40 = 10g

Solution 13:

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

Solution 14:

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

Solution 15:

3.2 g of S has number of atoms = $6.023 \times 10^{23} \times 3.2 /32$
= 0.6023×10^{23}
So, 0.6023×10^{23} atoms of Ca has mass = $40 \times 0.6023 \times 10^{23}/6.023 \times 10^{23}$
= 4g

Solution 16:

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

Solution 17:

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

Solution 18:

(a) 60 g urea has mass of nitrogen(N_2) = 28 g
So, 5000 g urea will have mass = $28 \times 5000/60$ = 2.33 kg
(b) 64 g has volume = 22.4 litre
So, 320 g will have volume = $22.4 \times 320/64$ = 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 × 28/22400 = 0.07 g

Solution 21:

18 g of water has number of molecules = 6.023×10^{23}
So, 0.09 g of water will have no. of molecules = $6.023 \times 10^{23} \times 0.09/18 = 3.01 \times 10^{21}$ 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 = $0.02 \times 6.023 \times 10^{23} = 1.2 \times 10^{22}$ molecules
No. of atoms in 1 molecule of S = 8
So, no. of atoms in 1.2×10^{22} molecules = $1.2 \times 10^{22} \times 8$
= 9.635×10^{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 $P_4 \equiv$ 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 × 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 × 32/22.4 = 3.14 g

Solution 25:

No. of atoms in 12 g C = 6.023×10^{23}
So, no. of carbon atoms in 10^{-12} g = $10^{-12} \times 6.023 \times 10^{23}/12$
= 5.019×10^{10} atoms

Solution 26:

Given:
P = 1140 mm Hg
Density = D = 2.4 g / L
T = 273 °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 × 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 × 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 = $\frac{12 \times 3 \times 10^{25}}{6.023 \times 10^{23}}$ = 59.7.7g

(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 + (16 × 4) + 5(1 × 2 + 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 × 100 = 36.07 %

Solution 5:

(a) Molecular mass of $Ca(H_2PO_4)_2$ = 234
So, % of P = 2 × 31 × 100/234 = 26.5%
(b) Molecular mass of $Ca_3(PO_4)_2$ = 310
% of P = 2 × 31 × 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 ×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 8.514 $\frac{8.5}{14}$ = 0.60712

O 29.0 16 $\frac{29.0}{16}$ = 1.816

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 × 56 + 3 × 16 = 160 g

Iron present in 80% of Fe_2O_3 = $\frac{112}{160}$ ×80 = 56 g
So, mass of iron in 100 g of ore = 56 g
∴ mass of Fe in 10000 g of ore = 56 × 10000/100
= 5.6 kg

Solution 9:
For acetylene, molecular mass = 2 × V.D = 2 × 13 = 26 g
The empirical mass = 12(C) + 1(H) = 13 g

n = $\frac{Molecular\ formula\ mass}{Empirical\ formula\ weight} = \frac{26}{13} = 2$
Molecular formula of acetylene = 2 × Empirical formula = C_2H_2
Similarly, for benzene molecular mass= 2 × V.D = 2 × 39 = 78
n = 78/13 = 6
So, the molecular formula = C_6H_6

Solution 10:
Element % At. Mass Atomic ratio simple ratio

H 17.71 $\frac{17.7}{1}$ = 17.7 $\frac{17.7}{5.87}$ = 3

N 82. 314 $\frac{82.3}{14}$ = 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

H9.9.091 $\frac{9.09}{1}$ = 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 × 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 2.221 $\frac{2.22}{1}$ = 2.22 1

O71.1916 $\frac{71.19}{16}$ = 4.44 2

(a) its empirical formula = CHO_2

(b) empirical formula mass = 45

Vapour density = 45

So, molecular mass = V.D × 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 4.071 $\frac{4.07}{1}$ = 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 × 2 = 29 × 2 = 58
So, molecular formula = C_4H_{10}

Solution 15:

Since, g atom of Si = given mass/mol. Mass
so, given mass = 0.2 × 28 = 5.6 g
Element mass At. mass Gram atom Ratio
Si 5.6 28 0.2 1
Cl 21.3 35.5 $\frac{21.3}{35.5}$ = 0.63
Empirical formula = $SiCl_3$

Solution 16:

Element % at. mass atomic ratio simple ratio
C 92.3 12 $\frac{92.3}{12} = 7.7^1$
H7.71 $\frac{7.7}{1} = 7.7^1$
So, empirical formula is CH
Empirical formula mass = 13
Since molecular mass = 78
So, n = 6
∴ 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 = $BaCl_2. \times H_2O$
Ba + 2Cl + × $[H_2 + O]$
= 137 + 235.5 + × [2 + 16]
= [208 + 18x] contains water = 14.8% water in $BaCl_2. \times H_2O$
= [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 = $ZnSH_{14}O_{11}$
Empirical 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 ⟶ 1 mole + 2 mole
(b) Grams : 42g + 36g ⟶ 74g + 4 g
(c) Molecules = $6.02 \times 10^{23} + 12.046 \times 10^{23} \longrightarrow 6.02 \times 10^{23} + 12.046 \times 10^{23}$

Solution 2:
(a) 100 g of $CaCO_3$ produces = 164 g of $Ca(NO_3)_2$
So, 15 g $CaCO_3$ will produce = 164 × 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 × 15/100 = 3.36 litres CO_2

Solution 3:

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

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
(a) 17g of NH_3 requires volume = 22.4 litres
(b) 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_4produces 1 V Cl_2
685g of Pb_3O_4has 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 × 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:

$CaCO_3 + 2HCl \longrightarrow CaCl_2 + H_2O + CO_2$
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:

$2H_2O \longrightarrow 2H_2 + O_2$
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 × 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 × 0.5 = 11.2 litres at S.T.P.

Solution 8:

$2Na_2O_2 + 2H_2O \longrightarrow 4NaOH + O_2$
2 V4 V1 V

(a) Mol. Mass of Na_2O_2 = 2 × 23 + 2 × 16 = 78 g
Mass of $2Na_2O_2$ = 156 g
156 g Na_2O_2 gives = 160 g of NaOH (4 × 40 g)
So, 1.56 Na_2O_2 will give = 160 × 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 × 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 × 1.56/156
= 32/100 = 0.32 g

Solution 9:

$2NH_4Cl + Ca(OH)_2 \longrightarrow CaCl_2 + 2H_2O + 2NH_3$
2 V1 V1 V2 V
Mol. Mass of $2NH_4Cl$ = 2[14 + (1 × 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 × 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 × 22.4/17 = 8.96 litre

Solution 10:

$Al_4C_3 + 12\ H_2O \longrightarrow 3CH_4 + 4Al(OH)_3$
1 V3 V4 V
144g3 × 22.4 *l* volume
Now, since 144 g of Al_4C_3 gives = 3 × 22.4 litre of CH_4
So, 14.4 g of Al_4C_3 will give =3 × 22.4 × 14.4 /144 = 6.72 litres CH_4

Solution 11:

$MnO_2 + 4HCl \longrightarrow MnCl_2 + 2H_2O + Cl_2$ 1
V4 V1 V1 V

(a) 1 mole of MnO_2 weighs = 87 g (mol. Mass)
So, 0.02 mole will weigh = 87 × 0.02 = 1.74 g MnO_2

(b) 1 mole MnO_2 gives = 1 mole of $MnCl_2$
So, 0.02 mole MnO_2 will 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 × 0.02 g = 2.52 g

(d) 0.02 mole MnO_2 will form = 0.02 mole of Cl_2

(e) 1 mole of Cl_2 weighs = 35.5 g
So, 0.02 mole will weigh = 71 × 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 × 0.02 = 0.448 litre

(g) 1 mole MnO_2 requires HCl = 4 mole
So, 0.02 mole MnO_2 will require = 4 × 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 × 0.02 = 0.08 mole
Mass of HCl = 0.08 × 36.5 = 2.92 g

Solution 12:

$N_2 + 3H_2 \longrightarrow 2NH_3$
28g 6g 34g
28g of nitrogen requires hydrogen = 6g
2000g of nitrogen requires hydrogen = 6/28 × 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 × 2000
= 2428.6g

MISCELLANEOUS EXERCISES:

Solution 1:

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

Solution 2:

$3Cu + 8HNO_3 \longrightarrow 3Cu\,(NO_3)_2 + 4H_2O + 2NO$
1 V 8 V 3 V 2 V
Mol. Mass of $8HNO_3$ = 8 × 63 = 504 g

(a) For 504g HNO_3, Cu required is = 192 g
So, for 63g HNO_3 Cu required = 192 × 63/504 = 24g

(b) 504 g of HNO_3 gives = 2 × 22.4 litre volume of NO
So, 63g of HNO_3 gives = 2 × 22.4 × 63/504 = 5.6 litre of NO

Solution 3:

(a) 28g of nitrogen = 1mole
So, 7g of nitrogen = 1/28 × 7 = 0.25 moles

(b) Volume of 71 g of Cl2 at STP = 22.4 litres
Volume of 7.1 g chlorine =22.4 × 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 × 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:

$2H_2O \longrightarrow H_2 + O_2$

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 + (3 × 1) = 15 g

Vapour density = 15

So, the molecular mass = 15(V.D) × 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) ss of C = 0.12 g

(iii) ma 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) $V.D = \frac{mass\ of\ gas\ at\ STP}{mass\ of\ equal\ volume\ of\ H_2} = \frac{85}{5} = 17$

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

Solution 11:

(a) $CO_2 + C \longrightarrow 2CO$
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) $2CO + O_2 \longrightarrow 2CO_2$
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 × 22400 cm^3 CO gives = 2 × 22400 cm^3 CO_2
so, 24cm^3 CO will give = 24 cm^3 CO_2

Solution 12:

$2Ca(NO_3)_2 \longrightarrow 2CaO + 4NO_2 + O_2$
2 V 2 V 4 V 1 V

(a) 56 g of CaO is obtained with NO_2 = 2 × 22.4 litre of NO_2
So, 5.6g of CaO is obtained with NO_2 = 2 × 22.4 × 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 × 56/164 g $Ca(NO_3)_2$
= 16.4 g of $Ca(NO_3)_2$ is heated.

Solution 13:

(a) Number of molecules in 100cm3 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 cm3 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 × 3 + 1 × 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 × 100 = 20.82%

% of chlorine in the compound = 21.2/26.9 × 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 × 1 + 3 × 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

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

$$V_2 = \frac{P_1V_1T_1}{T_1P_2} = \frac{700 \times 10 \times 273}{300 \times 760}$$

Molecular weight A = 60
So, weight of 22.4 liters of A at STP = 60g
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

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

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

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 $CaSO_4 . \times H_2O = 136 + 18x$
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 × 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
$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$
$V_2 = \frac{P_1V_1T_2}{T_1P_2} = \frac{760 \times 1400 \times 300}{273 \times 740}$ = 1580 cc
= 1580/1000 = 1.58l
(d) P_1 = 750mm P_2 =760mm
V_1 = 44lit. V_2 =?
T_1 = 298K T_2 = 273K
$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$
$V_2 = \frac{P_1V_1T_2}{T_1P_2} = \frac{750 \times 44 \times 273}{298 \times 760}$ = 39.78 lit
22.4 lit. of CO2 at STP has mass = 44g
39.78 lit. of CO2 at STP has mass = $\frac{44 \times 39.78}{22.4}$
= 78.14g

(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 × 100 = 58.5%

Solution 21:

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$
$$\frac{P_1 \times 22.4}{273} = \frac{2P_2V_2}{546}$$
V_2 = 22.4 litre

Solution 22:

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

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

Solution 23:

$$V \times \frac{760}{273} = \frac{360 \times 380}{360}$$
$$V = \frac{360 \times 380 \times 273}{760 \;\; 360} = 136.\,5 \text{ cm}^3$$
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 = 89.6 a.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 × 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 × 152/252 = 38 g

Solution 25:

$2H_2S + 3O_2 \longrightarrow 2H_2O + 2SO_2$
2 V 3 V 2 V
128 g of SO_2 gives = 2 × 22.4 litres volume
So, 12.8 g of SO_2 gives = 2 × 22.4 × 12.8/128
= 4.48 litre volume
Or one can say 4.48 litres of hydrogen sulphide.
2 × 22.4 litre H_2S requires oxygen = 3 × 22.4 litre
So, 4.48 litres H_2S will require = 6.72 litre of oxygen

Solution 26:

From equation, $2NH_3 + 2\,O_2 \longrightarrow 2NO + 3H_2O$
When 60 g NO is formed, mass of steam produced = 54 g
So, 1.5 g NO is formed, mass of steam produced = 54 × 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 × 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 (760 mm) 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 273^0C = 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:

$Na_2CO_3.10H_2O \longrightarrow Na_2CO_3 + 10H_2O$

286 g 106 g

So, for 57.2 g $Na_2CO_3.10H_2O$ = 106 × 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   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 × 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:

$4N_2O + CH_4 \longrightarrow CO_2 + 2H_2O + 4N_2$
4 V 1 V 1 V 2 V 4 V
2 x 22400 litre steam is produced by N_2O = 4 × 22400 cm^3
So, 150 cm^3 steam will be produced by= 4 × 22400 × 150/2 × 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 × 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) × 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:

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

1 V 2 V 1 V 2 V

From equation:

22.4 litres of methane requires oxygen = 44.8 litres O_2

$2H_2 + O_2 \longrightarrow 2H_2O$

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 × 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   6.02 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 $Cl_2 < SO_2 < CO_2 < O_2 < H_2$

6)
   (i) Least number of molecules in Cl_2
   (ii) Most number of molecules in H_2

Solution 38:

$Na_2SO_4 + BaCl_2 \longrightarrow BaSO_4 + 2NaCl$
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 × 142/233 = 4.26
The percentage of Na_2SO_4 in original mixture = 4.26 × 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 × 24
= 31.6 or 32 g

(b) $2KMnO_4 \longrightarrow K_2MnO_4 + MnO_2 + O_2$
316 g of $KMnO_4$ gives oxygen = 24 litres
So, 15.8 g of $KMnO_4$ will give = 24 × 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 × 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 = 6×10^{23} because according to mole concept 22.4 litre volume at STP has = 6×10^{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:
The formula of aluminium nitride is AlN.
The molecular mass = 41
So, the percentage of N = 14 × 100/41 = 34.146 %

Solution 43:
(a) $NaCl + NH_3 + CO_2 + H_2O \longrightarrow NaHCO_3 + NH_4Cl$
$2NaHCO_3 \longrightarrow Na_2CO_3 + H_2O + CO_2$
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 × 33.6/84
= 8.96 litre

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) $3CuO + 2NH_3 \longrightarrow 3Cu + 3H_2O + N_2$
3 V 2 V 3 V 1V
3 × 80 g of CuO reacts with = 2 × 22.4 litre of NH_3
so, 120 g of CuO will react with = 2 × 22.4 × 120/80 × 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 = $6.023 \times 10^{23} \times 0.05 = 3 \times 10^{22}$ molecules
Volume = 22.4 × 0.05 = 1.12 litres
(b) Molecular mass = 2 × V.D
S0, V.D = 28/2 = 14

Solution 46:

(a) Molecular mass of Na_3AlF_6 = 210

So, Percentage of Na = 3 × 23 × 100/210 = 32.85%

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

2 V 1 V 2 V

1 mole of O_2 has volume = 22400 ml

Volume of oxygen used by 2 × 22400 ml CO = 22400 ml

So, Vol. of O_2 used by 560 ml CO = 22400 × 560/(2 × 22400)

= 280 ml

So, Volume of CO_2 formed is 560 ml.

Solution 47:

(a) $NH_4NO_3 \longrightarrow N_2O + 2H_2O$

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 × 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 × 8.96/44.8

= 16g NH_4NO_3

(ii) % of O in NH_4NO_3 = 3 × 16/80 = 60%

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 × 80 = 252 g
molecular formula mass = 2 × 252(V.D) = 504 g
n = 504/252 = 2
so, molecular formula = C_2Br_6

Solution 49:

$2C_8H_{18} + 25O_2 \longrightarrow 16CO_2 + 18H_2O$
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 × 22.4 = 179.2 litre
(iii) 1 mole CO_2 has mass = 44 g
so, 16 moles will have mass = 44 × 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) $C + 2H_2SO_4 \longrightarrow CO_2 + 2H_2O + 2SO_2$
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 × 12/196 = 3 g
(ii) 196 g of H_2SO_4 occupies volume = 2 × 22.4 litres
So, 49 g H_2SO_4 will occupy = 2 × 22.4 × 49/196 = 11.2 litre
i.e. volume of SO_2 = 11.2 litre