2 Gas Laws and Mole Concept

Properties of gases

- Each gas contains a large number of minute particles called molecules.
- The volume of a gas molecule is very less when compared to the total volume of the gas.
- The molecules of a gas are in a state of rapid random motion in all directions.
- During this motion, the gas molecules collide with each other and also collide with the walls of the container in which it is kept.
- ***As the collisions of molecules are perfectly elastic in nature, there is no loss of energy.***
- ***The collision of the gas molecules with the walls of the container creates the pressure of the gas.***
- The force of attraction between the gas molecules is comparatively less.
- Energy of gas molecules is very high
- Distance between the molecules is very large
- Freedom of movement of molecules very high
- Attractive force between molecules and with the walls of the container is very low.

Volume of a gas

If a gas ,kept in a cylinder having a volume of 1 litre, is completely transferred to another 5 litre cylinder, its volume becomes 5 litres.

Volume of a gas is the volume of the container which it occupies.

1. Pull the piston of a syringe backwards. Press the piston after closing the nozzle of the syringe.

What will happen to the volume of air inside the syringe?

When we press the piston after closing its nozzle, the volume of the gas inside the syringe decreases.

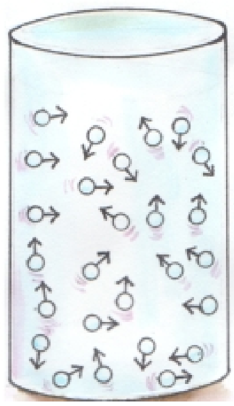
Temperature of a gas

When a gas is heated , the temperature increases. The kinetic energy of the molecules increases. The average kinetic energy is a measure of the temperature of a gas.

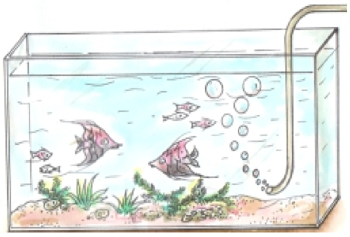
Pressure of a gas

Force exerted per unit area is called pressure.

Force on unit area= Total force exerted on the surface / Surface area



Relation between Volume of a gas and Pressure (Boyle's Law)



2.The size of the air bubbles rising from the bottom of an aquarium increases. Give reason.
Here the temperature is constant. From bottom to top, the external pressure decreases.
Hence volume of the bubble increases. (Boyle's law).

Boyle's law states that at a constant temperature, volume of a definite mass of gas is inversely proportional to its pressure. If P is the pressure and V the volume, then P x V is a constant.

Relation between Volume of a gas and its Temperature (Charle's Law)

3. Take a dry bottle (an injection bottle) having a rubber stopper. Fix an empty refill through the rubber stopper. Fill a drop of ink into in the lower end of the refill tube, then close the bottle. Dip this arrangement in luke warm water.

What do you observe?

The ink rises up.

What is the reason for the rising of the ink upwards?

When the temperature increases, the volume of the gas inside the bottle increases. This will push the ink up .

What did you observe on cooling the bottle after taking it out? Why?

On cooling the bottle, the volume of the gas decreases. Then the ink goes down.

When the temperature increases, the volume of the gas increases. When temperature decreases, volume of the gas decreases.

The table given below shows the relation between volume and temperature of a fixed mass of a gas. (Pressure is kept constant)

Volume V	**Temperature T (In Kelvin scale)**	**V/T**
900 mL	300 K	900 / 300 = **3**
960 mL	320 K	960 / 320 = **3**
819 mL	273 K	819 / 273 = **3**

[Note that the temperature is stated in kelvin scale]

Charle's law states that , At constant pressure, the volume of a definite mass of a gas is directly proportional to the temperature in Kelvin Scale.

If V is volume and T the temperature, Then V/T will be a constant.

4. *If an inflated balloon is kept in sunlight, it will burst. What may be the reason for this?*

When the temperature increases, the volume of the gas inside the balloon increases and finally it will burst. (Charle's Law)

Relation between volume and number of molecules (Avogadro's Law)

Avogadro's Law states that At constant temperature and pressure, the volume of a gas is directly proportional to the number of molecules.

5. How is the number of minute particles calculated?

If the particles having the same size and mass, even though they are in crores, we can determine their accurate number **on the basis of mass.**

Relative Atomic Mass

It is possible to find out the accurate mass of minute particles through the modern techniques.

For example, the mass of a Hydrogen atom is1.67 x 10^{-24} g. But in practice, it is stated in terms of relative mass.

In this method, the mass of an atom is compared to the mass of another atom and expressed as a number which shows how many times it is heavier than the other atom. The atomic mass of elements are expressed by considering 1/12 mass of an atom of carbon-12 as one unit.

When average atomic masses of elements are calculated taking into account the different isotopes of elements, the atomic masses of elements may have fractional values. However for practical purposes and calculations, most of these values are taken as whole numbers.

Towards mole concept..

If the relative atomic mass of an element is x grams, x grams of it contains **6.022 x 10^{23} atoms .**

Look at the following table for clarification

Element	**Atomic Mass**	**Atomic Mass in grams**	**Mass Actually taken**	**Number of Atoms**
Hydrogen	**1**	**1 g**	**1 g**	**6.022 x 10^{23}**
Carbon	**12**	**12 g**	**12 g**	**6.022 x 10^{23}**
Nitrogen	**14**	**14 g**	**14 g**	**6.022 x 10^{23}**
Oxygen	**16**	**16 g**	**16 g**	**6.022 x 10^{23}**
Sodium	**23**	**23 g**	**23 g**	**6.022 x 10^{23}**
Magnesium	**24**	**24 g**	**24 g**	**6.022 x 10^{23}**
Aluminium	**27**	**27 g**	**27 g**	**6.022 x 10^{23}**
Chlorine	**35.5**	**35.5g**	**35.5g**	**6.022 x 10^{23}**
Calcium	**40**	**40 g**	**40 g**	**6.022 x 10^{23}**

The mass of an element in grams equal to its atomic mass is called 1 Gram Atomic Mass (1 GAM) of the element. This may also be shortened as 1 Gram Atom.

Hence the table given above can be modified as

Element	Atomic Mass	Atomic Mass in grams	Mass Actually taken	GAM	Number of Atoms
Hydrogen	**1**	**1 g**	**1 g**	**1 GAM**	6.022×10^{23}
Carbon	**12**	**12 g**	**12 g**	**1 GAM**	6.022×10^{23}
Nitrogen	**14**	**14 g**	**14 g**	**1 GAM**	6.022×10^{23}
Oxygen	**16**	**16 g**	**16 g**	**1 GAM**	6.022×10^{23}
Sodium	**23**	**23 g**	**23 g**	**1 GAM**	6.022×10^{23}
Magnesium	**24**	**24 g**	**24 g**	**1 GAM**	6.022×10^{23}
Aluminium	**27**	**27 g**	**27 g**	**1 GAM**	6.022×10^{23}
Chlorine	**35.5**	**35.5g**	**35.5g**	**1 GAM**	6.022×10^{23}
Calcium	**40**	**40 g**	**40 g**	**1 GAM**	6.022×10^{23}

One gram atomic mass (1 GAM) of any element contains 6.022×10^{23} atoms. This number is known as Avagadro number. This is indicated as N_A.

Have a close look at the table given below

Element	Atomic Mass	Atomic Mass in grams	Given mass	Number of GAM	Number of Atoms
Hydrogen	1	1 g	1 g	1 GAM	6.022×10^{23}
Hydrogen	**1**	**1 g**	**2 g**	**2 GAM**	$2 \times 6.022 \times 10^{23}$
Carbon	12	12 g	12 g	1 GAM	6.022×10^{23}
Carbon	**12**	**12 g**	**24 g**	**2 GAM**	$2 \times 6.022 \times 10^{23}$
Nitrogen	14	14 g	14 g	1 GAM	6.022×10^{23}
Nitrogen	**14**	**14 g**	**42 g**	**3 GAM**	$3 \times 6.022 \times 10^{23}$
Oxygen	16	16 g	16 g	1 GAM	6.022×10^{23}
Oxygen	**16**	**16 g**	**80 g**	**5 GAM**	$5 \times 6.022 \times 10^{23}$
Sodium	23	23 g	23 g	1 GAM	6.022×10^{23}
Sodium	**23**	**23 g**	**230 g**	**10 GAM**	$10 \times 6.022 \times 10^{23}$

From the table given above , it is clear that

Number of Gram Atomic Mass = **Given Mass in grams / GAM of element**

6.How many GAM is present in 46 g of sodium?

(Hint: 1 GAM of sodium means 23 grams of Sodium)

Answer:

Number of GAM = **Given Mass in grams / GAM of element**

= **46 g / 23 g**

= **2**

It contains 2 × 6.022 x 10^{23} atoms of sodium

7.How many GAM is present in 69 g of sodium?

(Hint: 1 GAM of sodium means 23 grams of Sodium)

Answer:

Number of GAM = **Given Mass in grams / GAM of element**

= **69 g / 23 g**

= **3**

It contains 3 × 6.022 x 10^{23} atoms of sodium

Number of Atoms = **Number of GAM** x 6.022 x 10^{23}

8.Calculate the number of atoms present in each of the sample?

(Atomic mass N = **14**, O = **16)**

a) 42 g Nitrogen

b) 80 g Oxygen

Answer:

a) 42 g Nitrogen

Number of GAM = **Given Mass in grams / GAM of element**

= 42 g / **14 g**

= **3**

It contains 3 × 6.022 x 10^{23} atoms of Nitrogen

b) 80 g Oxygen

Number of GAM = **Given Mass in grams / GAM of element**

= 80 g / **16 g**

= **5**

It contains 5 × 6.022 x 10^{23} atoms of Oxygen

9.Complete the table given below.

Element	**Atomic Mass**	**Atomic Mass in grams**	**Given mass**	**Number of GAM**	**Number of Atoms**
Hydrogen	1	1 g	4 g	........(a)........	..........(b)...........
Carbon	**12**	**12 g**	.........(c)..........	**5 GAM**	..........(d)...........
Nitrogen	**14**	**14 g**	**42 g**	........(e).........	...........(f)...........
Oxygen	**16**	**16 g**	........(g)..........	........(h).........	5 x **6.022 x 10^{23}**

(a) = 4 (b) = 4 x 6.022 x 10^{23} **(c) = 60 g** (d)= 5 x 6.022 x 10^{23}

(e)= 3 **(f) = 3 x 6.022 x 10^{23}** (g) = 80 g **(h) = 5**

One mole of atoms

One mole of atoms = 6.022 x 10^{23} atoms = 1GAM

10. Find the number of mole atoms of the following

a.

Element	**Atomic Mass**	**Atomic mass in grams**	**Mass taken**	**Number of GAM**	**Number of atoms**	**Number of mole atoms**
Hydrogen	**1**	**1 g**	**1 g**	**1 GAM**	6.022 x 10^{23}	
Carbon	**12**	**12 g**	**12 g**	**1 GAM**	6.022 x 10^{23}	
Nitrogen	**14**	**14 g**	**14 g**	**1 GAM**	6.022 x 10^{23}	
Oxygen	**16**	**16 g**	**16 g**	**1 GAM**	6.022 x 10^{23}	

Answer:

Element	**Atomic Mass**	**Atomic mass in grams**	**Mass taken**	**Number of GAM**	**Number of atoms**	**Number of mole atoms**
Hydrogen	**1**	**1 g**	**1 g**	**1 GAM**	6.022 x 10^{23}	1
Carbon	**12**	**12 g**	**12 g**	**1 GAM**	6.022 x 10^{23}	1
Nitrogen	**14**	**14 g**	**14 g**	**1 GAM**	6.022 x 10^{23}	1
Oxygen	**16**	**16 g**	**16 g**	**1 GAM**	6.022 x 10^{23}	1

b.

Element	Atomic mass	Atomic mass in grams	Given mass	Number of GAM	Number of atoms	Number of mole atoms
Hydrogen	1	1 g	1 g	1 GAM	6.022×10^{23}	
Hydrogen	1	1 g	2 g	2 GAM	$2 \times 6.022 \times 10^{23}$	
Carbon	12	12 g	12 g	1 GAM	6.022×10^{23}	
Carbon	12	12 g	24 g	2 GAM	$2 \times 6.022 \times 10^{23}$	
Nitrogen	14	14 g	14 g	1 GAM	6.022×10^{23}	
Nitrogen	14	14 g	42 g	3 GAM	$3 \times 6.022 \times 10^{23}$	
Oxygen	16	16 g	16 g	1 GAM	6.022×10^{23}	
Oxygen	16	16 g	80 g	5 GAM	$5 \times 6.022 \times 10^{23}$	
Sodium	23	23 g	23 g	1 GAM	6.022×10^{23}	
Sodium	23	23 g	230 g	10 GAM	$10 \times 6.022 \times 10^{23}$	

Answer:

Element	Atomic mass	Atomic mass in grams	Given mass	Number of GAM	Number of atoms	Number of mole atoms
Hydrogen	1	1 g	1 g	1 GAM	6.022×10^{23}	1
Hydrogen	1	1 g	2 g	2 GAM	$2 \times 6.022 \times 10^{23}$	2
Carbon	12	12 g	12 g	1 GAM	6.022×10^{23}	1
Carbon	12	12 g	24 g	2 GAM	$2 \times 6.022 \times 10^{23}$	2
Nitrogen	14	14 g	14 g	1 GAM	6.022×10^{23}	1
Nitrogen	14	14 g	42 g	3 GAM	$3 \times 6.022 \times 10^{23}$	3
Oxygen	16	16 g	16 g	1 GAM	6.022×10^{23}	1
Oxygen	16	16 g	80 g	5 GAM	$5 \times 6.022 \times 10^{23}$	5
Sodium	23	23 g	23 g	1 GAM	6.022×10^{23}	1
Sodium	23	23 g	230 g	10 GAM	$10 \times 6.022 \times 10^{23}$	10

Molecular Mass and Gram Molecular Mass

11. The atomic masses of certain elements are given below.

(H=1 ,C =12 , N=14 , O= 16 , Na = 23 , S= 32)

Find the Molecular Mass and GMM of the following

1. H_2 **2.** O_2 **3.** N_2 **4.** H_2O **5.**NH_3

6.CO_2 **7.**NaOH **8.** $C_6H_{12}O_6$ **9.**Na_2CO_3 **10.** H_2SO_4

Sl No	Element/ Compound	Chemical Formula	Molecular Mass	GMM
1	**Hydrogen , H_2**	**H_2**	1+1 =**2**	**2 g**
2	**Oxygen , O_2**	**O_2**	16+16 =**32**	**32 g**
3	**Nitrogen , N_2**	**N_2**	14+14=**28**	**28 g**
4	**Water ,H_2O**	**H_2O**	1+1+16 = **18**	**18 g**
5	**Ammonia ,NH_3**	**NH_3**	14+1+1+1=**17**	**17 g**
6	**Carbondioxide ,CO_2**	**CO_2**	12+16+16=**44**	**44 g**
7	**Sodium hydroxide,NaOH**	**NaOH**	23+16+1=**40**	**40 g**
8	**Glucose,$C_6H_{12}O_6$**	**$C_6H_{12}O_6$**	(12 x 6) + (1 x12) + (16 x6)= 72 +12 + 96= **180**	**180 g**
9	**Sodium carbonate, Na_2CO_3**	**Na_2CO_3**	= (23 x 2) + (12 x 1) + (16 x 3) = 46 + 12 + 48 **= 106**	**106 g**
10	**Sulphuric acid, H_2SO_4**	**H_2SO_4**	(1 x 2) + (32 x 1) +(16 x 4) = 2 + 32 + 64 **= 98**	**98 g**

Number of Molecules

Analyse the table given below

Element / Compound	Molecular Mass	Mass in grams	GMM	Number of molecules
Hydrogen **(H_2)**	2	2 g	1 GMM	6.022×10^{23} H_2 molecules
Oxygen**(O_2)**	32	32 g	1 GMM	6.022×10^{23} O_2 molecules
Nitrogen**(N_2)**	28	28 g	1 GMM	6.022×10^{23} N_2 molecules
Water**(H_2O)**	18	18 g	1 GMM	6.022×10^{23} H_2O molecules
Ammonia**(NH_3)**	17	17 g	1 GMM	6.022×10^{23} NH_3 molecules
Carbon dioxide **(CO_2)**	44	44 g	1 GMM	6.022×10^{23} CO_2 molecules

The amount** of a substance in grams **equal to its molecular mass** is called **Gram Molecular Mass
One gram molecular mass of any substance contains Avagadro number of molecules.

12. One GMM oxygen is 32g Oxygen. This contains 6.022×10^{23} oxygen molecules.

(a) How many GMM are there in 64g oxygen?
(b) How many molecules are present in it?

Answer:
(a) One GMM oxygen is 32g Oxygen.
Hence ,
Number of GMM in 64 g oxygen = 64g/32g
=2

(b)
Number of molecules in 64g Oxygen = Number of GMM x 6.022×10^{23}
= 2 x 6.022×10^{23}

Number of Gram Molecular Mass = Mass given in grams / Gram Molecular Mass **(GMM)**

13. Calculate the number of GMM and number of ,molecules in each of the following samples

(a) 360 g glucose (Molecular mass = 180)
(b) 90 g Water (Molecular mass = 18)

Answer:
(a) 360 g glucose

Number of Gram Molecular Mass = Mass given in grams / Gram Molecular Mass **(GMM)**
= 360 g / 180 g
= 2
Number of molecules = Number of GMM x 6.022×10^{23}
= 2 x 6.022×10^{23}

(b) 90 g glucose

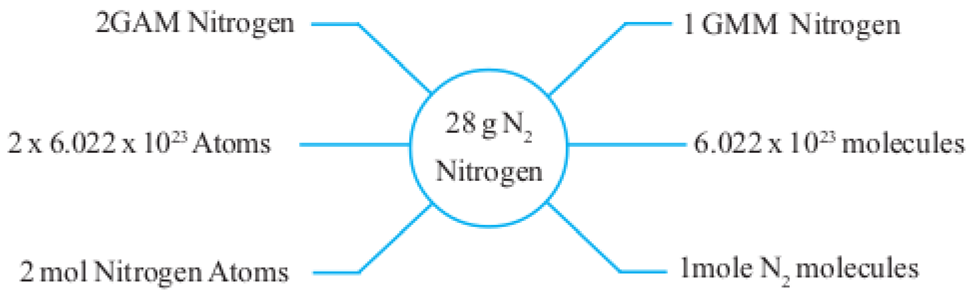
Number of Gram Molecular Mass = Mass given in grams / Gram Molecular Mass **(GMM)**
= 90 g / 18 g
= 5
Number of molecules = Number of GMM x 6.022×10^{23}
= 5 x 6.022×10^{23}

Number of Molecules = Number of GMM x 6.022×10^{23}

One Mole of molecules

6.022×10^{23} molecules are called one mole molecule.
1 GMM = 1 Mole = 6.022×10^{23} molecules.

N_2 is a diatomic molecule. The molecular mass of nitrogen is 28.
Look at the word diagram given below.



Relation between Volume of a gas and Moles

14. What is molar volume of a gas ?

The volume occupied by one mole of a gas is said to be its molar volume.

One mole of any gas under the same conditions of temperature and pressure will contain the same number of molecules and hence their volume will also be the same.

If the temperature or pressure changes, the volume and number of molecules will also change.

Scientists have proved that

1 mole of any gas at 273K and 1 atm pressure occupies 22.4 litres.

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273 K temperature and **1 atm** pressure are known as standard temperature and pressure or **STP.**

That is, at STP one mole of any gas will occupy a volume of 22.4 L. This is called molar volume at STP.

That is ,

One mole of H_2 at STP occcupies 22.4 Litres

One mole of N_2 at STP occcupies 22.4 Litres

One mole of O_2 at STP occcupies 22.4 Litres

One mole of Cl_2 at STP occcupies 22.4 Litres

One mole of CO_2 at STP occcupies 22.4 Litres

One mole of NH_3 at STP occcupies 22.4 Litres

15. If one mole of any gas at STP occupies 22.4 L, find the number of moles in 44.8 L

Answer : 44.8 L/ 22.4 L = 2 mol

16. If one mole of any gas at STP occupies 22.4 L, find the number of moles in 67.2 L

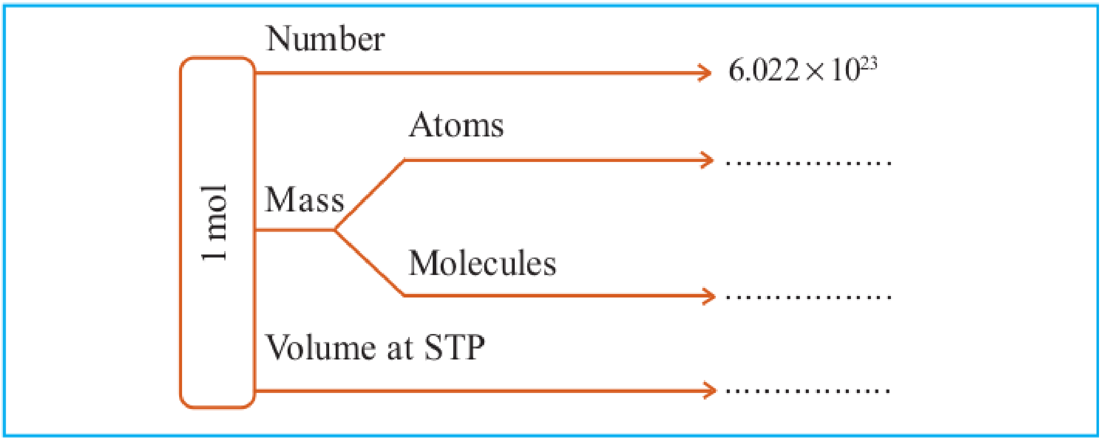
Answer : 67.2 L/ 22.4 L = 3 mol

17. If one mole of any gas at STP occupies 22.4 L, find the number of moles in 112 L

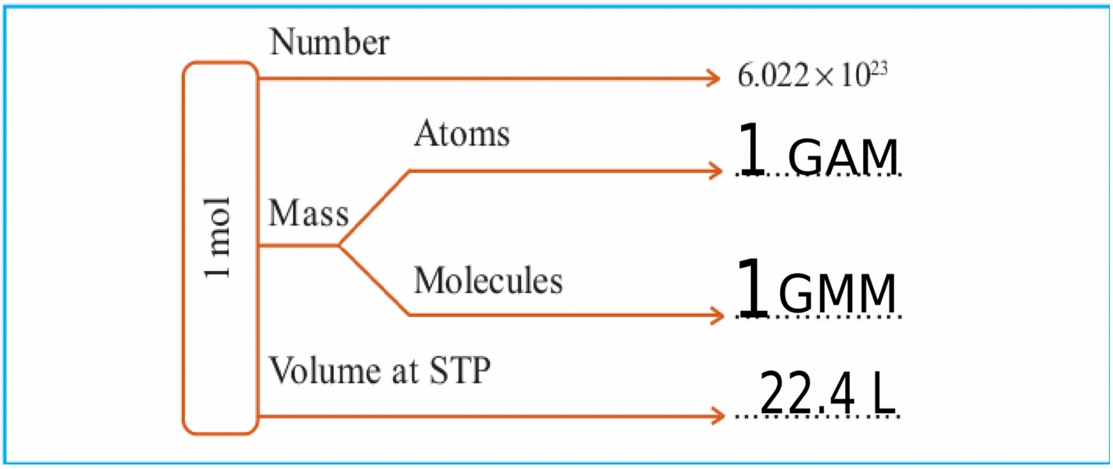
Answer : 112 L/ 22.4 L =5 mol

Number of moles of a gas at STP =Volume of the gas in litres at STP / 22.4 L

18. Complete the chart given below



Answer:



Problem Part in a Nutshell		
For Atoms	**For Molecules**	**For Gases @ STP**
Number of GAM = Given mass in grams / GAM of the element	Number of GMM = Given mass in grams / GMM	Number of moles of a gas at STP = Volume of the gas at STP in litres / 22.4 litres
Number of Atoms = Number of GAM x 6.022×10^{23}	Number of Molecules = Number of GMM x 6.022×10^{23}	Number of Molecules = Number of moles x 6.022×10^{23}

Let us assess

1. Examine the data given in the table (Temperature and number of molecules of the gas are kept constant).

Pressure (P)	Volume (V)
1 atm	8 L
2 atm	4 L
4 atm	2 L

   a) Calculate P x V.

   b) Which is the gas law related to this?

2. Analyse the situations given below and explain the gas law associated with it.

   a) A balloon is being inflated.

   b) When an inflated balloon is immersed in water, its size decreases.

3. Certain data regarding various gases kept under the same conditions of temperature and pressure are given below.

Gas	Volume (L)	No. of molecules
Nitrogen	10 L	x
Oxygen	5 L	
Ammonia	10 L	---
Carbon di oxide	---	2x

   a) Complete the table.

   b) Which gas law is applicable here?

4. a) Calculate the mass of 112 L CO_2 gas kept at STP (molecular mass =44).
   b) How many molecules of CO_2 are present in it?
5. a) Calculate the volume of 170g of ammonia at STP? (Molecular mass – 17)
6. Find out the number of moles of molecules present in the samples given below.
   (GMM – N_2 = 28g, H_2O = 18g)
   a) 56g N_2 b) 90g H_2O
7. The Molecular mass of ammonia is 17.
   a) How much is the GMM of ammonia?
   b) Find out the number of moles of molecules present in 170g of ammonia.
   c) Calculate the number of ammonia molecules present in the above sample of ammonia?
8. The molecular mass of oxygen is 32.
   a) What is the GMM of O_2?
   b) How many moles of molecules are there in 64 g of oxygen? How many molecules are there in it?
   c) Calculate the number of oxygen atoms present in 64g of oxygen?

Answers :

1 **(a) = 8 L atm** **(b) = Boyle's Law**

2 **(a) = Avogadro's Law (b) = Boyle's Law (Explanation of the example)**

3 **(a)**

Gas	Volume (L)	No. of molecules
Nitrogen	10 L	x
Oxygen	5 L	x/2
Ammonia	10 L	x
Carbon di oxide	20 L	2x

(b) **Avogadro's Law**

4

(a) Number of moles of a gas at STP = Volume of the gas in Litres at STP /22.4 L
= 112L / 22.4 L
= 5 moles

But , Number of moles = Mass given in grams / Gram **M**olecular **M**ass of the compound
Mass in grams = Number of moles x Gram **M**olecular **M**ass of the compound
= 5 x 44 g
= 220 g

(b) Number of molecules of CO_2 = Number of moles x 6.022 x 10^{23}
= 5 x 6.022 x 10^{23}

5

Number of moles = Mass given in grams / Gram **M**olecular **M**ass of the compound
= 170 g / 17 g
= 10 moles

Number of moles of a gas at STP = Volume of the gas in litres at STP / 22.4 L
Volume of the gas in litres at STP / 22.4 L = Number of moles at STP x 22.4 L
= 10 moles x 22.4 L
= 10 x 22.4 L = 224 L

6

(a) = 2 **(b) = 5**

7

(a) 17 g
(b) 170g / 17 g = 10
(c) 10 x N_A

8

(a) 32 g
(b) 2 , 2 x N_A
(c) Number of Oxygen atoms =Number of GAM x N_A
= (64g / 16 g) x N_A
= 4 x N_A

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Extended Activities

1. *How many grams of* Carbon and Oxygen are required to get the **same number of atoms as in one gram of Helium?**

2. Examine the samples given.
(Molecular mass : He =4 , NH_3 = 17 , N_2 = 28 , H_2SO_4 = 98 , Water = 18)

a. 20 g He **b.** 44.8 L of NH_3 at STP **c.** 67.2 L of N_2 at STP
d. 1 mol Of H_2SO_4 **e.** 180 g of Water

(i)Arrange the samples in the increasing order of number of molecules in each.
(ii) What will be the ascending order of the number of atoms in each ?
(iii)What will be the mass of samples b , c and d

3. In 90 g of Water,

(a) How many molecules are present?
(b) What will be the total number of atoms ?
(c) What will be the total number of electrons in this sample?

Answers

1. Atomic Mass of Helium = 4
Number of atoms in 4 grams of Helium = 6.022×10^{23}

Number of atoms in 1 gram of Helium = 6.022×10^{23} / 4
Atomic mass of carbon = 12
Mass of 6.022×10^{23} atoms of carbon = 12 g
Mass of 6.022×10^{23} / 4 atoms of carbon = 12 g / 4
= **3 g**
Atomic mass of oxygen = 16g
Mass of 6.022×10^{23} atoms of oxygen = 16 g
Mass of 6.022×10^{23} / 4 atoms of oxygen = 16 g / 4
= **4 g**

2. *Number of molecules in each sample*

a. 20 g He

Number of GMM = Given mass in grams / GMM of the Element
= 20 g / 4 g = **5**
Number of Molecules = Number of GMM x 6.022×10^{23}
= **5 x N_A**

b. 44.8 L of NH_3 at STP

Number of moles of a gas at STP = Volume of the gas at STP in litres / 22.4 litres
= 44.8 L / 22.4 L
= 2
Number of molecules = Number of moles x 6.022×10^{23}
= **2 xN_A**

c. 67.2 L of N_2 at STP

Number of moles of a gas at STP = Volume of the gas at STP in litres / 22.4 litres
= 67.2 L / 22.4 L
= 3

Number of molecules = Number of moles x 6.022×10^{23}
= **3 xN_A**

d. 1 mol Of H_2SO_4

Number of molecules = Number of moles x 6.022×10^{23}
= 1 x N_A
= **N_A**

e. 180 g of Water

Number of GMM = Given mass in grams / GMM of the compound
= 180 g / 18 g = 10

Number of Molecules = Number of GMM x 6.022×10^{23}
= **10 x N_A**

The increasing order of number of molecules in sample is

1 mol Of H_2SO_4 < 44.8 L of NH_3 at STP < 67.2 L of N_2 at STP < 20 g He <180 g of Water

Number of atoms in each sample

Sample	Element / Compound	Number of Molecules	Number of Atoms in one Molecule	Total number of atoms
(a)	*20 g He*	**5 x N_A**	He = 1	1 x 5 x N_A **= 5 N_A**
(b)	*44.8 L of NH_3 at STP*	**2 xN_A**	NH_3 = 1+ 3 = 4	4 x 2 xN_A **= 8 N_A**
(c)	*67.2 L of N_2 at STP*	**3 xN_A**	N_2 = 2	2 x 3 xN_A **= 6 N_A**
(d)	*1 mol Of H_2SO_4*	**N_A**	***H_2SO_4 = 2 + 1+4 =7***	7 x N_A **= 7 N_A**
(e)	*180 g of Water*	**10 xN_A**	Water (H_2O) = 2+1 = 3	3 x 10 xN_A **= 30N_A**

The ascending order of the number of atoms is

20 g He < 67.2 L of N_2 at STP < 1 mol Of H_2SO_4 < 44.8 L of NH_3 at STP < 180 g of Water

Mass of samples b , c and d

b. 44.8 L of NH_3 at STP

Number of molecules = $2 \times N_A$

Mass of N_A molecules = 1 GMM = 17 g of NH_3
Mass of 2 x N_A molecules = 2 GMM= 2 x 17 g of NH_3 = ***34 g of NH_3***

c. 67.2 L of N_2 at STP

Number of molecules = $3 \times N_A$

Mass of N_A molecules = 1 GMM = 28 g of N_2
Mass of 3 x N_A molecules = 3 GMM= 3 x 28 g of N_2= ***84 g of NH_3***

d. 1 mol Of H_2SO_4

1 mol of H_2SO_4 = *N_A molecules of H_2SO_4*

Mass of N_A molecules = 1 GMM **= 98g of H_2SO_4**

3. 90 g of Water (H_2O)

Number of GMM = Given mass in grams / GMM of the Element
= 90 g / 18 g = **5**
Number of Molecules = Number of GMM x 6.022 x10^{23}
= 5 x N_A

Number of atoms in 1 molecule of Water (H_2O)= 2 + 1 = 3
Therefore ;
*Total Number of atoms in **5 x N_A** molecules of Water = 3 x 5 x **N_A= 15 N_A***

Number of electrons in 1 molecule of Water = 2 + 8 = 10
Therefore ;
Total Number of electrons in 5 x N_A molecules of Water = 10 x 5 x N_A = 50 x N_A