**ALL SAINTS’ SECONDARY SCHOOL, OYIGBO**

**SS 1 CHEMISTRY**

***LECTURE 4***

**TOPIC: GAS LAWS (CONTINUES)**

**CORRECTION OF THE PREVIOUS ASSIGNMENT**

1. V1 = 0.15dm3

V2 = 100cm3 we need to convert 100cm3 to dm3 to march with the unit of the first volume

T1 = 25oC = 25 + 273 = 298K

T2 = ?

Pressure is constant; therefore, the question is from Charles’ law

That is to keep the pressure constant, the temperature needs to be reduced to 198.67.

That is 198.67 – 273 = -94.33

1. V1 = 20dm3

T1 = 273K

P1 = 1atm

V2 = 6dm3

T2 = ?

Pressure is constant

1. V1 = 1.16dm3  
   T1 = 40oC = 40 + 273 = 313K

P1 = 2.05atm

V2 = ?

T2 = 35oC = 35 + 273 = 308K

P2 = 1.52atm

No variable is constant, so we use general gas equation.

The second volume is 1.54dm3.

**3. *Gay-Lussac’s law***

Gay-Lussac’s law states that constant temperature and pressure, the volume of gaseous reactants and products of a reaction are in simple integral ratio.



This means that 2 unit volume of hydrogen gas combine with 1 unit volume of oxygen to produce 2 unit volume of steam.

Another example is:



That is, 1 unit volume of nitrogen combines with 3 unit volume of hydrogen to produce 2 unit volume of ammonia.

***Note:***

1. The number of moles or amount of every balanced chemical equation is expressed in simple ratio.
2. For Gay-Lussac’s law to be obeyed, all the reactants and products must be gases and as the amounts are simple ratio is as the volumes are expressed in simple ratio.

**4. *Avogadro’s Principle***

The Avogadro’s principle states, that at the same temperature and pressure, equal volume of gases contain the number of molecules. In other words, at constant temperature and pressure, the volume of a given mass of an ideal gas is directly proportional to the number of moles of the gas (n).

(at constant T and P)

**IDEAL GAS LAW**

The ideal gas law or ideal gas equation is derived from the Boyle’s law, Charles’ law and Avogadro’s principle.

That is:

Boyle’s law (at constant T, n)

Charles’ law (at constant P, n)

Avogadro’s law (at constant T, P)

These three variables can be joined together as follows:

OR

where ‘R’ is the constant known as the ***molar ideal gas constant.***

The equation can be written as

This equation is called ***ideal gas law*** or ***idea gas equation.***

**Numerical value and unit of R**

From the ideal gas equation;

Recall the standard pressure = 1atm, standard temperature = 273K

Volume of 1mole of ideal gas at s.t.p is 22.4dm3. Calculating the value of R in 1mole of an ideal gas at s.t.p.,

**WORKED EXAMPLES**

1. A sample of an ideal gas consists of 0.176mol and occupies 8.64dm3 at a pressure of 0.432atm. What is the temperature?

***Solution***

n =0.176mol

V = 8.64dm3

P = 0.432atm

R = 0.0821dm3.atm.K-1.mol-1

If:

1. none of the variables has 2 values
2. number of moles is given or there is a way of calculating it,

then, we will use ideal gas equation.

or 258.31 – 273 = -14.69oC

***Note:***

If you check the unit of R, you discover that we have atm, dm3, K-1 and mol-1. This means that when you are calculating with the ideal gas equation, the pressure must be in atm, the volume must be in dm3 and temperature must be in Kelvin. You may decide to convert the unit afterwards.

1. A sample of oxygen gas has a mass of 5.00g and is contained in a flask with a capacity of 6.0dm3 at 35oC. Assuming ideal behaviour for the oxygen gas, calculate the pressure of the gas in mmHg.

***Solution***

m = 5.00g

V = 6.0dm3

T = 35oC = 35 + 273 = 308K

Atomic mas of oxygen = 16

Number of moles is not given but we can get it with the formula:

Where m = mass, M = molar mass, n = number of moles.

Oxygen exists as molecules. That is O2

Molecular mass of oxygen

PV = nRT

P = 0.6585atm

Because of the unit of R, that of P is I atm. But the question said “calculate pressure in mmHg, so we need to convert to mmHg

1atm = 760mmHg

1. 4.0moles of an ideal gas at a temperature -33oC exerts a pressure of 5atm. What will be its volume in dm3?

***Solution***

n = 4.0mol

T = -33oC = -33 + 273 = 240K

P = 5atm

V = ?

PV = nRT

1. Calculate the volume occupied by 0.125mole of oxygen at 27oC and pressure of

***Solution***

n = 0.125mol

T = 27oC = 27 + 273 = 300K

P =

V = ?

PV = nRT

***Assignment***

1. 7.5g of nitrogen gas occupies 6500cm3 at 25oC. What is the pressure of the gas?
2. A 2litre bulb contains **n** moles of nitrogen at 0.5atm pressure at **T** K. On addition of 0.01mole of oxygen, it is necessary to cool the bulb to a temperature of 10oC in order to maintain the same pressure. Calculate **n** and **T.**