NAME

SECOND TERM E-LEARNING NOTES

SUBJECT: CHEMISTRY **CLASS: SS1**

SCHEME OF WORK

WEEK **TOPIC**

1. **Revision of last terms work**

2. **Gaseous state and gas laws:** State of matter, kinetic theory of gases, applications of kinetic theory of gases, and phenomena to illustrate kinetic theory of matter

3. **Gaseous state and gas laws:** Boyle's laws, Charles' law, general gas law and ideal gas law

4. **Gaseous state and gas laws:** Gay- Lussac's Law and Avogadro's Law, Graham's law of diffusion, Molar volume of gases- Avogadro number and the mole, concept, Dalton's law of partial pressure

5. **Standard Separation Techniques for mixtures:** compound and mixture, separating a mixture of two solids, separating a mixture of an insoluble solid and a Liquid, separating a soluble solid from a liquid

6. **Standard Separation Techniques for mixtures:** separating a soluble Solid from a liquid, separating a mixture of two or more liquids, Chromatography

7. **Mid – term break and holiday assignment**

8. **Standard Separation Techniques for mixtures:** Floatation, Frostation (Froth flotation), Pure and impure substances, Test for purity

9. **Revision**

10. **Examination**

REFERENCE TEXTS:

1 .Comprehensive Certificate Chemistry for Senior Secondary Schools by G N C Ohia et al

2. New School Chemistry for Senior Secondary Schools by Osei Yaw Ababio

3. Chemistry for Senior Secondary Schools 1 by Magbagbeola O, et al; Melrose Books and Publishers

4. Revised edition understanding chemistry for schools and colleges by Godwin O. Ojokuku.

WEEK 1

1. Revision of last terms work

WEEK 2

CONTENTS:

1. State of matter,

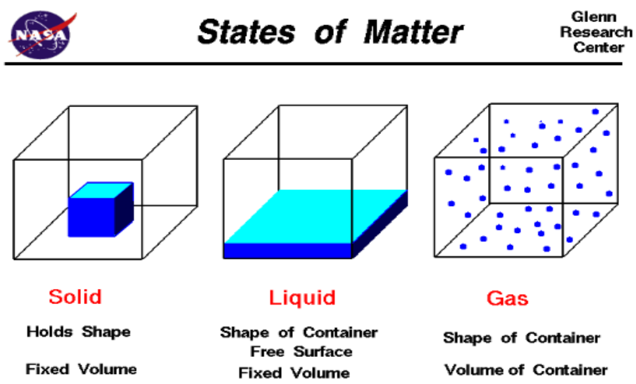
2. Kinetic theory of gases,

3. Applications of kinetic theory of gases

4. Phenomena to illustrate kinetic theory of matter

PERIOD 1: STATE OF MATTER

Matter is made up of very tiny particles such as atoms, molecules and ions. Matter exists in three physical states namely; solid, liquid and gas. Matter has mass and occupies space.



(i) Solid: The tiny particles in solid are packed very closely together hence they cannot move about. The presence of forces of attraction among the tiny particles of solid made them to be very closely packed together and allowing only vibration among them instead of moving about. This is what makes the solid to have a fixed shape and volume with high density. However, at high temperature, the molecules gain more energy and break the forces of attraction among the particles thereby causing the particles to move faster. As the temperature increases more and more, the solid melts and turns to liquid. Therefore, solid have fixed shape and volume, incompressible and very dense with the least kinetic energy when compared with those of liquid and gasses.

(ii) **Liquid:** The particles in the liquid are slightly further a [art than those in a solid and there exist among them weaker forces of attraction (weaker force of cohesion); thus allowing them to vibrate rotate and move about. Liquid have fixed volume and a fixed shape but takes the shape of its container. When the liquid is heated, its temperature increases, the forces of cohesion / attraction becomes progressively weaker. Eventually, a stage is reached when the molecules acquire enough energy to escape as a gas. The temperature at which this occurs is called the boiling point of the liquid. Therefore, the liquid have fixed volume, no fixed shape, less dense and incompressible with kinetic energy relatively higher than those of solid state.

(iii) Gas: The particles in the gaseous state are very freely with large distances between them. The particles of gases have no fixed volume and shape, compressible and least dense with the highest kinetic energy when compared with particles of other states of matter.

EVLUATION

1. Define the term matter.
2. Enumerate the three main state of matter.
3. Explain each of the states.

PERIOD 2: KINETIC THOERY OF GASES

EXPLANATION OF KINETIC THEORY

The kinetic theory of matter postulates that the tiny Particles of matter are continually moving and so possess kinetic energy. An increase in temperature causes an increase in the average kinetic energy of the particle.

Dalton's experimental evidence shows that chemical compounds consists of molecules, which are groups of atoms of various elements. The gas laws which explained the physical behaviour of gases can be explained by kinetic theory of gases. This theory describes the behaviour of an ideal or perfect gas. This is to say that the kinetic theory of gases explains quantitatively the properties of gas molecules and in so doing put up the following assumptions.

1. A gas consists of very tiny particles (usually molecules and atoms).
2. The cohesive forces of the gas molecules are negligible.
3. These particles are in constant random and rapid motion in straight lines.
4. As a result of these movements, collisions occur between the molecules and also with the walls of the container, hence the molecules exert pressure. No energy is lost when collision occupy. This means that the collisions are perfectly elastic.
5. The space between the molecules is very large compared to the size of the molecules. The molecules therefore have negligible (almost zero) volume compared to the volume of the container.
6. The average kinetic energy per molecule is the same for all gas samples at any given temperature. The absolute temperature of the gas is a measure of the average kinetic energy of the gas particles.

EVALUATION

1. The kinetic theory of matter postulates ……………………..
2. When the temperature of the particles of the molecules increases, what happens to kinetic energy?
3. Enumerate the six assumptions if the kinetic theory of matter.

PERIOD 3: THE APPLICATION OF KINETIC THEORY

The kinetic theory is useful in several respects and such aspects includes;

1. It provides reasonable explanations for the behaviour of gas.
2. It accounts for the gas laws
3. It explains important phenomenon such as diffusion
4. It provides a fundamental equation for gases.

$$PV = \frac{1}{3} NMC^2$$

EVALUATION

1. Mention four applications of kinetic theory of matter.

PERIOD 4: PHENOMENA TO ILLUSTRATE THE KINETIC THEORY OF MATTER

The following phenomena illustrate the kinetic theory of matter

1. Dispersion

2. Evaporation

3. Diffusion:

4. Brownian motion

5. Osmosis

6. Tyndall effect

7. Effusion

GENERAL EVALUATION

OBJECTIVE TEST:

1. The kinetic theory of matter states ____________
2. Water (H_2O) exists as a solid, liquid and gas respectively because: (a) water is colorless. (b) water is electrovalent (c) Water in any state possesses a certain degree of motion in the molecules (d) water is molecular
3. Which of the three states of matter has no fixed volume and least dense? (a) Gas (b) Solid (c) Liquid
4. The presence of sodium chloride in ice will. (a) Decrease or lower the boiling point of sodium chloride (b) Increase the melting point of sodium chloride (c) Make sodium chloride impure (d) Lower the freezing point of sodium chloride.
5. The escape of molecules with more than average kinetic energy of the molecules is called _____________ (A) Melting (b) Freezing (C) Evaporation (d) Efflorescence

ESSAY QUESTION:

1. Define the term matter.
2. State the three state of matter.
3. Explain two out of the three main sate of matter.
4. List four importance of kinetic theory.

5. Give assumptions of kinetic theory of matter.

WEEKEND ASSIGNMENT:

Read New School Chemistry for Senior Secondary Schools, by Osei Yaw Ababio pages 584-594

PRE- READING ASSIGNMENT

Read the meaning of chemical industry and its development.

WEEKEND ACTIVITY

Explain with at least three points what you understand by chemical industry and also mention specifically five types of chemical industry.

REFERENCE TEXT:

1. New School Chemistry for senior Secondary Schools by Osei Yaw Ababio 6th edition
2. Comprehensive certificate chemistry by G.N.C Ohia, G.I, Amasiatiu, J.O Ajagbe =, G.O. Ojokuku and U Mohammed. 2nd Edition

WEEK 3

TOPIC: GASEOUS STATE AND GAS LAWS

CONTENTS:

I. Boyle's law

2. Charles' law

3. General gas law

4. Ideal gas law

PERIOD 1: BOYLE'S LAW

The relationship between volume and pressure of a gas was first started by Robert Boyle in 1662.

Boyle's law states that *the volume of a given mass of gas is inversely proportional to its pressure, provided that the temperature remains constant.*

According to Boyle's law, volume of a gas increases as the pressure decreases and vice versa.

This relationship is independent of the nature of the gas and it can be expressed mathematically as:

$V \propto \frac{1}{P}$

$\therefore\ V = \frac{k}{p}$

Or PV =k

Where V= volume at pressure P

K = a mathematical constant

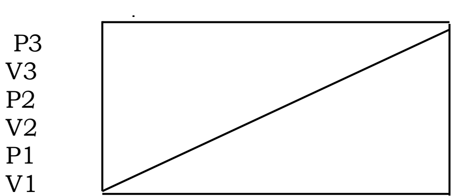
For a given mass of a gas, the product of its pressure and its volume is always a constant. If the pressure of a given mass of gas increases, its volume will decrease by a similar proportion and vice versa, as long as the temperature remain constant. This relationship can also be expressed mathematically as:

$P_1V_1 = P_2\ V_2$

Where V_1 = volume at pressure P_1

V_2= Volume at pressure P_2

Boyle's law can still be re-stated as: 'The pressure of a given mass of gas is inversely proportional to its volume, provided the temperature remains constant. Boyle's law can further be illustrated with the diagram below, showing that when P is increasing, V is decreasing and when P is decreasing, V is increasing.



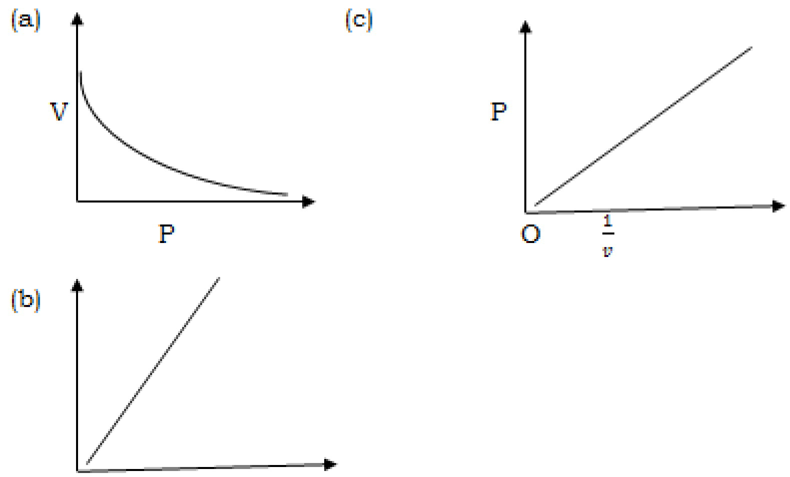
P_1 = Initial pressure

P_2= Final pressure

V_1=Initial volume

V_2= final volume

Graphical representation of Boyle's law



Worked examples

1. 375cm^3 of a gas has a pressure of 770mmHg. Find its volume if the pressure e is reduced to 750mmHg.

$P_1V_1 = P_2V_2$ (Boyle's law)
$P_1 = 770$mmHg
$P_2 = 750$mmHg
V_1=375cm3
V2 =? (new volume of gas)
$P_1V_1 = P_2 V_2$
$V_2 = \frac{P1\,V1}{P2} = \frac{770 \times 375}{750} = 385cm^3$
The new volume will be 385cm^3

2. 100cm^3 of a gas has pressure of 1 atmosphere. Determine the volume of the gas at 5 atmospheres keeping the temperature constant.

Solution: since T is constant, we are to use Boyle's law.

$P_1 \rightarrow$ Initial pressure = 1 atmosphere
$P_1 \rightarrow$Final pressure= 5
$V_1 \rightarrow$ Initial volume= 100cm^3
V2 $\rightarrow$ (required quantity)
Recall: V2 = $P_1V_1 = P_2V_2$
$V_2 = \frac{P1\,V1}{P2} = \frac{100 \times 1}{5} = 20cm^3$

EVALUATION:

1. A given quantity of gas occupies a volume of $228cm^3$ at a pressure of 750mmHg. What will be its at atmospheric pressure if temperature is kept constant?

2. A given mass of gas at 55^0C has a pressure of $3.6 \times 10^4 Nm^{-2}$ and occupies a volume of 1.8dm3. What volume will it occupy if its pressure is increased to $4.8 \times 10^4 Nm^{-2}$ if the temperature is kept constant?

PERIOD 2: CHARLES' LAW

The effect of temperature changes on the volume of a given mass of a gas at a constant pressure is described by Charles. **Charles' law states that t***he volume of a given mass of gas is directly proportional to its temperature in Kelvin, provided that pressure remains constant.*

The volume of the gas decreases as the temperature decreases, and increases as the temperature increases.

Mathematically, the law can be expressed as:

$V \propto T$

$\therefore$ V = kT

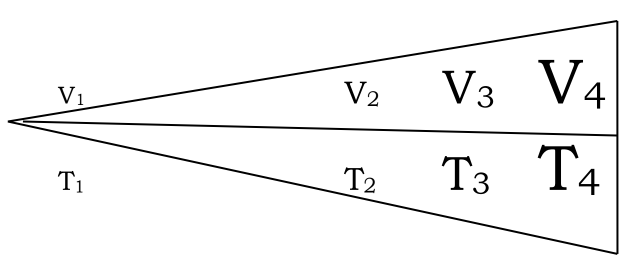
Or $\frac{V}{T}$ = k

Where v= volume

T= Kelvin Temperature

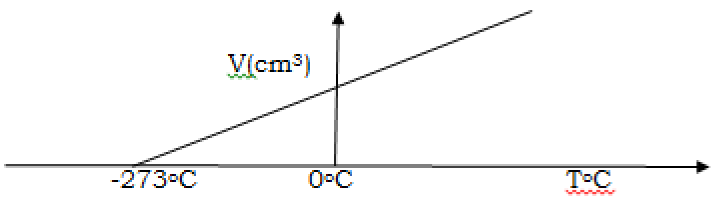
K= mathematical constant

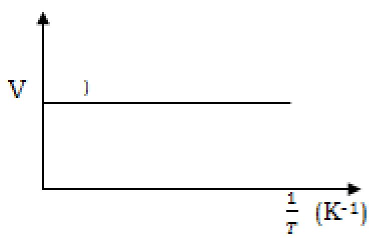
A Representation of Charles's law

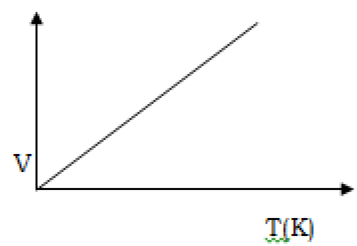


For a direct relationship, when the temperature increases, the volume will also increase at the same rate and vice versa, at constant pressure .The diagram above shows that when V is decreasing, T is also decreasing and when V is increasing, T is also increasing thus, making the quotient constant.

Charles's law can be represented graphically has shown below.







If we divide the varying gas volumes by the corresponding temperature in Kelvin, the result would always be a constant. This relationship can also be expressed in another form.

$\frac{V1}{T1} = \frac{V2}{T2} \therefore V_2 = \frac{T2\,V1}{T1}$

Where V_1 is the volume at temperature T_1

V_2 is the volume at temperature T_2

ABSOLUTE ZERO

This is the temperature at which the volume of a gas is theoretically zero..At this temperature there is no motiom of any form and all gases have been liquefied or solidified. The value of the temperature is -273^0C.

TEMPERATURE CONVERSION

1. To convert from Celsius scale to Kelvin scale, add 273 i.e. T= ^0C + 273. This is because O^{0}C=273K.

2. To convert from Kelvin scale to Celsius scale, subtract 273. i.e

^0C= T- 273.
Where T= Temperature in Kevin
^0C= Temperature in Celsius.

Examples:

1. Convert the following Celsius temperature to Kelvin temperature.

(a) 100^{0}C (b) 0^{0}C (c) -570C

Solution

Recall: T= 0C + 273

(a) 100^{0}C= (100 + 273) = 373k

0C=(0 + 273) = (0 + 273) = 373k

(b) -57^{0}c = (- 57 + 273)k = (273-57)= 216k

2. Convert the following Kelvin temperatures to Celsius temperature.

(a) 298k (b) 405k (b) 285k (d) 0k

Solution

Recall 0^{0}c = k – 273

298k = (298 – 273)^{0}C= 25^{0}C

405k = (405 – 273)^{0}C = 12^{0}C

0k = (0 – 273)^{0}C = - 273^{0}C

Worked examples on Charles's law

1. A gas occupies a volume of 20.0dm^3 at 373k. Its volume at 746k at that pressure will be?

Here pressure is constant. Charles's law will apply.

V_1=20.0dm^3

$T_1 = 273k$

$T_2 = 746$

$V_2 = ?$

Recall Charles's law = $\frac{V1}{T1} = \frac{V2}{T2} V_2 = \frac{V1\,T2}{T1} V_2 = \frac{20 \times 746}{273} = 40.0 dm^3$

EVALUATION:

1. State Charles's law

2. Express the two laws mathematically

3. Draw two graphs to illustrate Charles' law.

PERIOD 3: GENERAL GAS LAW

From the gas laws, we know that the volume of a gas depends on both its temperature and pressure. The relationship between the three variable; i.e. volume,, temperature and pressure can be summarized up as follows:

If V $\propto \frac{1}{P}$ (Boyle's law at constant temperature) and V $\propto$ T (Charle's law at constant pressure)

V $\propto \frac{1}{P} \times$ T (both temperature and pressure may vary) or $\frac{PV}{T}$ = K (a mathematical constant for a fixed mass of gas)

$\frac{PV}{T}$ =k is often known as the general gas equation.

GENERAL GAS EQUATION

General gas equation states that *for fixed mass of a gas under any set of conditions of V, P and T, the value of* $\frac{PV}{T}$ *must remain constant.* If for a fixed mass of gas V_1 is the volume at pressure

P_1 and absolute temperature T_1 and V_2 is the volume at pressure P2 and absolute temperature T2 it follows that.

$\frac{P1V1}{T} = \frac{P2V2}{T2}$

The general gas equation can be used to find the volume of a gas when both its pressure and temperature change. Thus;

$V_2 = \frac{P1\ V1\ T2}{P2\ V2}$

The standard temperature and pressure

The value of gases are sometimes given in standard temperature and pressure (S. T. P). These values are standard temperature= 273k and standard pressure = 760mmHg. The S.I unit of standard pressure when used is $1.01 \times 10^3 Nm^{-2}$

Examples

1. At S. T. P a certain mass of gas occupies a volume of $790cm^3$, find the temperature at which the gas occupies 1000cm3 and has a presence of 720mmHg

$$\frac{P1V1}{T1} = \frac{P2V2}{T2}$$

P_1 = 760mmHg (at stp), $V_{1=}$ $790cm^3$

T_1 = 273k (at stp), $V2$ = $1000cm^3$

P_2 = 726mmHg

T_2 = New Temperature

$\therefore T_2 = \frac{P2\ V2\ T1}{P1\ V1}$

$= \frac{720 \times 1000 \times 273}{760 \times 790}$ = 330.1k

The new temperature of the gas is 330.1k

2. A given mass of gas occupies $850cm^3$at 320k and $0.92 \times 10^3 Nm^{-2}$

of pressure. Calculate the volume of the gas at S.T.P.

$$\frac{P1V1}{T1} = \frac{P2V2}{T2}$$

P_1= $0.92 \times 10^3 Nm^{-2}$ T_1= 320k

V_1= $850cm^3$ P_2= SP + $1.01 \times 10^3 Nm^{-2}$

T_2= 273k (at stp)

V_2 = new volume of gas.

$\therefore V_2 = \frac{P1\,V1\,T2}{P2\,T1} = \frac{0.92 \times 850 \times 273}{1.01 \times 10^3 \times 320} = 660.5cm^3$

EVALUATION

1. Explain the general gas equation.

2. If the volume of a given mass of a gas at 298k and a pressure of 205.2 $\times 10^5 Nm^{-2}$ is $2.12dm^3$. What is the volume of the gas S.T.P (standard pressure= 1013 $\times 10^5 Nm^{-2}$, standard temperature = 273)

PERIOD 4: IDEAL GAS LAW

The ideal gas: This is a gas sample whose properties correspond, within experimental error, to the relationship PV =RT. An ideal gas must obey all the rules guiding Boyle's and Charles's laws. Ideal gas conforms to the kinetic theory of gases. Four quantities' are important in all experimental work, measurements or calculations involving gases. They are: (i) volume (ii) pressure (iii) temperature and (iv) numbers of moles

Ideal gas equation is given by PV = nRT

The value of R for one mole of a gas at 273K, 1atm and volume $22.4dm^3$ is $0.0821atmdm^3K^{-1}mol^{-1}$ or $8.314JK^{-1}mol^{-1}$

Examples:

1. Calculate the volume occupied by 2.5moles of an ideal gas at -23°C and 4.0atm. (R = $0.0821atmdm^3K^{-1}mol^{-1}$)

Solution:

Using PV = nRT where P = 4.0atm n = 2.5 mole T = -23+273 = 250K

Hence, $V = \frac{nRT}{P} = \frac{2.5X0.0821X250}{4}$

$= 12.8dm^3$

NOTE: Pressure can also be measured in other units. 760mmHg = 1atm = $101325Nm^{-2}$

Ideal gases only exist at experimental conditions of high pressure and low temperature. Basically all gases are real

REASONS WHY REAL GASES DEVIATE FROM IDEAL GAS BEHAVIOUR

1. The forces of attraction in real gases are not negligible.

2. The volume of real gases are not negligible. Hence, real gases have their own volume called excluded volume.

3. Real gases undergo inelastic collision

EVALUATION:

1. What is an ideal gas?

2. Write down the ideal gas equation for n-mole of a gas.

GENERAL EVALUATION

OBJECTIVE TEST

1. A gas occupies $30.0dm^3$ at S.T.P. What volume will occupy at 91^0C and $52662.5Nm^{-2}$. (a) $20.0dm^3$ (b) $40.0dm^3$ (c) $60.0dm^3$ (d) $76.96dm^3$

2. Gases can be easily compressed because. (a) the molecule are relatively far apart (b) the molecule are quite close together (c) the molecule are very soft (d) the molecules are in constant, rapid motion

3. A give mass of gas occupies X_1cm^3 at Y_1K. When the temperature is changed to Y_2K, the volume becomes X_2cm^3, the pressure remaining constant. Which of the following equations correctly express the relationship between $X_1X_2Y_1$andY_2? (a) $X_1Y_1 = X_2Y_2$ (b) $\frac{X1}{Y1} = \frac{X2}{Y2}$ (c) $X_1X_2 = X_1 Y_2$ (d) $X_1 = X_2Y_1Y_2$

4. Kelvin temperature can be converted into Celsius temperature by. (a) $^oC= K - 273$ (b) k + 273 (c) $\frac{0C+273}{k}$ (d) $\frac{k+273}{0C}$

5. What will be the new volume (v) if the new pressure is halved and the initial pressure remain the same. (a) $2p_1 V_1 = p_2 V_2$ (b) $p_1 V_1 = 2p_2 V_2$ (c) $\frac{P1\,V1}{2} = \frac{P2\,V2}{2}$ (d) $p_1 V_1 = \frac{P2\,V2}{2}$

ESSAY QUESTIONS

1. $130cm^3$ of a gas at 20^0C exert a pressure of 750mmHg. Calculate its volume is increased to $150cm^3$ at 35^0C

2. Draw the graphical representation of both Boyle's and Charles' law respectively.

3. Convert the following temperature to K. (a) 15^0C (b)275^0C (c) 88^0C

4. The volume of gas at 25^0C (298k) is $100cm^3$. What will be the volume at (a.) 75^0C (348k) (b). 50^0C (223)k, pressure remaining constant?

WEEKEND ASSIGNMENT:

Read about Graham's law, Avogadro's number and the mole concept.

WEEK 4

TOPIC: GASEOUS STATE AND GAS LAWS

CONTENTS:

1. Gay- Lussac's Law and Avogadro's Law.
2. Graham's law of diffusion.
3. Molar volume of gases- Avogadro number and the mole concept.
4. Dalton's law of partial pressure.

PERIOD 1: GAY- LUSSAC'S LAW AND AVOGADRO'S LAW

Gay- Lussac's law describes the combining volumes of gases that react together. In his experiment, all temperatures and pressures were kept constant:

A. STEAM: Gay- Lussac's observed that two volumes of hydrogen reacted with one volume of oxygen to yield two volumes of steam

	$2H_{2(g)}$ +	$O_{2(g)}$	$\longrightarrow$ $2H_2O_{(g)}$
Volume	2 :	1	2
Ratio	2 :	1	2

B. HYDROGEN CHLORIDE GAS: One volume of hydrogen combined with one volume of chloride to yield two volumes of hydrogen.

Hydrogen + Chlorine → Hydrogen Chloride

i.e. $H_{2(g)}$ + $Cl_{2(g)}$ → $2HCl_{(g)}$

Volume= 1 : 1 2

Ratio = 1 : 1 2

C. Carbon (ii) oxide + Oxygen + Carbon (IV) oxide

$2CO_{(g)}$ + $O_{2(g)}$ → $2CO_{2(g)}$

Ratio 2 : 1 : 2

Gay- Lussac's noticed that the combining volumes as well as the volumes of the products, if gaseous, were related by simple ratios of whole numbers. He proposed the law of combining volume or gaseous volumes.

Hence; **Gay- Lussac's law combining volumes states that** *when gases react, they do so in volumes which are in simple ratios to one another and to the volumes of the products, if gaseous provide that the temperature and the pressure remain constant.*

EXAMPLES

1. What is the volume of oxygen required to burn completely $45cm^3$ of methane (CH_4)?

Equation of reaction:

$CH_4(g) + 2O_{2(g)} \rightarrow CO_{2(g)} + 2HO_{2(g)}$

Vol: 1 2 1 2

Ratio: 1 2 1 2

By Gay- Lussac's Law:

1 volume of methane required 2 volumes of oxygen i.e.

$1cm^3$ of methane requires $2cm^3$ of oxygen

∴ $45cm^3$ of methane require $90cm^3$ *of oxygen*

2. $20cm^3$ of carbon(I) oxide are sparked with $20cm^3$ of oxygen. If all the volumes of gases are measured at a S.T.P, calculate the volume of the residual gases after sparking?

Equation of reaction	$2CO_g$ +	O_{2g}	$\longrightarrow$	$2Co_{2g}$
Combining volume	2 :	1	:	2
Volumes before sparking	$20cm^3$	$10cm^3$,		$20cm^3$
Volumes after sparking	-10	20		

Residual gases = un-reacted oxygen + carbon (IV) oxide formed

Volume of residual gas = $10cm^3$+ $20cm^3$= $30cm^3$

AVOGADRO'S LAW

Avogadro's Law states that *equal volumes of all gases at the same temperature and pressure contain the same number of molecules.*

This law means that for all of gases e.g. oxygen, hydrogen, Chlorine etc if their volumes are the same, they will have the same number of molecules.

Avogadro's Law is easily applied to convert volume of gases to the number of molecules. Avogadro's Law can be used to solve problem under Gay – Lussac's law of combining volumes.

The formation of steam from reaction of Hydrogen and Oxygen is given below:

Reaction: Hydrogen + Oxygen → Steam

Volume: 2 1 2

Gay –Lussac's: 2 : 1 : 2

Avogadro's Law: 2 : 1 : 2

This agrees with the equation below:

$2H_{2(g)}$ + $O_{2(s)}$ $\longrightarrow$ $2H_2O(s)$

i.e 2 molecules of hydrogen combine with 1 molecule of oxygen to produce 2 molecules of steam

Example:

1. $60cm^3$of hydrogen are sparked with $20cm^3$ of oxygen at 100^0C and 1 atmosphere. What is the volume of the steam produced?

Solution

$2H_2$ + O_2 $\longrightarrow$ $2H_2O$

From the equation, 2 molecules of hydrogen react with 1 molecule of oxygen to produce 2 molecules of steam.

$2H_2 + O_2 \longrightarrow 2H_2O$

2 vol 1vol ⟶ 2 vol (combining volumes)

i.e. $2cm^3$ $1cm^3$ $2cm^3$

From the above information, when $2cm^3$(2 vol) of H_2 react, $1cm^3$(1 vol) of O_2will react i.e. half of H_2vol, to give $2cm^3$(2 vol) of H_2O.

Thus, $10cm^3$ of H_2 will react with 5 cm^3 of O_2 to produce $10cm^3$ of H_2O and so on.

From the question, we have $60cm^3$of H_2 and $20cm^3$ of O_2, thus, when all the $20cm^3$ of O_2react, only $40cm^3$ ofH_2 will react to give $40cm^3$ of H_2O,because the volume of H_2 is the same as that of H_2O i.e.

$2H_2 + O_2 \longrightarrow 2H_2O$

2 vol 1 vol ⟶ 2 vol

$2cm^3$ $1cm^3$ $2cm^3$

$40cm^3$ $20cm^3$ $40cm^3$

Thus, the volume of steam (H_2O) formed is $40cm^3$

2. What volume of propane is left unreacted when $80cm^3$ of oxygen and $20cm^3$ of propane react according to the equation below?

$C_3H_{8(g)} + 5O_{2(g)} \longrightarrow 3CO_{2(g)} + 4H_2O$

Solution

$C_3H_{8(g)} + 5O_{2(g)} \longrightarrow 3CO_{2(g)} + 4H_2O$

1vols 5vols

$1cm^3$ $5cm^3$

$4cm^3$ $20cm^3$

Volume of the propane before the reaction $=20cm^3$

The volume that reacted $=4cm^3$

Volume that did not react= volume before

Reaction – volume that reacted i.e. 20 – 4 $=16cm^3$

EVALUATION

1. State Gay –Lussac's law

2. State Avogadro's law.

3. $50cm^3$ of methane were burnt completely in oxygen according to the equation below.

$$CH_4 + 2O_2 \longrightarrow Co_2 + 2H_2O$$

Calculate: (a) volume of oxygen used (b) Volume of carbon(Iv) oxide produced

(c) Volume of steam produced.

WEEKEND ACTIVITY:

(a) Define Graham's law of diffusion.(b) What is mole and mole concept?

PERIOD 2: GRAHAM'S LAW OF DIFFUSION.

This law states that, *at constant temperature and pressure, the rate of diffusion of a gas is inversely proportional to the square root of its relative molecular mass or square root of its vapour density.*
Mathematically, Graham's law of diffusion can be represented as:

$\frac{R1}{R2} \propto \sqrt{\frac{p2}{p1}}$ Where R_1 and R_2 are the rates of diffusion and P1 and P2, the densities of the two gases.

The density is directly proportional to its molecular mass.

EXAMPLES

1. 100$cm^3$of oxygen diffuse through an office in 60 seconds while it takes 120seconds for the same office. Calculate the molecular mass of the unknown gas [0=16]

Solution

$\frac{R}{Rx}O_2 = \frac{Mx}{MO2}$

Since the rate of diffusion is inversely proportional to the time taken:

$\frac{R}{Rx}O_2 = =\frac{tx}{tO2} = \sqrt{\frac{Mx}{MO2}}$

$(\frac{tx}{tO2}) = \frac{Mx}{MO2}$

$M_x = MO_2 \times (\frac{tx}{tO2})^2 = 32 \times (\frac{120}{60})^2 = 32 \times 2^2$

Mx = 32 × 4 = 128g

2. 200$cm^3$of hydrogen diffused through a porous pot in 40 seconds. How long will it take 300$cm^3$of chlorine to diffuse through the same pot?

Solution

200$cm^3$of hydrogen diffused in 40secs

∴ 300cm^3 of chlorine will diffuse in

$\frac{3\cancel{00}cm^3}{2\cancel{00}cm^3} \times \cancel{40}20$

$(3 \times 20) = 60$seconds

Now, using the equation

$\frac{t1}{t2} = \sqrt{\frac{M1}{M2}}$

Where t= 60s, M_1 = molecular mass of hydrogen

i.e H_2= (2 ×1) =2

M2= molecular mass of chlorine = cl_2 =2× 35.5 = 71

$T_2 = t1\sqrt{\frac{M1}{M2}} = 60\sqrt{\frac{71}{2}} = 60\ \sqrt{35.5} = 60 \times 5.96$

= 357.5sec

Time of diffusion of chlorine = 358s.

3. How many times the rate of diffusion of hydrogen is faster than that of oxygen and what law do you use to get the answer? [vapour density] of [H=1, O=16]

Solution

Rate (R+) of diffusion of H_2=

$$\sqrt{\frac{Density\ of\ O_2}{Density\ of\ H_2}}$$

$\frac{R1}{R2} = \sqrt{\frac{16}{1}} = \frac{R1}{R2} = \frac{4}{1}$

∴Hydrogen diffuses four times faster. The law used is Graham's law of diffusion.

RELATIVE VAPOUR DENSITY OF A GASE

The vapour density of a gas or vapour is the number of times a given volume of gas (or vapour) is heavier than the same volume of hydrogen measured and weighed under the same temperature and pressure

Vapour density = $\frac{mass\ of\ 1\ vol\ of\ a\ gas\ or\ vapour}{mass\ of\ equal\ volume\ of\ hydrogen}$

Applying Avogadro's law, it is possible to show that the vapour density of a gas is related to the relative molecular mass of the gas.

V.D= $\frac{mass\ of\ 1\ mole\ of\ a\ gas\ or\ vapour}{mass\ of\ 1\ molecule\ \ of\ hydrogen}$

V.D = $\frac{mass\ of\ 1\ vol\ of\ a\ gas}{mass\ of\ 2\ atoms\ of\ hydrogen}$

∴2 x V.D =relative molecular mass

The density of hydrogen at S.T.P is 0.09dm^3

Example

Calculate the vapour densities of the following gases from the given data.

1. 560cm^3 of oxygen at S.T.P weighs 0.8g
2. 1,400cm^3 of sulphur (iv) oxide weighs 4g

Solution

1. 1000m^3 of hydrogen at S.T.P weighs 0.09g

∴ 560cm^3 of hydrogen at $\frac{560cm^3}{100cm^3}\times$ 0.09

$= 0.05$g

V.D= $\frac{massofagivenvolumeofgas}{massofeequalvolumeofhydrogen}$

∴Vapour density of oxygen=

$$\frac{mass\ of\ \ 560\ of\ oxygen}{mass\ of\ 560\ of\ hydrogen}$$

2. $1000cm^3$ of hydrogen at S.T.P weighs 0.09g.

∴ 1400 of hydrogen will weighs

$\frac{1400\ \times 0.09}{1000}$= 0.126g

Vapour density= $\frac{massofagivenvolumeofgas}{massofeequalvolumeofhydrogen}$

∴Vapour density of SO_2= $\frac{mass\ of\ \ 1400cm^3\ of\ \ SO2}{mass\ of\ 1400cm^3 of\ H_2}$

= $\frac{4g}{0.126}$= 31.74= 32

EVALUATION

1. Deduce the relationship between relative molecular mass and vapour density of a substance.
2. Define vapour density of a gas.

PERIOD 3: MOLAR VOLUME OF GASES- AVOGADRO NUMBER AND THE MOLE CONCEPT

The molar volume of any gas is the volume occupied by one mole of that gas at s.t.p. and is numerically equally to $22.4dm^3$ i.e. one mole of any gas at s.t.p. occupies the same volume the value of which is $22.4dm^3$. This value is called molecular mass or molar mass.

From the Avogadro's law, the molar volume for all gases contains the same number of molecules. This number is called the Avogadro's number or constant and the value is 6.02×10^{23} at s.t.p

MOLE: The mole can be defined as the amount of substance which contain as many elementary particles or entities e.g. ions, molecules, atoms, electrons as the number of atoms in exactly 12 grams of carbon -12.

The mole of any substance represents 6.02×10^{23} particles of any substance. Therefore, a mole refers to Avogadro's number of particles of any substance.

In summary, the molar mass of a gas contains Avogadro's number of molecules which is 6.02×10^{23} and occupies a volume of $22.4dm^3$ at s.t.p.

The atomic mass of every element also contains Avogadro's number of atoms.

The mole concept- This says that one mole of any substance contains the same number of particles; which can be atoms, molecules or ions. This number is $6.023 \times 10^{23}dm^3$ (the Avogadro's number)

Examples

1.158g of a gas at s.t.p. occupies a volume of $5000dm^3$. What is the relative molecular masss of the gas? (Molar volume at s.t.p= $22.4dm^3$ mol^{-1}

Solution

Volume of gas: V = $50.00dm^3$

Molar volume of gas; V = $22.4dm^3$ mol^{-1}

N= amount in moles

$=\frac{V}{V}$

N= $\frac{50}{22.4dm^{3mol-1}}$= 2.23mol

Molar mass M of the gas = $\frac{M}{n}$ = $\frac{158g}{22.4dm^3\ \text{mol}-1}$ = 70.8

Molar mass = 71 $gmol^{-1}$

2. What is the mass of 3 moles of oxygen gas O_2? (O = 16)

Mass of 1 mole of O_2= (2× 16)g =32g

Mass of 3moles of O_2= (3 × 32)g = 96g

3. How Many moles are there in 20g of $CaCO_3$? [$CaCO_3$ =100]

Molar mass of $CaCO_3$= 100g

100g of $CaCO_3$= 1 mole

20g of $CaCO_3$ = $\frac{20}{100}$ ×1mole = 0.2moles

EVALUATION

1. Using the relationship between mole and Avogadro's number. Define mole in six ways.

PERIOD 4: DALTON'S LAW OF PARTIAL PRESSURE

Dalton's law of partial pressure states that for a mixture of gases that do not react chemically, the total pressure exerted by the mixture of gases is equal to the sum of the partial pressures of the individual gases.

Mathematically, Dalton's law of partial pressure for a mixture of n gases can be expressed as:

$P_{total} = P_1 + P_2 + P_3 + ... + P_n$ where P_{total} is the total pressure exerted by the mixture of gases that dot not react, P_1, P_2, P_3......P_n are partial pressure of the individual gases.

Example:

If 20.0dm^3 of hydrogen were collected over water at 17^oC and 79.7kNm^{-2} pressure; Calculate the

(a) Pressure of dry hydrogen at this temperature.

(b) Volume of dry hydrogen at s.t.p.

(vapour pressure of water is 1.90 kNm^{-2} at 17^OC)

Solution:

(a) $P_{H2} = P_{total} - P_{water\ vapour}$

$= 79.7 - 1.90$

$= 77.8\ kNm^{-2}$

(b) $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

$$\frac{77.9X20}{290} = \frac{101.3V_2}{273}$$

$V_2 = 14.5dm^3$

GENERAL EVALUATION

OBJECTIVE TEST

1. A liquid begins to boil when (a) Its vapour pressure is equal to the vapour pressure of its solid at the given temperature (b) Molecules start escaping from its surface (c) Its vapour pressure equals the atmosphere pressure (d) Its volume is slightly increased.

2. Hydrogen diffuses through a porous plug (a) At the same rate as oxygen (b) Twice as fast as oxygen (c) Three times as fast as oxygen. (d) Four times as fast as oxygen

3. When pollen grains are suspended in water and viewed through a microscope, they appear to be in a state of constant but erratic motion. This is due to: (a) Convention current (b) small change in temperature (c) a chemical reaction between the pollen grains and the water (d) the bombardment of the pollen grain by molecules of water.

4. If the quantity of oxygen occupying a 2.76litre container at pressure of 0.825 atmosphere and 300k is reduced by one-half, what is the pressure exerted by the remaining gas? (a) 1.650atm (b) 0.825atm (c) 0.413atm (d) 0.275atm

5. 200$cm^3$of oxygen diffused through a porous plug in 50secs. How long will 80cm^3 of methane (CH_4) take to diffuse through the same porous plug under the same conditions (C= 12, O= 16, H=1) (a) 40sec (b) 20sec (c) 14sec (d) 7sec

ESSAY QUESTIONS

1(a) State Graham's law of diffusion

(a) Arrange the following gases in decreasing order of diffusion rate: Chlorine, hydrogen chloride, hydrogen sulphide and Carbon(IV) oxide
[H=1, C= 12, O=16, S= 32, Cl=35.5]

2.(a) What do you understand by s.t.p?

(b) If the volume of a given mass of gas at 298k and pressure of $205.2 \times 10^3\ Nm^{-2}$ is $2.12dm^3$, what is the volume at S.T.P? Standard pressure= $101.3 \times 10^3\ Nm$. Standard temperature= 273k

3. (a) Calculate the number of moles of the following at s.t.p

i. 16g of oxygen

ii. $67.2dm^3$ of nitrogen gas, and

iii. $1.14dm^3$ of hydrogen chloride gas.

O=16, H=14, N=1. Molar volume of gas at S.T.P = $22.4dm^3$

(b) (i) Convert 33℃ and -41℃ to Kelvin scale

(ii) Convert 270k and 315k to 0℃

PRE READING ASIGNMENT:

Read about standard separation techniques.

WEEKEND ACTIVITY:

List all the separation techniques that you know.

WEEK 5

TOPIC: STANDARD SEPERATION TECHNIQUES FOR MIXTURES

CONTENTS:

1. MIXTURES AND COMPOUNDS

2. SEPARATING A MIXTURE OF TWO SOLIDS

3. SEPARATING A MIXTURE OF AN INSOLUBLE SOLID AND A LIQUID,

4. SEPARATING A SOLUBLE SOLID FROM A LIQUID

PERIOD 1: COMPOUNDS AND MIXTURES

COMPOUND

A compound is a substance which contains two or more elements chemically combined together. A compound is formed as a result of a chemical change. It is a new substance with entirely different properties from those of substances from which it is formed. For example water is a compound of hydrogen and oxygen chemically combined in the ratio 2:1 by mass respectively. Other example of mass are sound, limestone, common salt, petrol, kerosene etc.

MIXTURE:

A mixture is made up of two or more substances which can be mixed together, mechanically, in any proportion. It can be said to contain two or more constituents which easily be separated by physical method. Examples are air, soil, well water, tap water, milk, sweat, blood etc.

DIFFERENCES BETWEEN COMPOUNDS AND MIXTURES

COMPOUNDS	**MIXTURES**
1. Constituents are present in a fixed proportion by mass	Constituents can be mixed in any proportion
2. Constituents are joined by chemical bonds	No chemical bond between constituents
3. It is always homogeneous	It may be homogeneous or heterogeneous
4**.**The properties differ entirely from those of its components elements	The properties are the sum of those of its individual constituents
5. Constituents of compounds cannot be separated by physical means	Components of mixtures can be separated by physical means

EVALUATION:

1. Define and give one example of (a) homogeneous mixture (b) heterogeneous mixture

2. Describe an experiment to show that sea water is a mixture.

3. Explain why air is regarded as a mixture

PERIOD 2: SEPARATING A MIXTURE OF TWO SOLIDS

They following methods are employed in the separation of a mixture of two solids:

1. Sieving

2. Magnetic separation

3. Sublimation

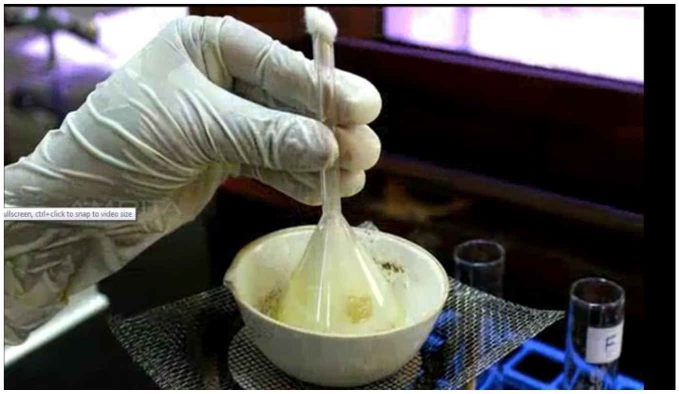
1. SIEVING: This is a method used to separate a mixture of two solids of different sizes. The mixture is placed on a sieve with a mesh of a particular size. Particles smaller than the mesh size of the sieve will pass through the sieve while the bigger particles remain on the sieve. Sieving method is applied in the mining industries, gari making industries etc.

2. Magnetic separation: To separate magnetic solids from non-magnetic ones. This method is used in the steel industry and to remove magnetic impurities from tin ore.

3. Sublimation: Solids which sublime are separated from other solids that sublime (i.e. they turn directly from solid to gas and ffrom gas to solid without turning to liquid) are

- Ammonium chloride
- Aluminum chloride
- Camphor
- Iodine crystals
- Solid CO_2 (dry ice)

Purification by sublimation



EVALUION

1. (a) Define sublimation (b) Give three examples that can sublime

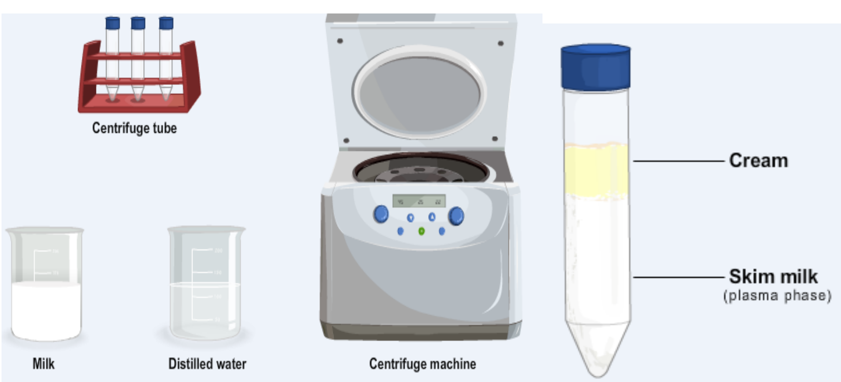
2. Give three applications of sieving as separation technique.

PERIOD 3: SEPARATING A MIXTURE OF AN INSOLUBLE SOLID AND A LIQUID.

1. DECANTATION: The mixture is allowed to stand for some time until it separates into two distinct layers and an upper clear liquid layer. The clear liquid can be carefully poured or decanted into a second container.

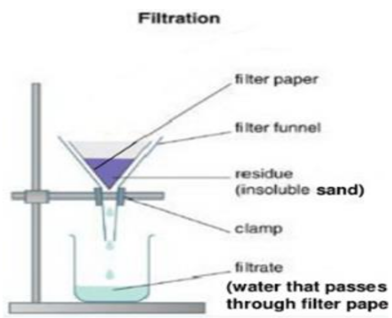
2. CENTRIFUGATION: This involves the use of a centrifuge to separate solid particles from a liquid as shown in the diagram below. As the centrifuge spins the mixture, the solids separates and settles at the bottom of the test tube while the liquids on the top layer can easily be decanted.

Centrifugation process



3. FILTRATION: As shown below, the mixture is poured into s porous material (filter paper) folded inside a funnel. The solid particle that remains inside the liquid that drips through the filter paper is known as the **filtrate**.

Filtration process



EVALUATION:

1. Explain briefly, how a mixture of sand and water can be separated.

2. Explain how plasm can be separated from blood.

PERIOD 4: SEPARATING A SOLUBLE SOLID FROM A LIQUID

1. Evaporation: Evaporation method is used to recover a solid solute from a solution in which it is soluble to give a solution. The method is suitable if the solid has a high melting point i.e. cannot be decomposed by heating.

Evaporation is based on the large different between the boiling points of the solid and solvent**.** For example common salt can be recovered from its aqueous solution by complete evaporation of water. The solvent (liquid) is usually sacrificed.

Evaporation process

Note: Evaporation method is not suitable for salts that can easily be destroyed by heating.

2. Crystallization: Crystallization is a method used to separate salts which decompose easily on heating from their solutions. The salt solution (the mixture) is heated to drive away some of the liquid (i.e. to evaporate some of the liquid) (i.e. to evaporate some of the liquid) until solution becomes concentrated or saturated. The concentrated solution remaining is allowed to cool slowly resulting in the formation of crystals. Crystal formation can be induced by (i) adding crystals of the same salt to serve as seed. (ii) Scratching the inside of the vessel containing the solution.

Note: If all the liquid is evaporated a powder will be obtained and not crystals. This powder might also contain impurities which otherwise would have remained in the solution and not contaminate the crystals. Many crystals formed on cooling saturated solution contain water which is chemically combined and loosely bonded to the crystals. This water is called **water of crystallization**. Salts which contain water of crystallization are said to be **hydrated**. Those which do not are **anhydrous**. Those are often powders.

EVALUATION:

1. Outline the processes involved in recovery of salt from its aqueous solution.

2. State one difference between crystallization and evaporation to dryness.

3. Give two ways of inducing the recovery of salt by crystallization.

GENERAL EVALUATION

OBJECTIVE TEST

1. A mixture of gari and stones can be separated by (a) filtration (b) centrifugation (c) sieving (d) sublimation

2. A mixture of iodine crystals and common salt can be separated by. (a) Sublimation (b) filtration (c) sieving (d) centrifugation

3. Sieving is a technique used to separate mixtures containing solid particles of (a) small sizes (b) large sizes (c) the same sizes (d) different sizes

4. Which of the following methods can be used to separate a mixture of iron fillings and sulphur? (a) Filtration (b) magnetization (c) sublimation (d) centrifuging

5. The following are subliming substances **except** (a) Ammonium chloride (b) sulphur (c) Sodium chloride (d) Camphor

ESSAY QUESTIONS

(1) Draw a clearly labeled diagram to illustrate separation of a mixture of chalk suspension.
(2) Explain how a centrifuge machine works.
(3) Explain using diagram how you would separate a mixture of sand and ammonium chloride.
(4) List all the methods that can be used to separate an insoluble solid from a liquid.
(5) Fill in the gaps.

A porous material like _________ can be used to separate ______ particles from ___________. After separation the liquid is called ________ while the particles are called ____________.

WEEKEND ASSIGNMENT:

Read about the industrial applications of distillation and fractional distillation.

WEEKEND ACTIVITY:

Mix sand and water together in a container. Allow it to stand for some minutes. What method would you use to separate the sand from the water?

WEEK 6

TOPIC: STANDARD SEPARATION TECHNIQUES FOR MIXTURE

CONTENT:

1. SEPARATING A SOLUBLE SOLID FROM A LIQUID,
2. SEPARATING A MIXTURE OF TWO OR MORE LIQUIDS,
3. SEPARATING FUNNEL
4. CHROMATOGRAPHY

PERIOD 1: SEPARATING A SOLUBLE SOLID FROM A LIQUID:

1. FRACTIONAL CRYSTALLIZION:

This is a method used to separate a mixture containing different soluble solid solutes in a liquid. The solubility of the different solid solutes in the given solvent must differ at different temperatures. The process of separation is the same as in crystallization process. While cooling the solution crystals of the relevant solid solutes will come out of the solution leaving behind the others which are still within their limits of solubility.

2. PRECIPITATION (PHYSICAL): There are physical and chemical separation techniques involving precipitation.

In physical precipitation, two solids that are soluble in the same solvent are separated by the addition of another solvent in which one of the solids is insoluble, e.g. an aqueous solution of common salts (sodium chloride) and green vitriol(a compound of iron). It is a method used to separate a solid which has a difference in solubility in two different miscible liquids. For example, ethanol and water are two miscible liquids. Iron(II) tetraoxosulphate(VI) is soluble in water but not in ethanol. On addition of ethanol to a solution containing a mixture of iron(II) tetraoxosulphate and water, the iron(II) tetraoxosulphate(VI) will be precipitated out and can be separated by filtration.

PERIOD 2: SEPARATING A MIXTURE OF TWO OR MORE LIQUIDS

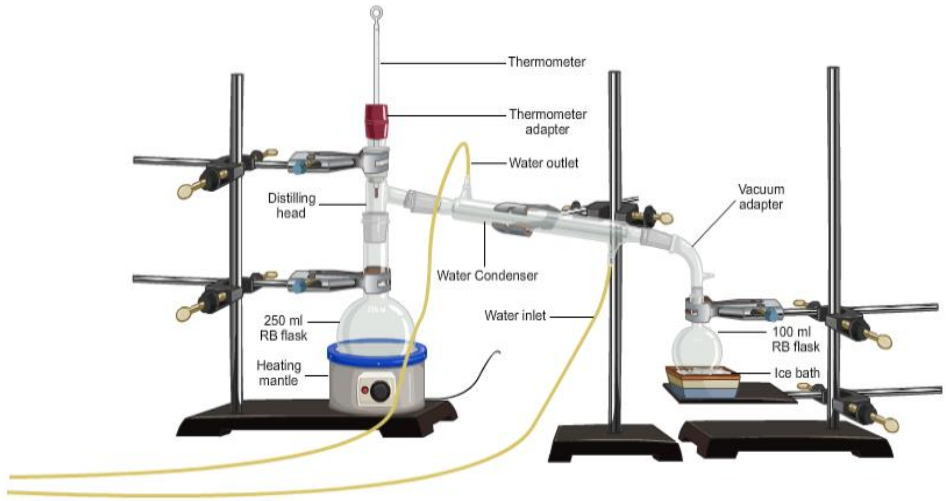
1. DISTILLATION

Distillation is the evaporation of water or other liquids from a solution and its recovery on a pure state by condensation. The method of distillation is used to recover a solvent (liquid from a solution mixture). That is, a pure liquid from an impure liquid (mixture). The apparatus used are shown in the diagram below.

(a) Simple distillation process

A mixture of two liquids with widely differing boiling points can be separated by evaporating one from the other and re-condensing it in a separate vessel. The process is called simple distillation.

Distillation is carried out by condensing the vapour, using a condenser. The vapour which is condensed and collected in a separate vessel is called the distillate.



At the end of the distillation process the liquid that is collected at the end of the Liebig condenser is called the **distillate**. The solutes and other impurities are left behind in the distillation flask.

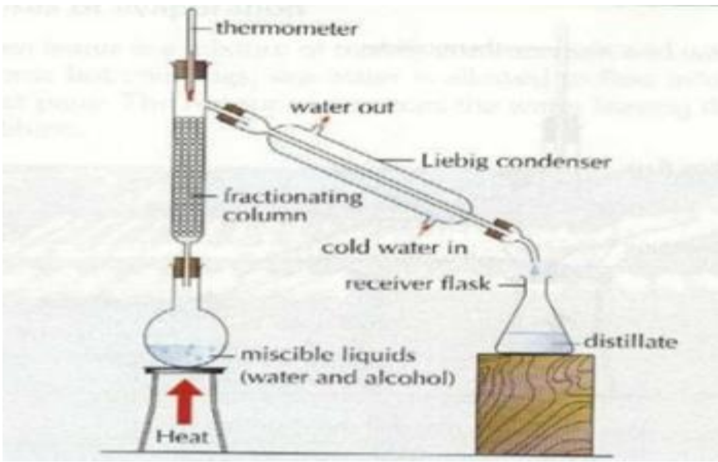
Difference between evaporation and distillation

DISTILLATION	**EVAPORATION**
Mainly obtaining the solvent	Mainly for obtaining salt from solution.
It involves boiling and condensation	It involves boiling only.

(b) Fractional Distillation

Fractional Distillation is a process used to separate or mixture of miscible liquids by a repeated evaporation and condensation making use of fractionating column (as shown in the diagram below)

Mixture of two or more miscible liquids are separated into, its component parts. The liquids distil according to their boiling points starting with the liquid with the lowest boiling point. The apparatus used is the same as in distillation except for the presence of a **fractionating column** between the flask and the condenser.



Note: For efficient fractional distillation, the difference in the boiling points between successive fractions must be more than 10^0c.

EVALUATION:

1. Explain briefly, the process of distillation.

2. Explain briefly, the process of fractional distillation.

PERIOD 3. SEPARATING IMMISCIBLE LIQUIDS (USING SEPARATING FUNNEL METHOD)

This a method used to separate a mixture of immiscible liquids e.g. a mixture of petrol and water. When the two liquids are added together they do not mix, instead they separate into two distinct layers, a lower denser layer and an upper less dense layer in the funnel as below.

EVALUATION:

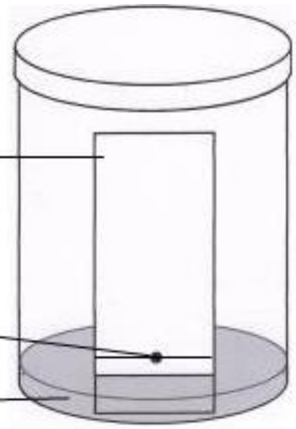
Draw a labeled diagram to show how you would separate a mixture of kerosene and water.

PERIOD 4: CHROMATOGRAPHY

Separating complex mixtures by chromatography: This is a method of separation of the components of mixtures of solutes from a solution (mixture) using a solvent (liquid) moving over a porous, adsorbent medium e.g. filter paper or gel. This method can be mixtures f soluble substances. There are different types of chromatographic methods. Paper chromatography (ascending paper chromatography), column chromatography, thin layer chromatography and gas chromatography.

ASCENDING PAPER CHROMATOGRAPHY

As shown in the above diagram, the apparatus include: a glass jar with lid, filter paper, clips, solvent (water or ethanol). The solution containing the mixture of solutes to be separated is spotted unto the strips of paper near one end.



The paper is then suspended in a closed air- tight jar with the spotted end (but not the spot) dipping into the solvent. As the solvent ascends the paper the different solutes in the mixture gets dissolved and also more along the paper strip at different speeds and hence become separated. The paper strip is removed from the jar when the solvent has moved about three-quarters way up the strip. It is dried and if necessary sprayed with appropriate chemical reagents to locate the positions of the various along the strip. Each solute can then be identified by the distance it has traveled. This is done by comparing its distance with those of known standard substances.

GENERAL EVALUATION

OBJECTIVE TEST:

1. Separating funnel is used to separate one of the following mixtures. (a) Ethanol and water (b) Iodine and salt (c) petrol and water (d) sand and water

2. Fractional distillation of petroleum depends on differences in (a) Molar mass (b) densities (c) freezing points (d) boiling point

3. Fractional distillation is used to separate (a) an insoluble substance from a soluble volatile substance (b) substances which are absorbed differently and which differ in their solubility in a solvent(c) Liquids with differing boiling points (d) Gas, Liquid or solid impurities from a mixture

4. A mixture of sand, ammonium chloride and sodium chloride is best separated by. (a) Sublimation followed by addition of water and filtration (b) Sublimation followed by addition of water and evaporation (c) addition of water followed by crystallization and sublimation.

5. Separating funnel is used for separating a mixture of (a) Liquids with different boiling points (b) sediments of liquid. (c) Liquids with different colours. (d) liquids that are immiscible

ESSAY QUESTIONS:

(1) Name the most suitable physical method for each of the following. (a) Containing groundnut oil from a mixture of the oil and water. (b) Obtaining pure water from sea water.
(2) Draw the laboratory set up most suitable for each of the following. (a) Separating of a mixture of palm oil and water (b) Separate of pure liquid from an impure liquid.
(3) State one industrial application of each of the following methods of separation explaining clearly the procedure. (a) crystallization (b) filtration (c) fractional distillation (d) evaporation
(4) With the aid of a labelled diagram only show how pure sample of ethanol (alcohol) can be obtained from a mixture of ethanol and water.
(5) Why is sodium chloride solution regarded as a mixture? (b) Draw a labelled diagram to show how pure sodium chloride can be obtained from its solution.

WEEKEND ASSIGNMENT:

Read about **recrystallization** from page 5 of comprehensive certificate chemistry; write out the procedures.

WEEKEND ACTIVITY:

Get some impure water in a container and try to purify it by using Alum. How will you separate the pure liquid after the precipitating process?

WEEK 8

TOPIC: STANDARD SEPARATION TECHNIQUES FOR MIXTURES.

CONTENTS:

1. **FLOATATION**
2. **FROSTATION (FROTH FLOTATION)**
3. **PURE AND IMPURE SUBSTANCES**
4. **TEST FOR PURITY**

PERIOD 1: FLOATATION:

Floatation method is based on the wide difference in the densities of the components of the mixture. The method is used for the separation of a mixture of two solids in which one component is light and the other is heavy. On the addition of a liquid in which neither is soluble, one component sinks, while the other floats. e.g. a mixture of coarse sand and wooden cork.

Lead Process Plant(Pb)

Copper Process Plant

Stannum Process Plant

PROCEDURE: Place the mixture in a beaker and add plenty of water. The sand particles sink, while the wooden corks float.

PERIOD 2: FROTH FLOTATION (FROSTATION)

This method is specifically used to separate an ore of a metal from earthy impurities.

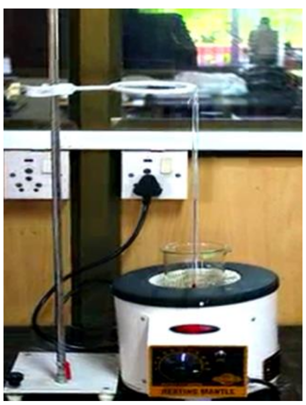
PROCEDURE: The ore is crushed into powder and then mixed with water containing detergent, in order to cause frothing (foaming).

Air is then blown into the mixture so that the earthy impurities sink while the ore floats and mixes with the foam. The ore is finally recovered from the foam

PERIOD 3: PURE AND IMPURE SUBTANCES: The following are the criteria for purity of chemical substances.

DENSITY: The density of a pure substance is definite and constant, while that of an impure substance higher than expected.

MELTING POINT: The melting point of a pure solid is sharp and definite. The presence of an impurity lowers the melting point of a substance, and spread its melting point over a wide range of temperature.



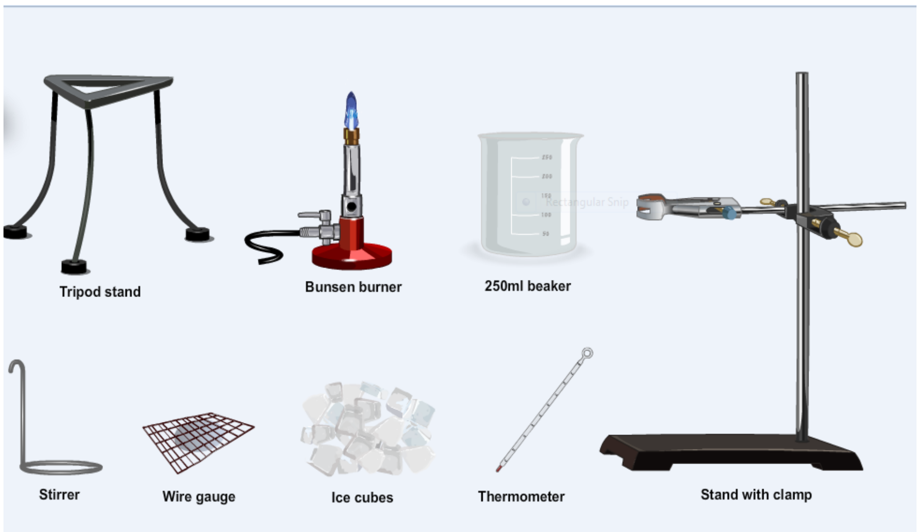
FREEZING POINT: The freezing point of a pure liquid is sharp and definite; the presence of an impurity lowers the freezing point.

BOILING POINT: The boiling point of a pure liquid is sharp and definite. An impurity raises the boiling point of a pure liquid.

PERIOD 4: TEST FOR PURITY

After separation of substances from mixtures, it is important to know if they are pure. A pure solid should melt at a constant temperature. A pure liquid should boil at a constant temperature. A pure dye should give only one spot on a chromatogram. The melting points or boiling points of pure substances are fixed. These temperatures change if impurities are present. To assess the purity of a substance its melting point (if it is a solid) or its melting point (if it is liquid) is determined (if the value obtained agrees with that given in a book of data, then the substance is pure).

The apparatus below can be used to find the melting point of a solid.



The melting point of a solid is the temperature at which it changes to liquid. The melting point tube is very thin- a capillary tube- and the substance under test must be finely powdered so that it can be packed into the capillary tube (melting point tube). The beaker containing the oil is heated slowly and the oil stirred vigorously. If the solid is pure it will all melt at a constant temperature. i.e. it will have a sharp melting point.

NOTE: If impurities are present the mixture will melt slowly over a range of temperatures below the melting point of the pure solid.

EVALUATION:

1. How will you know that a given liquid is not pure?

DETERMINATION OF THE BOILING POINT OF LIQUIDS

(a) Flammable liquids (b) In flammable liquids

The boiling point of a liquid is the temperature at which its vapour pressure equals atmospheric pressure.

The apparatus shown above can be used to find the boiling points of liquids.

A pure sample of liquid will boil at a fixed temperature and the reading on the thermometer will remain constant. If the light is not pure it will boil over a range of temperature *above* the boiling point of the pure liquid.

Impurities lower the melting point of a substance and raise its boiling point.

EVALUATION:

1. List five pieces of apparatus that are common to the determination of melting and boiling points of a chemical substance.

GENERAL EVALUATION

OBJECTIVE TEST

1. The chromatographic separation of ink is based on the ability of the component to.

A: react with each other
B: react with the solvent
C: dissolve in each other in the column
D: move at different speeds in the column

2. The criteria to verify the purity of a solid substance are. I boiling point II melting point III density IV refractive index

A: I, II B: II, III C: I, II, III D: I, II, III, IV

3. A pure dye will A: have a constant boiling point B: have many spots on a chromatogram C:separate from camphor by evaporation method

4. A flammable liquid A: can be heated directly with flame when it is in a container.

5. The best method to separate a mixture of black ink is

A: floatation B: frostation C: ascending paper chromatography D: evaporation

ESSAY QUESTIONS

1. (a) Define the term' chromatography'. (b) Name the different types of chromatography (c) Describe with the aid of a diagram how you would separate a mixture of inks.

2. (a) List three physical properties that are common criteria for purity of substances. (b) List five pieces of apparatus that are common to the determination of melting and boiling points of a chemical substances

3. (a) State the importance of the measurement of melting and boiling points. (b) Explain briefly why salt is always sprinkled can the icy roads in countries where the temperature falls below 273k.

4. Explain the following term briefly (i) floatation (ii) frostation

5. Draw a labelled diagram only to illustrate the determination of the boiling point of a flammable liquid.

WEEKEND ASSIGNMENT:

WEEK 9: REVISION

WEEK 10: EXAMINATION

NOTE: THE EDUCATORS ARE TO KNOW THAT THEY ARE TO USE SATURDAYS FOR ALL PRACTICALS FROM SS1 TO SS3.

CHEMISTRY PRATICALS

TOPIC: CHEMISTRY LABORATORY AND APPARATUS

SUBJECT: CHEMISTRY PRATICALS

CLASS: SS1

CONTENT:

(a) Introduction

(b)Chemistry laboratory apparatus and their uses

(C) Chemistry laboratory set-ups.

(d) Common laboratory accidents

(e) Safety precautions

SUB-TOPIC1-INTRODUCTION:

A Chemistry laboratory is a place, usually a room, where scientific experiments are performed by the use of pieces of apparatus and chemical reagents.

Chemistry laboratory apparatus: Mostly all the apparatus are usually made up of glass such as Pyrex (borosilicate)soda glass, beaker, test tube etc., metals, wood, plastics, and porcelain. Some are improvised i.e. they are locally made such as bamboo for making measuring cylinder, coconut shell for making beaker etc.

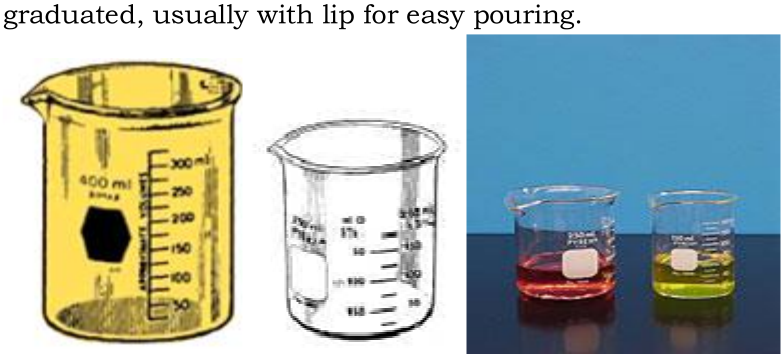
EVALUATION

i) What is the purpose of laboratory?

ii) List three materials that can be used to produce laboratory apparatus.

Sub-topic 2-CHEMISTRY LABORATORY APPARATUS AND THEIR USES

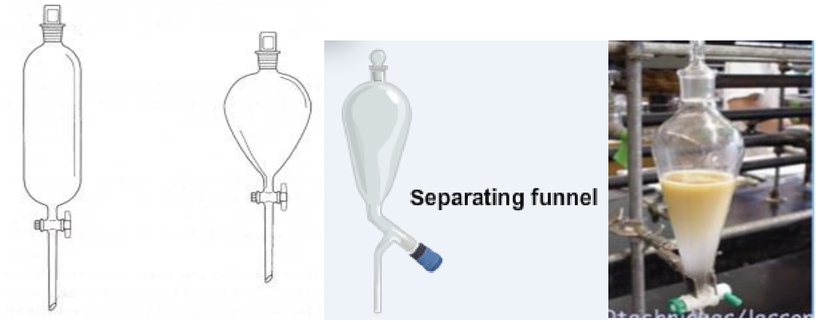
1. BEAKER: Commonly made of Pyrex glass. It has a flat bottom, cylindrical and graduated, usually with lip for easy pouring.



Beakers

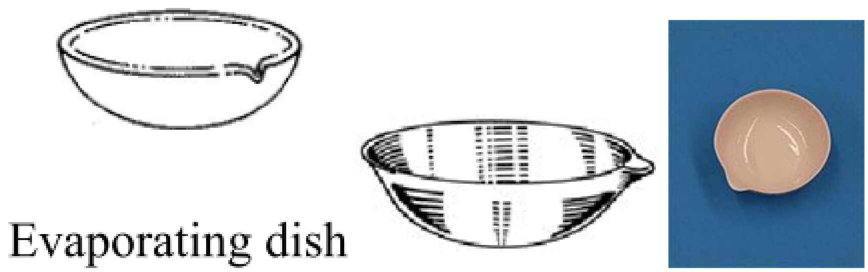
USE: Used to keep reagents for chemical tests.For holding and pouring liquids.it is also used for measuring the volume of liquids.

2.SEPARATING FUNNEL: Made of glass with ashort stem, stopcork,and a stoper. It may be conical, cylindrical,or spherical.



USE:it is used in sepration of immiscible liquids,e.g.a mixture of kerosine and water.

1. **EVAPORATING BASIN OR DISH:** Is made of porcelain. It may be round –bottomed or flat-bottomed, usually shallow, and with spout (lip).



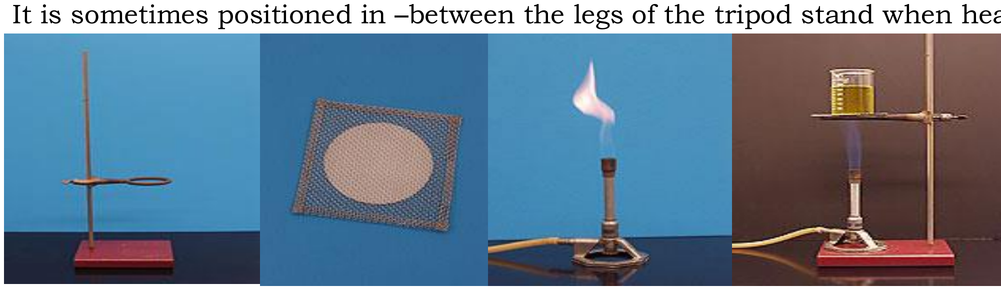
USE: It is used in the evaporation of a liquid solution to dryness, or to concentrate a solution.

2. **TRIPOD STAND, WIRE GAUZE AND BUNSEN BURNER:**

i) TRIPOD STAND: Made of iron, has either a triangular or circular top. It is used as a support for flask when heating.

ii) WIREGAUZE: Madeof iron mesh with asbestos center. It is usually placed on a tripod stand as a support for flask or boiling tube when heating.

Iii) BUNSENBURNER: Used in providing heat (high temperature) by the combustion of liquefied gas (propane or butane).It is composed of a metal tube with a wide metal base. It is sometimes positioned in –between the legs of the tripod stand when heating.



RETORT STAND, WIREGAUZE, BUNSEN BURNERCOMBINED FOR HEATING

5. DISTILLATION FLASK: has a flat or round bottom made of glass with a slanting side arm.

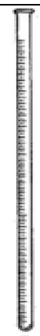
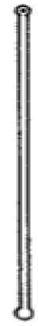
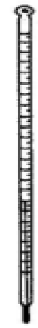
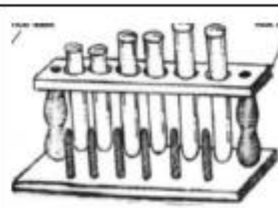
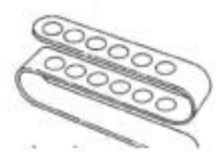
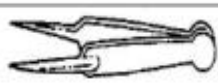
USE: during distillation.

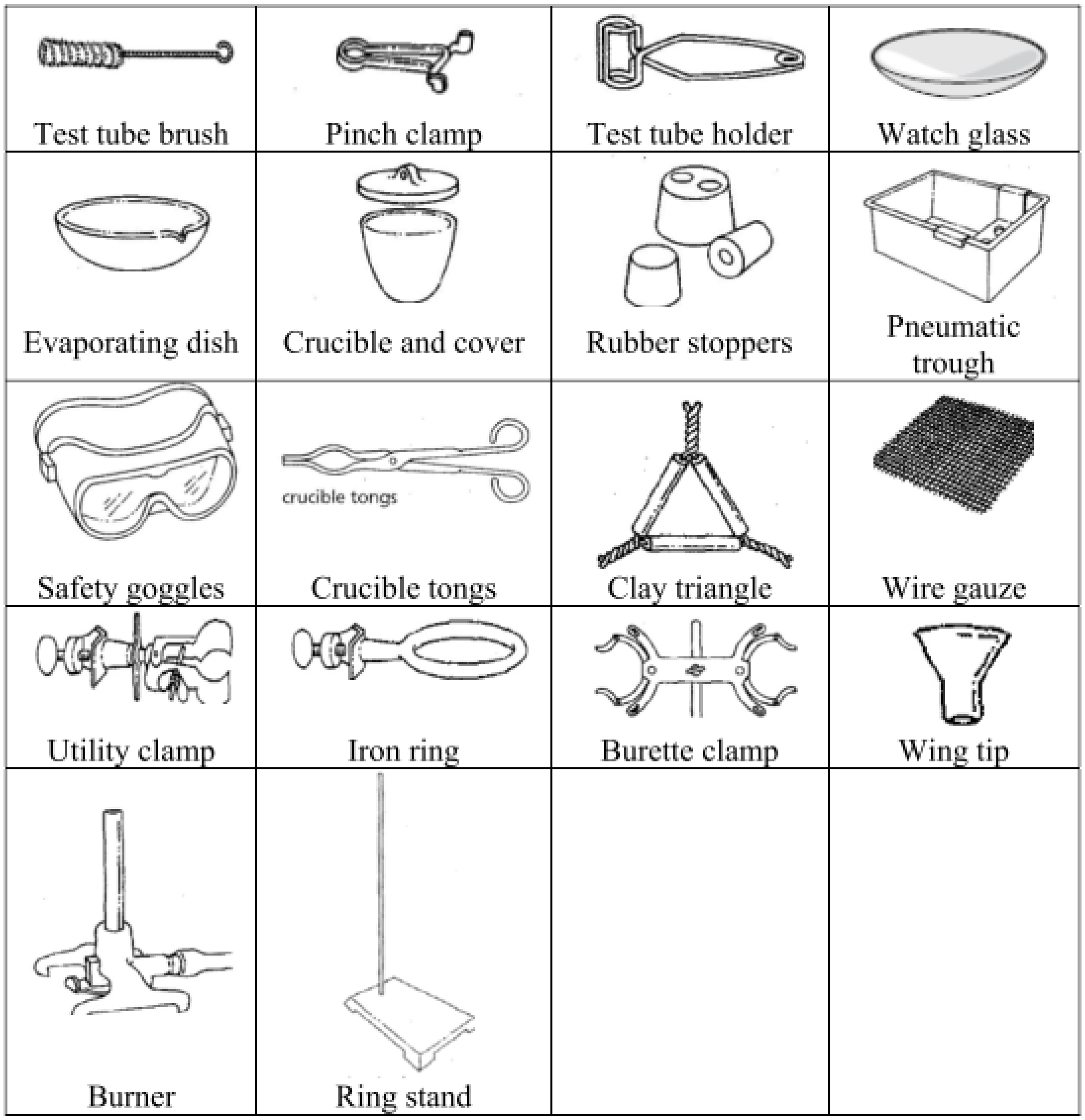
6. MORTAL AND PESTILE: are made of porcelain or agate.

MORTAL AND PESTILE

USE: They are used in grinding or crushing solids into fine powder.

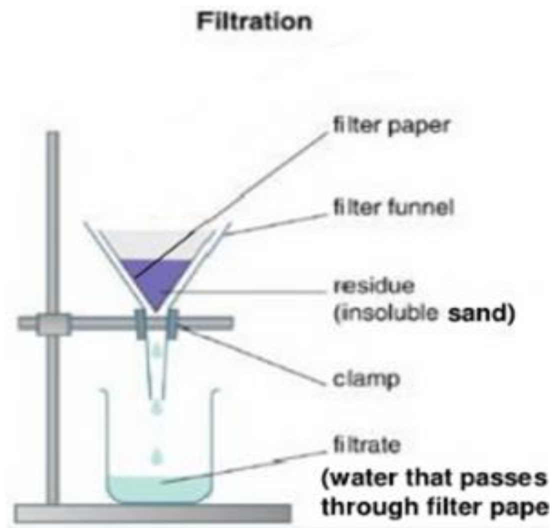
Chemistry Laboratory Common Equipment

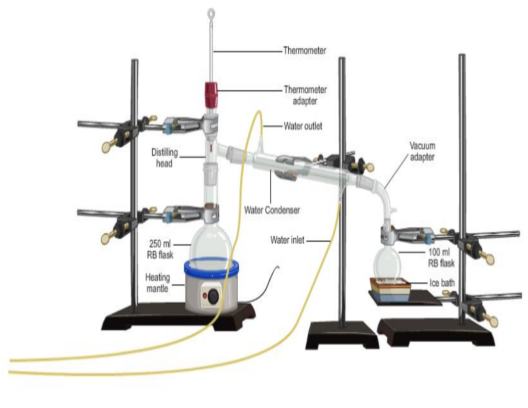
 Gas collecting tube	 Measuring pipette	 Stirring rod	 Thermometer
 Glass-stoppered burette	 Volumetric flask	 funnel	 Graduated cylinder
 Test tube	 Test tube rack	 Spot plate	 s-shaped test tube rack
 Forceps	 Dropper pipette	 spatula	 Triangular file
 Erlenmeyer flask	 Plastic wash bottle	 Beaker	 Gas-collecting bottle



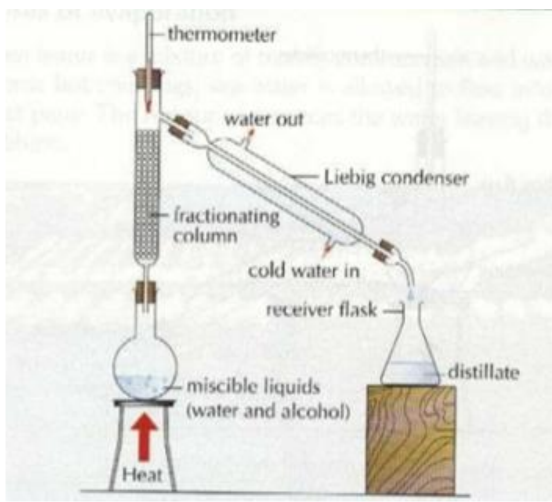
SUB-TOPIC 3:CHEMISTRY LABORATORY SET-UPS.

A laboratory set-up is the combination of two or more apparatus, which are arranged in such a manner that the set-up is workable.

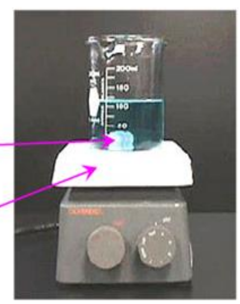




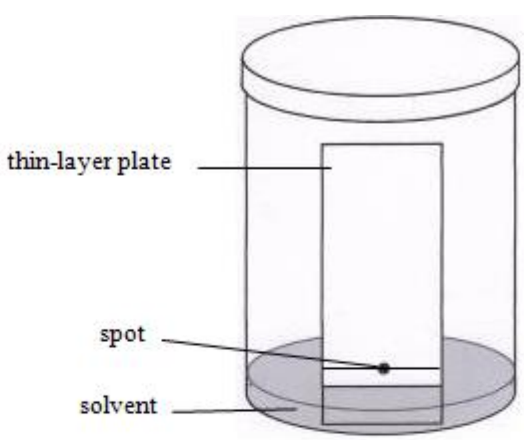
1. FILTRATION **2. SIMPLE DISTILATION**

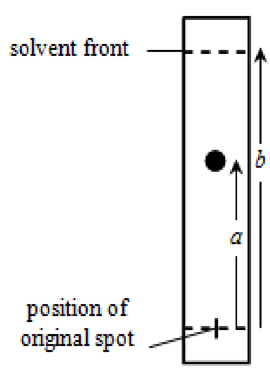


- A combination **hotplate/magnetic stirrer** provides safer conditions than an open flame in many situations.
- Stirring is by means of a small, **coated magnet** placed in the bottom of the beaker.
- A hotplate heats without the danger of an open flame.



3.FRACTIONAL DISTILATION **4. HOTPLATE WITH MAGNETIC STIRRER**





$$R_f = \frac{a}{b}$$

5.PAPER CHROMATOGRAPH

6.DESICCATORS

7.TITRATION **8.EVAPORATION OF A SOLUTION**

SUB-TOPIC4: COMMON LABORATORY ACCIDENTS

Laboratory accidents are something unpleasant, undesirable or damaging that happens unexpectedly or by chance in the laboratory.

Generally it could involve the inhalation of dangerous substances or physical injury as the case may be. Most of the laboratory accidents occur as follows:

1. GLASS CUT:

- **Report the situation to your facilitator and let him help the injured person.**
- There is always a **possibility of infection**, even with the most minor injury. For this reason you should report **any** cut or scrape, even if there is no visible blood.
- If there is blood at **any** laboratory station, move to your seat in the classroom area until told it is safe to return to the laboratory.

2. FIRES:

- **Laboratory burners** are the source of most problems:

- Bunsen burners have very few malfunctions. If a malfunction occurs, turn off the gas and notify your **facilitator-** end of problem.

  - The flame from alcohol burners is hard to see. Pay close attention when using them.
  - Be aware when a burner is in use at your lab station. Be extremely careful during that time.
  - **Paper** is the most common type of fire in the lab.
  - This type of fire is cause by carelessness and easily prevented. Take only one lab sheet to your station to follow your written procedures and record data. Leave all reference materials at your desk. If you need to refer to reference material, leave the lab area to do so.
  - **If a paper fire occurs, push the paper into the lab sink and turn on the water** - end of problem.
  - **Clothing or Hair** is the most dangerous type of fire in the lab.
  - **Don't panic!**
  - If you are the one involved in a fire - **stay where you are - help is coming**. "Stop, drop, and roll" is still the best course of action. If the fire is not at your lab station - **stay away!**

THE FIRE EXTINGUISHER IS LOCATED ON THE WEST WALL.

  - **Only the science facilitator is authorized to use the fire extinguisher.**
  - Fire extinguishers are classified according to a particular fire type and are given the same letter and symbol classification as that of the fire.

TYPES OF FIRE EXTINGUISHERS

Our lab fire extinguisher is Type ABC, effective against Types A, B, and C.

The average fire extinguisher only operates about 10 seconds.**Do not waste it!**

You must get close to the fire - as close as 5 or 6 feet!

To effectively operate an extinguisher, think **P-A-S-S.**

P -- Pull the pin
A -- aim the hose at the base of the fire
S -- squeeze the handle
S -- sweep the hose back and forth

3. ACID BURNS

4. INHALING TOXIC GASES

5. EXPLOSION

6. ELECTRIC SHOCK

7. SWALLOWING TOXIC CHEMICALS

SUB-TOPIC4: SAFETY PRECUTIONS

The following are the basic rules and regulations to guide your safety and hence prevent accidents in the laboratory.

A. DANGER

i) Always handle glass wares being fragile, with care to avoid glass cuts.
ii) Never use sodium, potassium, phosphorus or concentrated (conc) acids and alkalis unless you are specially instructed. These chemicals are corrosive. Always add concentrated acid to water slowly, when diluting the acid, never add water to acid. This is to avoid acid burns, explosion and fire.
iii) Do not taste or drink any chemical, and never smell any chemical directly .This is to avoid swallowing or inhaling toxic chemicals.
iv) Do not mix chemicals aimlessly, or carry out any experiment except when instructed, to avoid explosion or fire outbreak
v) Do not put a glowing splint or a burning paper in the waste bin, to avoid fire outbreak.
vi) Do not touch or hold any electric instrument with wet hands.
vii) All accident should be reported immediately to your facilitator.
viii) Laboratory coats must be worn to protect clothing from soiling, damage from accidents of various sorts.

CLEANLINESS AND EXPENSES

i) Pour liquids only down the sink or funnel, and never pour solids, to avoid blockage.

ii) Clean the apparatus after use and replace them in their proper places.
iii) Wipe down your bench and leave it clean and dry.
iv) Do not light the Bunsen burner or other sources of heat until required. Turn it off when no longer required.

v) Do not bring any food or drink in to the laboratory and avoid eating, drinking or smoking in the laboratory.

No eating or drinking in the lab!

Vi) Contact lenses should NOT be worn in the laboratory

- It is almost impossible to remove contacts after chemicals have been splased into the eye.
- Chemicals trapped under contacts will damage the eye even more than normal.

- The plastic used for some types of contact lensess is per meable to vapours found in the laboratory.if these vapors found in the laboratory.if these vapour are trapped behind the lens, extrnsiveirritationmay occur.

EVALUTION

ESSAY QUESTIONS

1.You are provided with the folllowing laborary appratus give one use for each of the following pieces of apparatus.

(a) Reagent bottle(b) Water bath(c) Combustion boat(d) Wash bottle(e) Deflagratine spoon(f) Evaporating dish(g) Desiccator(h) Tripod stand (i) Test tube rack(j) Liebig condezer(k)Beam balance.

2.With the aid of diagram,draw the laboratory apparatus/set –up for drying solids in the laboratory.

3.Mention **THREE**basic rules and regulations regarding safety in the laboratory.

4.Mention two laboratory accident and they can be prevented.

5.name two apparatus used during filtration process.

6.identfy the apparatus you would use to carry out the following in the laboratory

i.Separatingtwo immiscible liquids

ii.Condenzing steamto liquid

iii.Drying a sample of residues

iv.Measuring a small quantity of liquid