1st SEMESTER CHEMISTRY

SCHEME OF WORK

SCHEME OF WORK FOR FIRST TERM

WEEK	TOPIC
1.	Introduction to chemistry
2	Nature of matter
3	Elements
4	Elements
5	Particulate nature of matter
6	Relative atomic masses of elements
7	Compounds
8	IUPAC nomenclature of chemical compounds
9	Mixture
10	Practical on separation of mixture
11-13	Revision and Examination

Learning Outcomes

- ***At the end of the lesson, you should be able to***:
- - Define chemistry and list branches of chemistry;
- - State the importance of chemistry;
- - List uses of chemistry
- - Mention adverse effects of chemistry;
- - Mention possible careers in chemistry

Introduction: WHAT IS CHEMISTRY

Chemistry is the study of the composition, properties and uses of matter.

Matter *is anything that has mass and occupies space.*

The branches of chemistry include:

Physical, Organic, Analytical, Inorganic, Environmental, Industrial and Pharmaceutical e.t.c.

Why do we study chemistry?

We study chemistry :

I. to acquire knowledge about matter;

II. to acquire scientific knowledge and training in scientific method;

III. to have training in handling and manipulating scientific equipment.

Uses of Chemistry:

Chemistry has contributed greatly towards providing:

1. Food e.g.., production of fertilizer and insecticides;
2. Clothing e.g.., production of fibers, dyes and processing of wool;
3. Military hardware and ammunition;
4. Housing e.g.., production of cements, paints, adhesives, tiles, steel bricks etc..
5. Medicine e.g.., research, production of wide range of drugs, syringe etc..

Careers in Chemistry:

Many job opportunities are available for students with knowledge of chemistry which include:

- Teaching service; Health service; Food processing; Manufacturing industry; Petroleum and petrochemical industries; Agriculture and Forestry.

Adverse effects of chemistry

Chemical processes and products have also affected our life adversely such as:

1. corrosion of iron;
2. pollution;
3. drug abuse.

SCIENTIFIC PROCESSES OF KNOWLEDGE

Make an Observation

↓

Form a Hypothesis

↓

Research

↓

Experiment

↓

Analyze the Data and

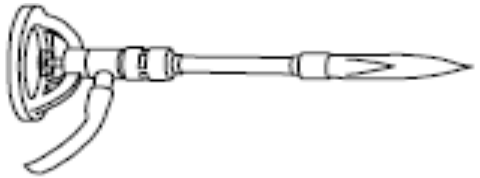
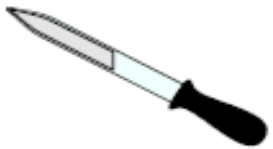
↓

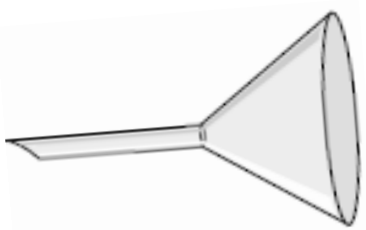
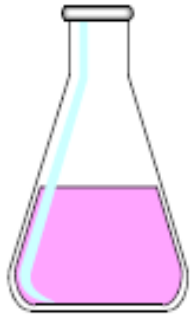
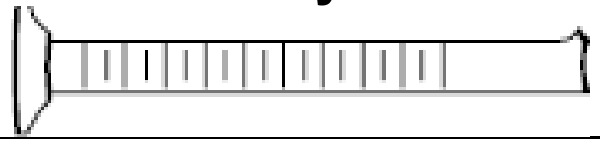
Draw a Conclusion

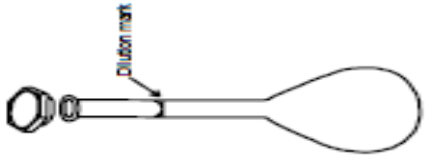
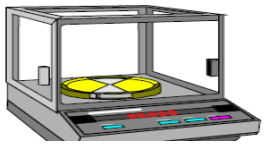
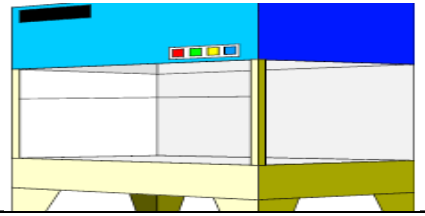
Assignment 1

State two ADVERSE EFFECTS of chemistry AND EXPLAIN WHY

CHEMISTRY APPARATUS AND USES

S/No	Apparatus	Uses
1	Beakers 	**Beakers** are useful as a reaction container or to hold liquid or solid samples. They are also used to catch liquids from titrations and filtrates from filtering operations.
2	**Bunsen Burners** 	**Bunsen Burners** are sources of heat.
3	**Burettes** 	**Burets** are for addition of a precise volume of liquid.
4	 EVAPORATING DISH	This is used to dry substances by allowing the liquid to evaporate
5	 **Droppers**	**Droppers** are for addition of liquids drop by drop

6	**Funnels** 	**Funnels** are for funneling liquids from one container to another or for filtering when equipped with filter paper
7	**Conical flask** 	**Conical or Erlenmeyer Flasks** are useful to contain reactions or to hold liquid samples. They are also useful to catch filtrates.
8	**Graduated Cylinders** 	**Graduated Cylinders** is used for accurate measure volumes of liquids and dispense small measurable amounts of liquids
9	**Pipettes** 	**Pipettes are** used to measure very accurately dispense volumes of liquids

10	**Volumetric Flasks** 	**Volumetric Flasks** are used to measure precise volumes of liquid or to make precise dilutions.
11	**Wash bottles** 	**Wash bottles** are used for dispensing small quantities of distilled water
12	**Balances** 	**Balances** are used to determine the mass of a reagent or object.
13	**Fume Hoods** 	**Fume Hoods (fume cup board)** are used to ventilate noxious or harmful gases.
14	**Spatula** 	**Spatulas are used to transfer solid chemicals**
15	**Stirring or glass rods** 	**The stirring rod is used to: a) manually stir solutions; b) assist in pouring liquids; and c) to transfer a single drop of a solution**

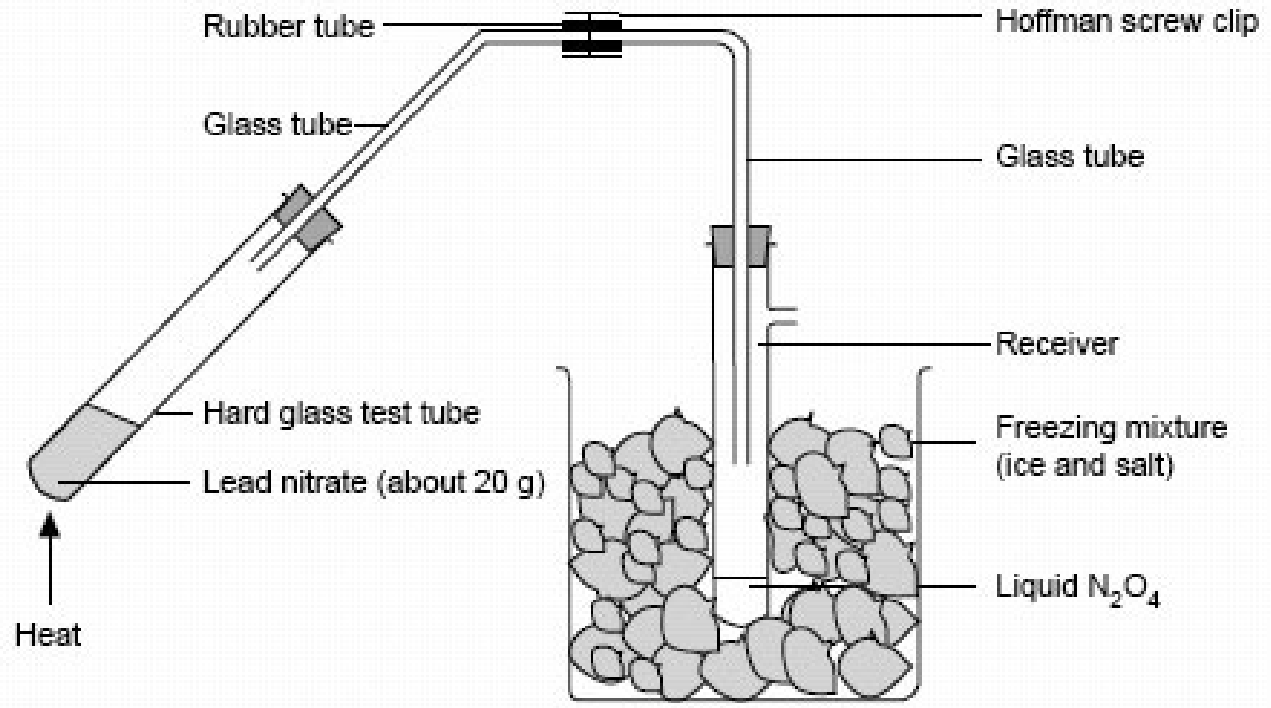
Assignment 2 20 marks

Draw 15 laboratory apparatus and state their uses

NOTE: THEY MUST NOT BE SAME AS THE ONE'S STATED IN YOUR NOTE.

WEEK TWO: NATURE OF MATTER

- Learning Outcomes: Students should be able to:
- - define matter;
- - mention and identify states of matter;
- - mention properties of matter;
- - define physical and chemical changes;
- - list differences between physical and chemical changes.



Preparation of dinitrogen tetroxide

TOPIC: **NATURE OF MATTER**

What is matter?

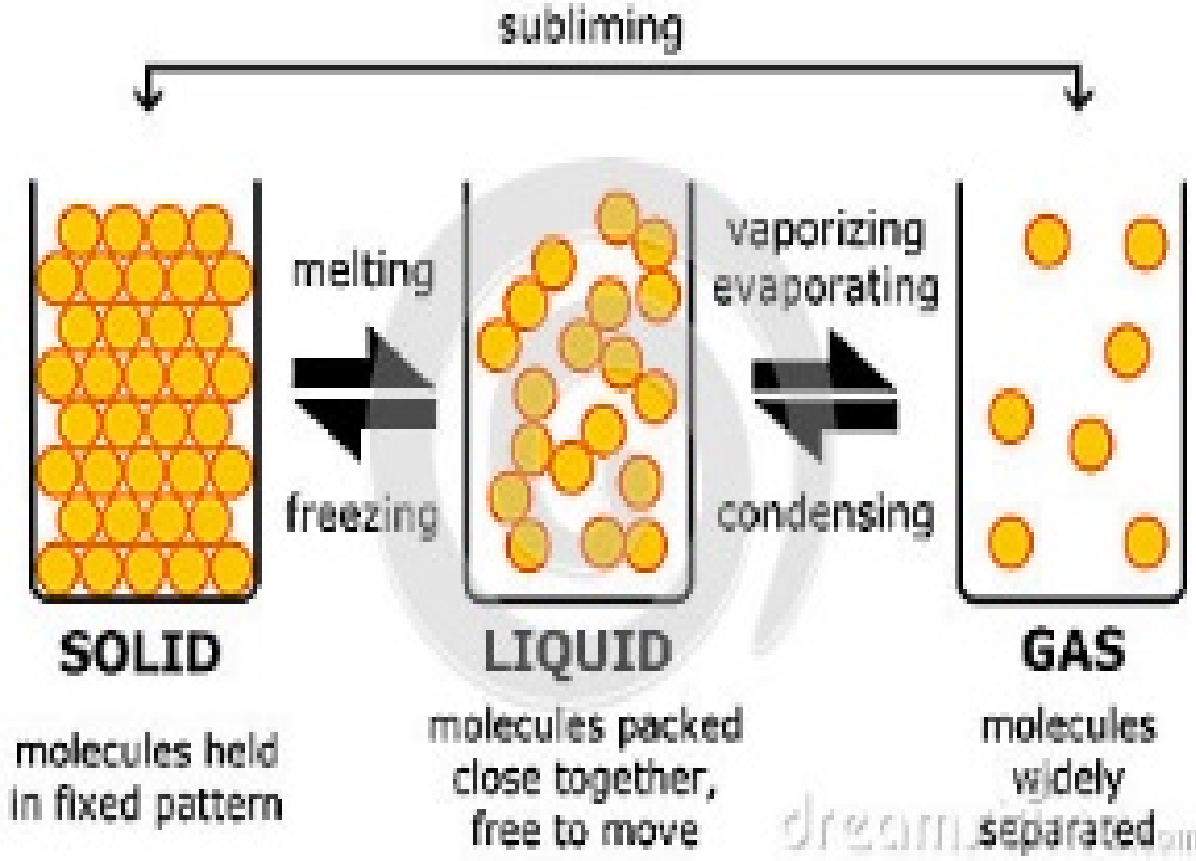
Matter is anything that has mass and occupies space.

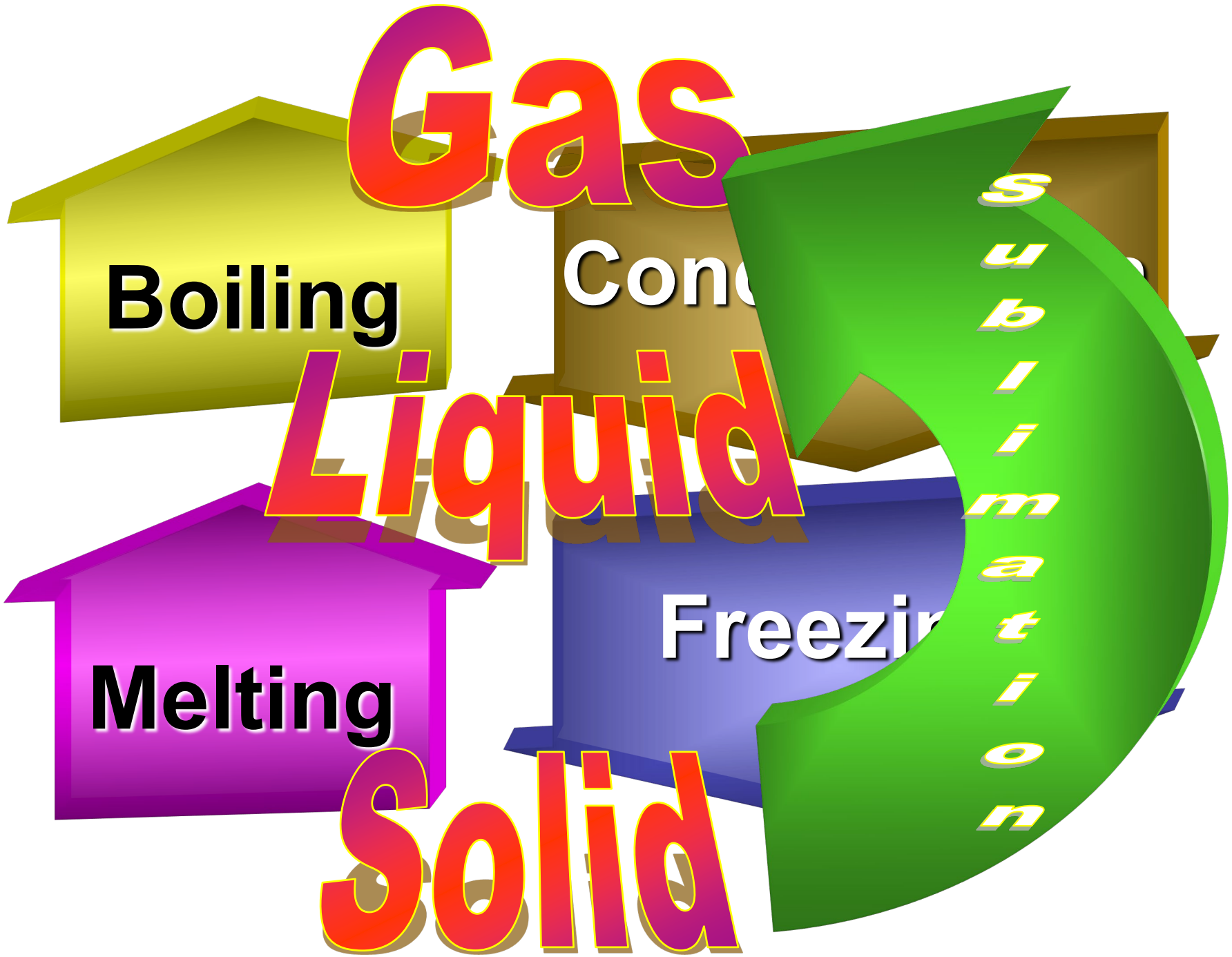
Almost everything in the universe is made up of matter. Matter is built up from one or more of the following simpler particles: atoms, molecules and ions.

States OF MATTER

There are three states of matter

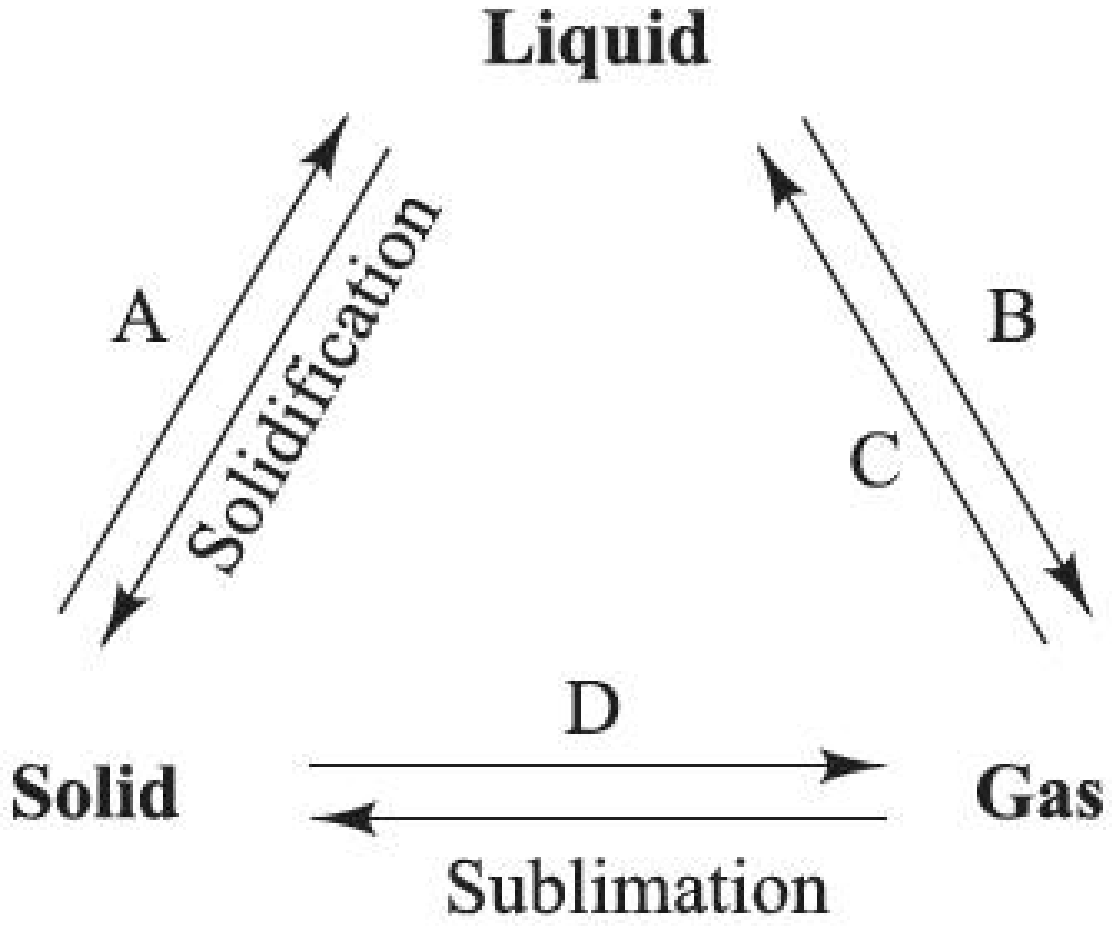
- Solid
- Liquid and
- Gases




Gas
Boiling
Liquid
Melting
Solid
sublimation

Assignment 3

State the name of each change of state lettered A, B, C and D



COMPARISON BETWEEN STATES OF MATTER

Solid	**Liquid**	**Gases**
Solids have definite volume and shape	Liquids have no fixed shape but assumes the shape of the container, it has a fixed volume	Gases have no fixed volume nor shape
Cohesive Force of attraction is high	Weak force of attraction	Negligible force of attraction (very weak)
Type of motion is vibratory	Slowly slide over each other randomly	Fast movement in random direction
Low kinetic energy	Moderate kinetic energy	High kinetic energy
Cannot be compressed	Can be hardly compressed	Very compressible

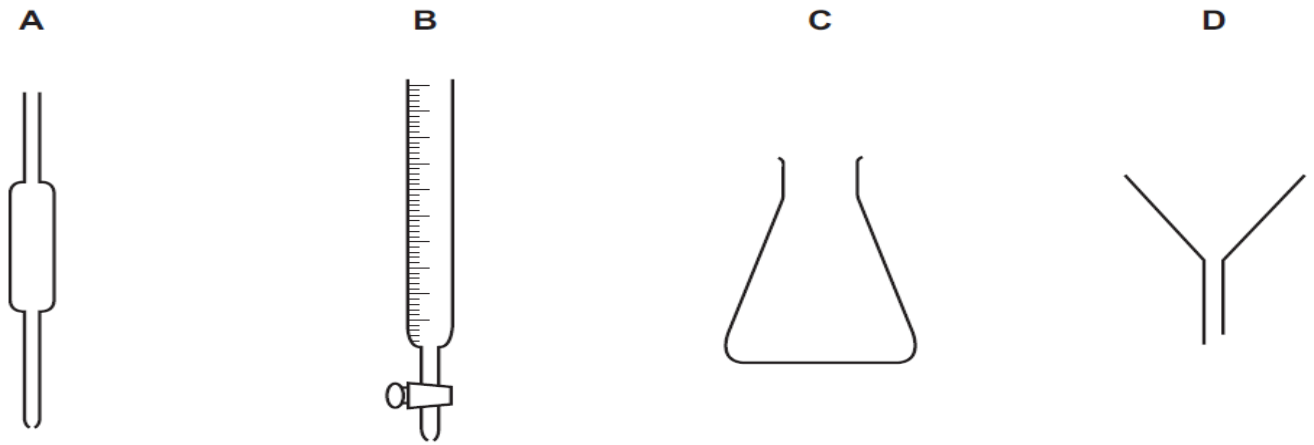
CLASSWORK

1. Arrange the states of matter in order of:

(a) Decreasing intermolecular force of attraction

(b) Increasing kinetic energy

2



State the name of each of these pieces of apparatus.

A .....**B** .....

C .....**D** .....

Properties of matter.

Matter can be characterized by its attributes that distinguish it from other types of matter.

Physical Properties:

These are properties that are associated with physical changes e.g.., change of state, density, color, melting and boiling points, malleability etc..

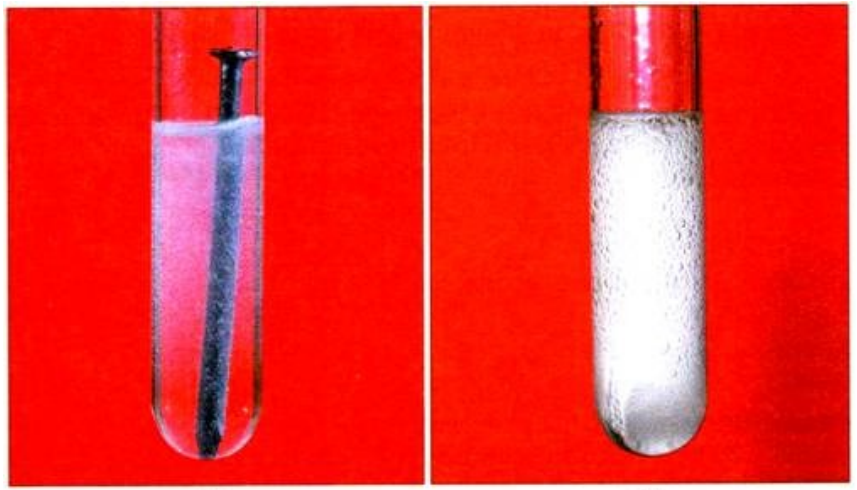
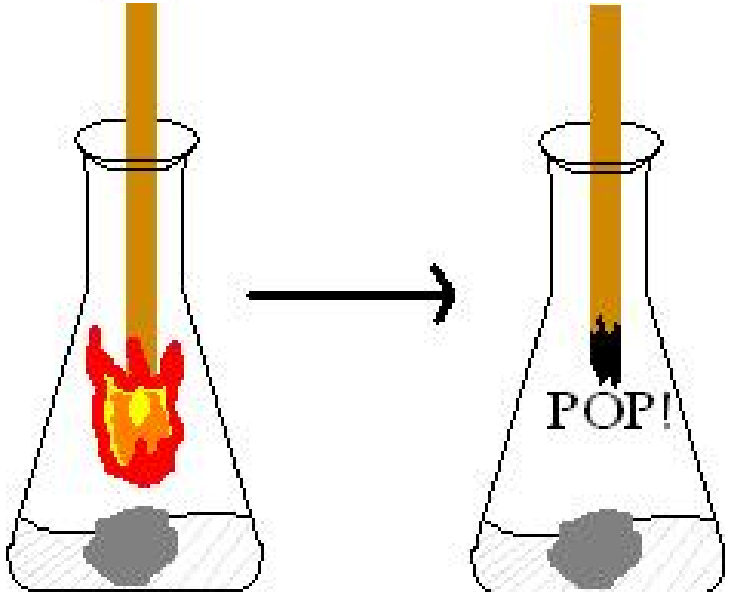


Fig. 6.10 (a) Iron displaces hydrogen from dilute sulphuric acid. (b) Magnesium reacts more vigorously with an acid than iron does.

Chemical Properties:

These are properties involved when a substance changes to new substance e.g.., burning of substances in air(combustion), rusting of iron (oxidation), dissolution of metals in acids (displacement)



Types of change

Physical and Chemical changes:

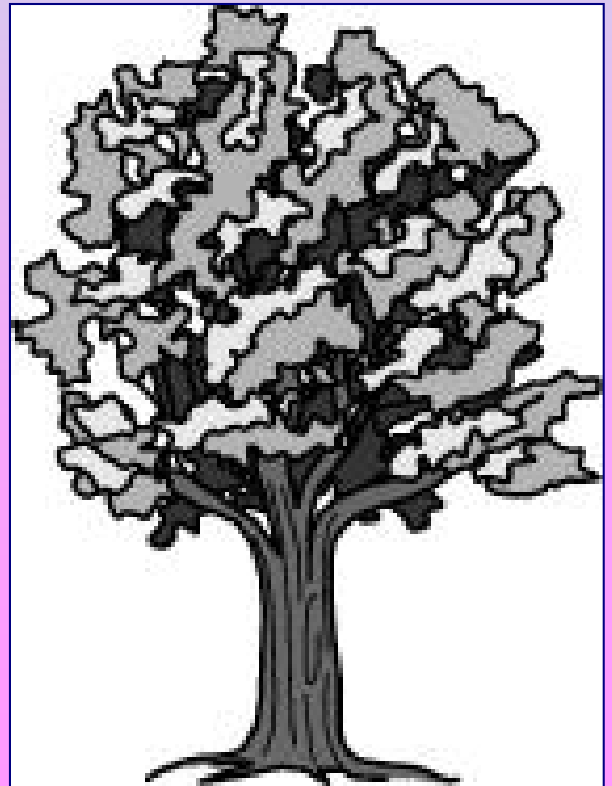
Physical Change: *This is the type of change in which no new substance is formed and which is easily reversed*. Examples are:

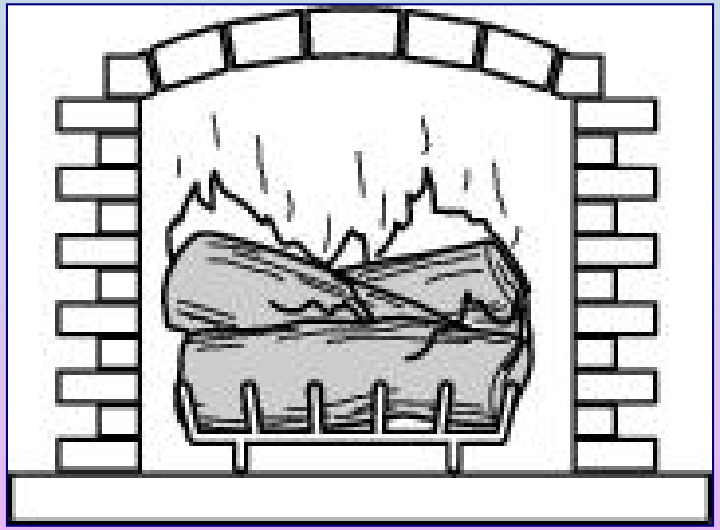
I. - **change of states e.g.**., melting, freezing, evaporation, the heating of a metal wire by electricity, etc.

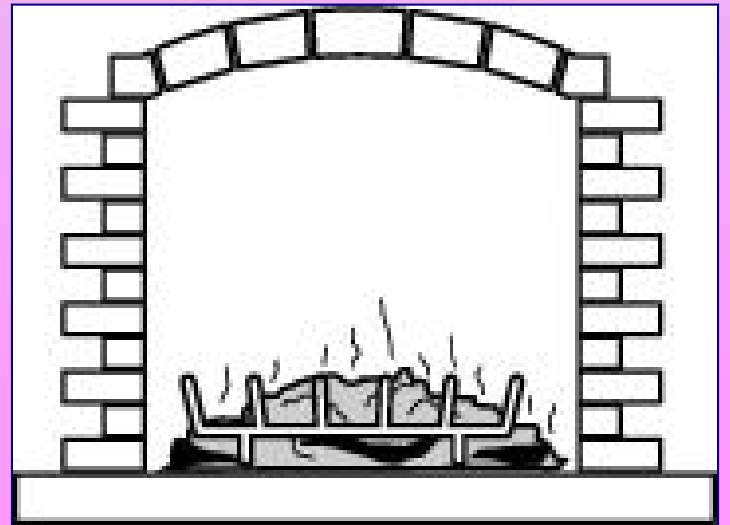
II. Separation of mixtures by physical methods e.g. sieving, chromatography, distillation etc..

III. Magnetization and demagnetization of Iron fillings

Which picture shows only a physical change in the wood?







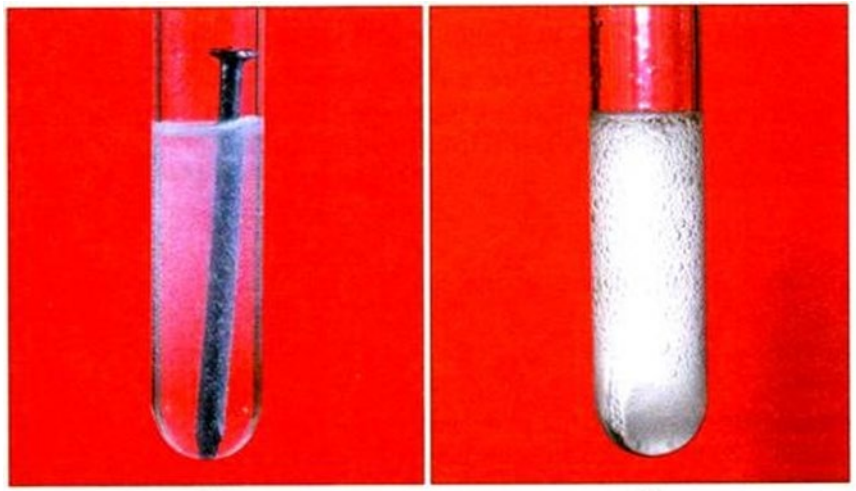

CHEMICAL
REACTIONS

PERIODIC TABLE OF THE ELEMENTS

IA	IIA	IIIB	IVB	VB	VIB	VIIB	VIIIB			IB	IIB	IIIA	IVA	VA	VIA	VIIA	VIIIA
1 H 1.0079																	2 He 4.0026
3 Li 6.941	4 Be 9.0122											5 B 10.811	6 C 12.011	7 N 14.007	8 O 15.999	9 F 18.998	10 Ne 20.180
11 Na 22.990	12 Mg 24.305											13 Al 26.982	14 Si 28.086	15 P 30.974	16 S 32.065	17 Cl 35.453	18 Ar 39.948
19 K 39.098	20 Ca 40.078	21 Sc 44.956	22 Ti 47.867	23 V 50.942	24 Cr 51.996	25 Mn 54.938	26 Fe 55.845	27 Co 58.933	28 Ni 58.693	29 Cu 63.546	30 Zn 65.39	31 Ga 69.723	32 Ge 72.64	33 As 74.922	34 Se 78.96	35 Br 79.904	36 Kr 83.80
37 Rb 85.468	38 Sr 87.62	39 Y 88.906	40 Zr 91.224	41 Nb 92.906	42 Mo 95.94	43 Tc (98)	44 Ru 101.07	45 Rh 102.91	46 Pd 106.42	47 Ag 107.87	48 Cd 112.41	49 In 114.82	50 Sn 118.71	51 Sb 121.76	52 Te 127.60	53 I 126.90	54 Xe 131.29
55 Cs 132.91	56 Ba 137.33	57-71 La-Lu	72 Hf 178.49	73 Ta 180.95	74 W 183.84	75 Re 186.21	76 Os 190.23	77 Ir 192.22	78 Pt 195.08	79 Au 196.97	80 Hg 200.59	81 Tl 204.38	82 Pb 207.2	83 Bi 208.98	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra (226)	89-103 Ac-Lr	104 Rf (261)	105 Db (262)	106 Sg (266)	107 Bh (264)	108 Hs (277)	109 Mt (268)	110 Uun (281)	111 Uuu (272)	112 Uub (285)		114 Uuq (289)				

57 La 138.91	58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm (145)	62 Sm 150.36	63 Eu 151.96	64 Gd 157.25	65 Tb 158.93	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.04	71 Lu 174.97
89 Ac (227)	90 Th 232.04	91 Pa 231.04	92 U 238.03	93 Np (237)	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (262)

Chemical Change: *This is the type of change in which new substance(s) is formed and which is not easily reversed*.



(a) (b)

Fig. 6.10 (a) Iron displaces hydrogen from dilute sulphuric acid. (b) Magnesium reacts more vigorously with an acid than iron does.

Examples are:

I. - burning of any substance in air;

II. - the rusting of iron; III. Slaking of lime

IV. Reaction of active metals with water

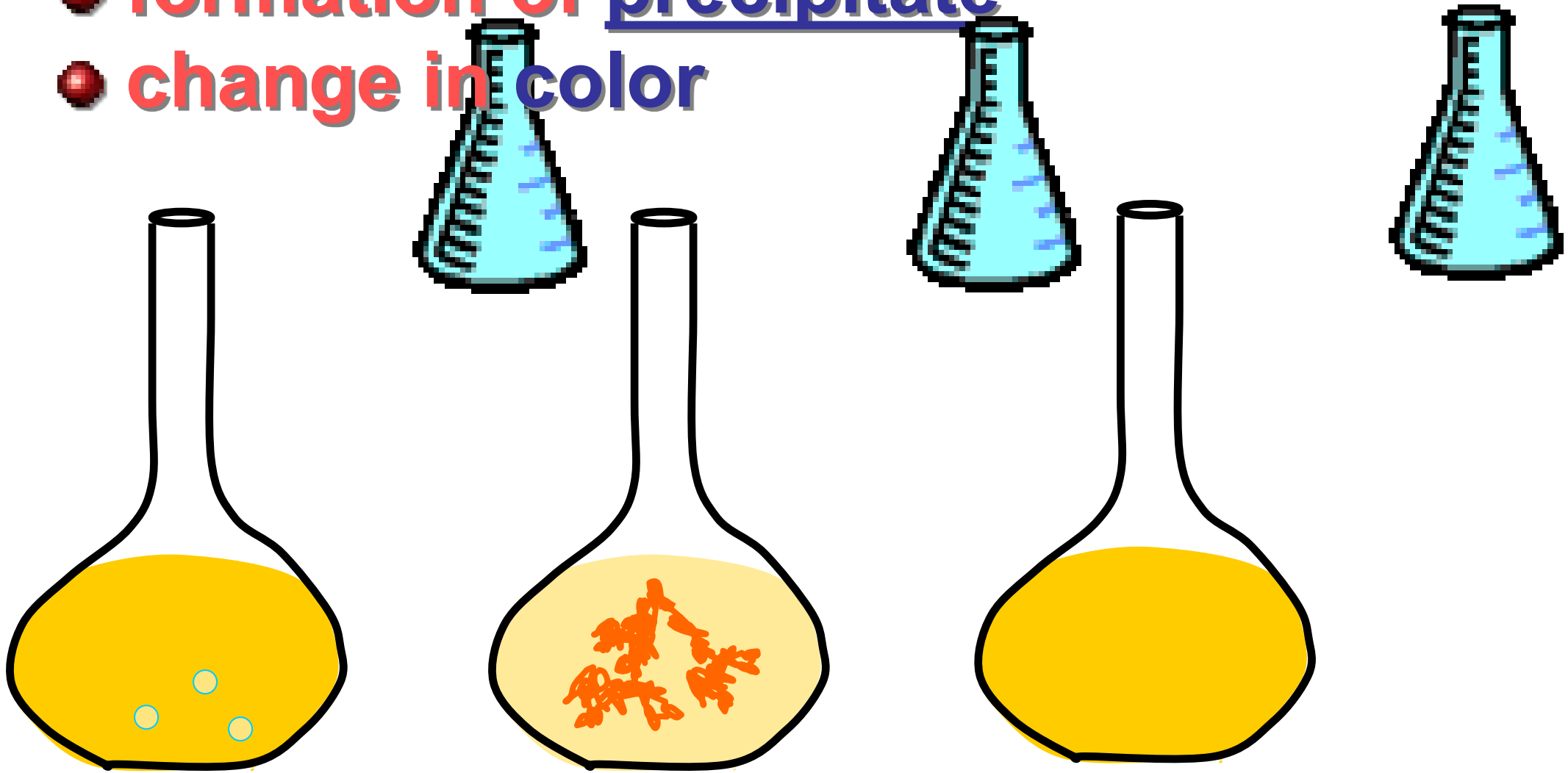
V. explosion of natural gas with air.

Differences between Physical and Chemical changes

Physical change	Chemical Change
It is easily reversed	**It is not easily reversed**
No new substances are formed	**New substances are formed**
There is no change in mass of substances formed	**There is change in mass of substances involved**
It does not involve great heat changes	**It involve great heat changes**

evidence of Chemical Change:

- development of a gas
- formation of precipitate
- change in color



Class activity/Responses required

Which is an example of a chemical change?

ice melting

salt crystals being ground to powder

water evaporating

wood burning

Assignment 4

1. Classify each of the following changes into physical or chemical change

(a) Melting of candle wax

(b) Dissolution of common salt in water

(c) Addition of water to lime

(d) Dissolution of copper in dilute acid

(e) Hardening of cement

(f) Burning of wood

2. State 2 differences between physical and chemical change marks

Week 3

ELEMENTS

An **element** *is a substance which cannot be split into two or more simpler units by any known chemical process*

Example of elements are: Oxygen, Lead, Nitrogen, Sulphur, Copper, Platinum, Gold, Silver etc.

There are about 118 known elements.

Classification of elements

Elements are classified into

1. **Metals**
2. **Non-metals**
3. **Metalloids**

Metalloids are elements that share the properties of metals and non-metals

Elements are further classified into states of matter

Just think

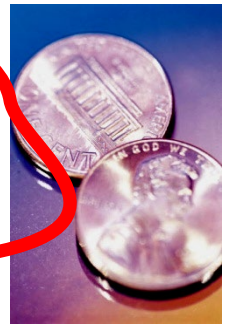
Metals

- Extra electrons
- Conductive
- Malleable

- Dense
- Shiny
- Ductile

	IA												IIIA	IVA	VA	VIA	VIIA	0
1	1 H	IIA																2 He
2	3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
3	11 Na	12 Mg	IIIB	IVB	VB	VIB	VIIB		VII		IB	IIB	13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
4	19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
5	37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
6	55 Cs	56 Ba	57 *La	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
7	87 Fr	88 Ra	89 +Ac	104 Rf	105 Ha	106 Sg	107 Ns	108 Hs	109 Mt	110 110	111 111	112 112	113 113					

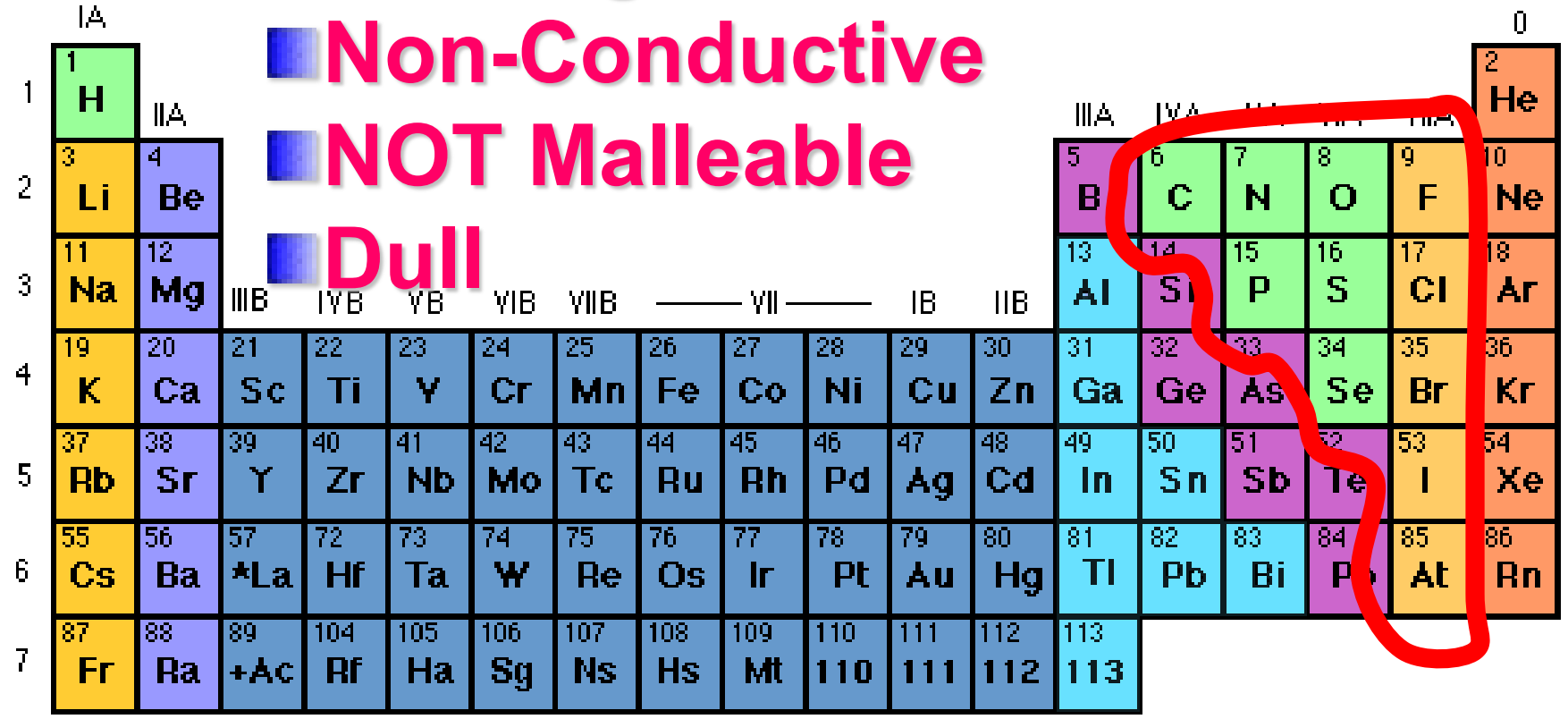
thanide	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu
es	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr



Non-Metals

- missing electrons
- Non-Conductive
- NOT Malleable
- Dull

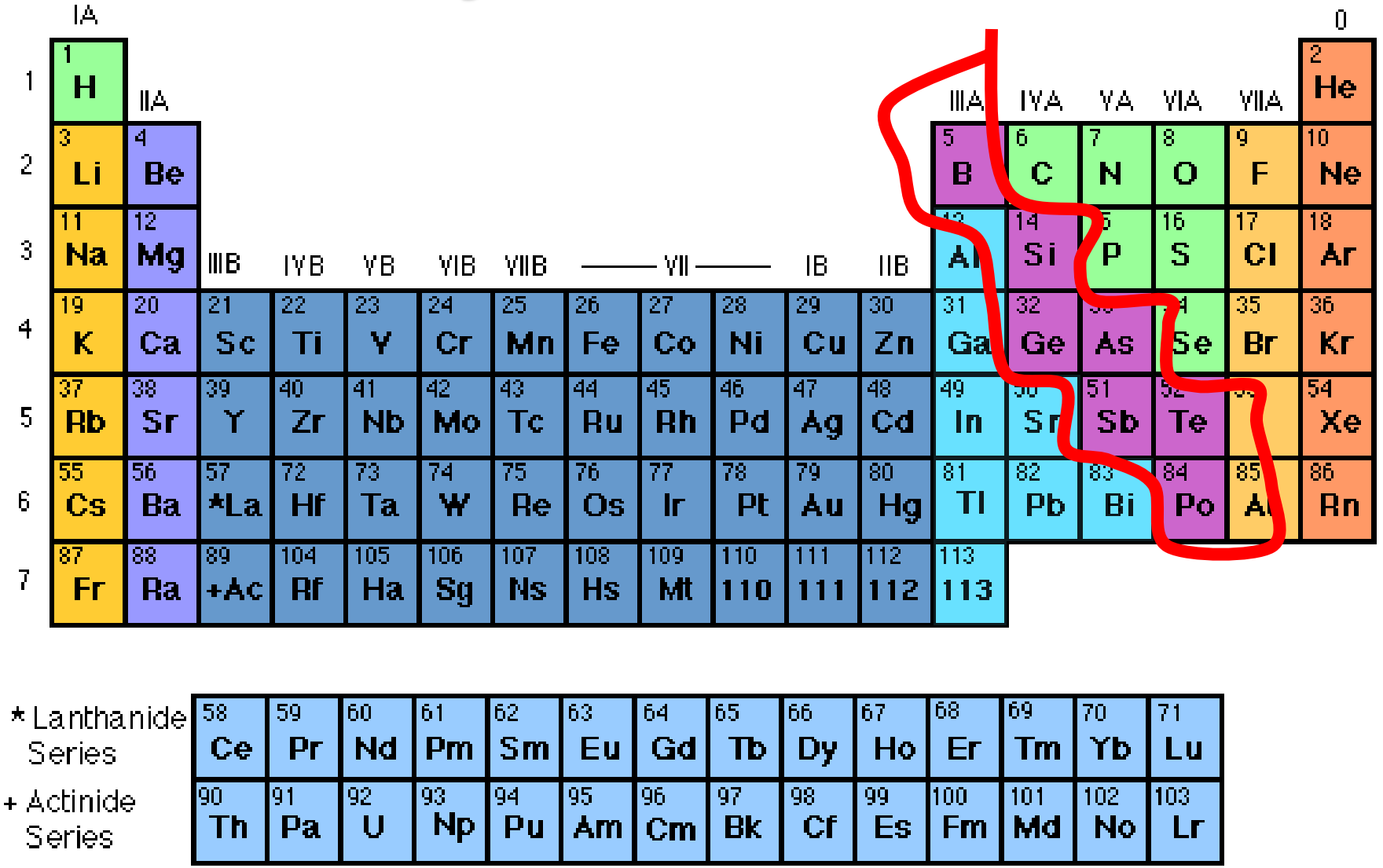
Amazing chemistry



* Lanthanide Series	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu
+ Actinide Series	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr

Metalloids

- Partly conductive



* Lanthanide Series	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu
+ Actinide Series	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr

Physical Property:	Metals	Non-Metals
State In Room Temperature	Solid (Except Mercury, Liquid)	Gas (Except Bromine, Liquid while Iodine is solid)
Density	Very Dense (Except Group 1)	Low Density
Appearance	Shiny, Most Are Grey Except Copper And Gold	Most Are Dull (Except Diamond
Melting Point	High (Except Groups 1 & 2)	Low (Except Diamond-Graphite)
Boiling Point	High (Except Groups 1 & 2)	Low (Except Diamond-Graphite)
Malleability	Hard And Malleable	Soft And Brittle
Ductility	Ductile(ability to be drawn into thin wire)	Not Ductile
Electrical and thermal Conductivity	Good Conductors of heat and electricity	Poor Conductors of heat and electricity (Except Graphite-Silicon)
Sonority	Sonorous	Non-Sonorous

First twenty elements and their symbols

S/No	Name	Symbol
1	Hydrogen	H
2	Helium	He
3	Lithium	Li
4	Beryllium	Be
5	Boron	B
6	Carbon	C
7	Nitrogen	N
8	Oxygen	O
9	Fluorine	F
10	Neon	Ne
11	Sodium	Na
12	Magnesium	Mg
13	Aluminium	Al
14	Silicon	Si
15	Phosphorus	P
16	Sulphur	S
17	Chlorine	Cl
18	Argon	Ar
19	Potassium	K
20	Calcium	Ca

Other Elements and their symbols

S/No	Name	Symbol	
	Copper	Cu	
	Silver	Ag	
	Mercury	Hg	
	Gold	Au	
	Tin	Sn	
	Tungsten	W	
	Manganese	Mn	
	Iron	Fe	

ATOMS

An atom is the smallest particle of an element which can take part in a chemical reaction. Atoms retain the chemical properties of an element.

All elements are made up of atoms.

Atoms are made up of particles such as protons, electrons and neutrons.

The number of protons or electrons in an atom is called atomic number.

Molecules

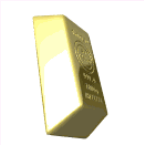
A molecule is the smallest particle of a substance that can normally exist alone and still retain the chemical properties of that substance be it an element or a compound.

Combination of two or more atoms of the same element make a molecule.

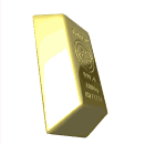
Atomicity. This is the number of atoms in a molecule of an element.

Class Activity

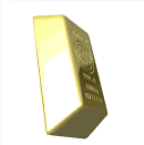
What is the smallest particle of the element gold (Au) that can still be classified as gold?



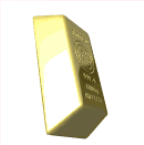
atom



molecule



neutron



proton

Class of elements

Monoatomic. One atom makes a molecule. Most metals are monoatomic

Diatomic: Two atoms make a molecule. e.g. gases. H_2, Cl_2, Br_2, O_2, N_2

Triatomic: Three atoms make a molecule e.g.. Ozone O_3

ELEMENT	FORMULAR OF MOLECULE	ATOMICITY
Sodium	Na	1 MONOATOMIC
Neon	Ne	1 MONOATOMIC
Hydrogen	H_2	2 DIATOMIC
Oxygen	O_2	2 DIATOMIC
Chlorine	Cl_2	2 DIATOMIC
Ozone	O_3	3 TRI ATOMIC
Phosphorus	P_4	4 TETRA-ATOMIC
Iodine	I_2	2 DIATOMIC
Sulphur	S_8	8 POLYATOMIC

Dalton's Atomic Theory.

1. All elements are made up of small indivisible particles called atoms.
2. Atoms can neither be created nor destroyed.
3. Atoms of the same elements are alike in every aspect, and can differ from atoms of all other elements.
4. When atoms combine with other atoms, they do so in simple ratios.
5. All chemical changes result from the combination or separation of atoms.

The above law was partially supported by evidences deduced from the law of conservation of mass, law of definite proportions, law of multiple proportions etc..

Modification Of Dalton's Atomic Theory

1. All elements are made up of small indivisible particles- the atom is made (built) up of three main types of sub-particles i.e. the proton, electron and neutron.
2. During nuclear reactions, the nucleus is broken up into smaller units which form simpler atoms while tremendous amount of heat energy is released.
3. Atoms of the same elements are alike in every aspect, and can differ from atoms of all other elements ;- The discovery of isotopes makes the above statement unacceptable.
4. The statement is generally true only for inorganic compounds which contain a few atoms per molecule unlike organic compounds.

WEEK 5

PARTICULATE NATURE OF MATTER.

Structure of an atom.

An atom has two main parts; the nucleus and shells which surround the nucleus at definite distances.

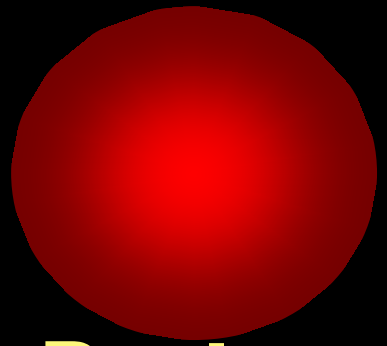
An atom is made up of Protons, Electrons and Neutrons (P.E.N.)

The protons and neutrons are found in the nucleus while the electrons are constantly revolving round the shells.

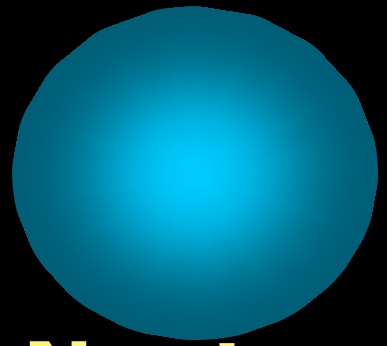
- **Constituents of the atom**:
- Atoms are themselves built up from smaller particles, three of which are: protons, neutrons and electrons.

Properties of subatomic particles:

Atomic particles	Location	Charge	mass
Proton (p)	Nucleus	Positive (+)	1
Electron (e)	Outside/shells	Negative (-)	1/1842 or 0.0005 negligible
Neutron (n)	Nucleus	Nil or zero	1



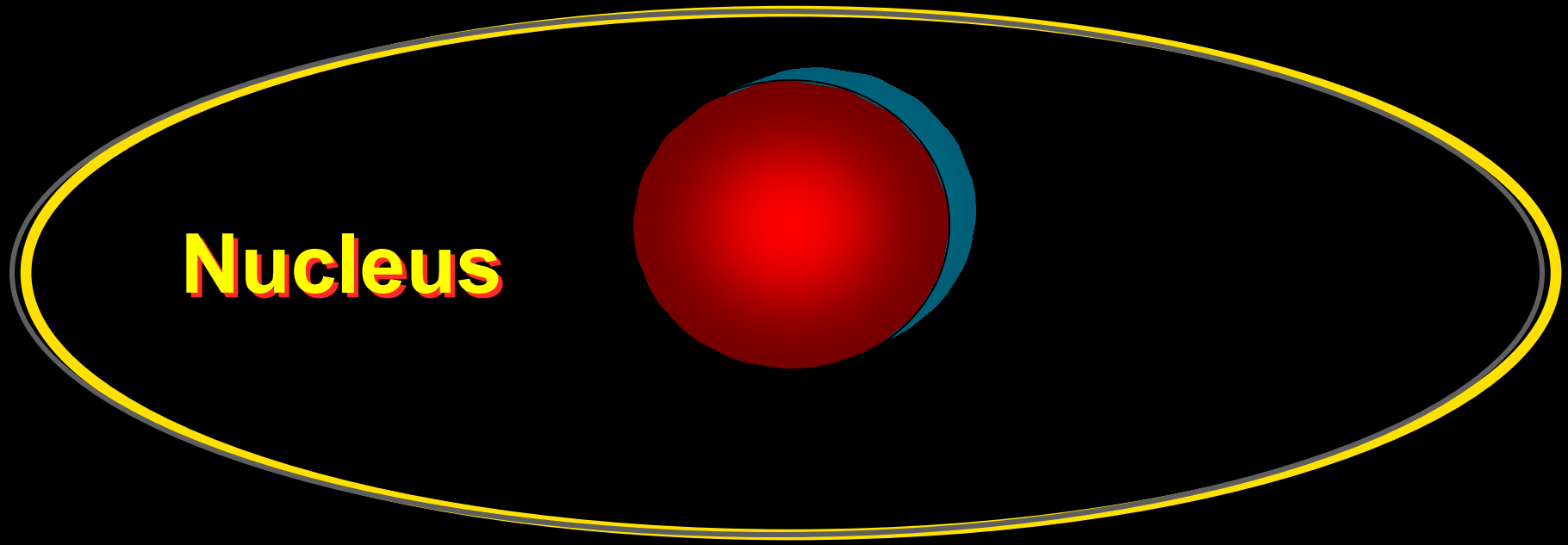
Proton



Neutron

Electron

Electron shell / Electron cloud

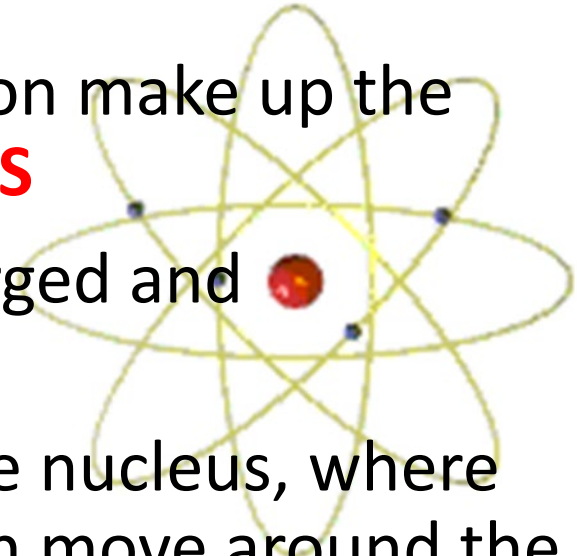


The Atom

assignment

- Draw the structure of an atom and label it fully
- State 3 differences between protons and electrons

Atomic theories



According to Rutherford nuclear theory, the neutron and proton make up the nucleus of an atom and these are collectively called **NUCLEONS**

Rutherford theory proposed that the nucleus is positively charged and surrounded by electrons in an orbital manner.

He deduced that the atom consists of a positive core called the nucleus, where most of the mass of the atom is contained and electrons which move around the nucleus.

- J.J. Thompson discovered electrons and protons. He proposed that an atom is a sphere of positively charged matter in which negatively electrons are embedded.

R. A Millikan discovered the charge of electrons during his oil droplet experiment

- James Chadwick discovered neutrons

Electronic Configuration

- Electronic configuration of an element is the arrangement of electrons of the atom of the element in various energy levels.

Arrangement of Electrons in Atoms

Electrons in atoms are arranged as

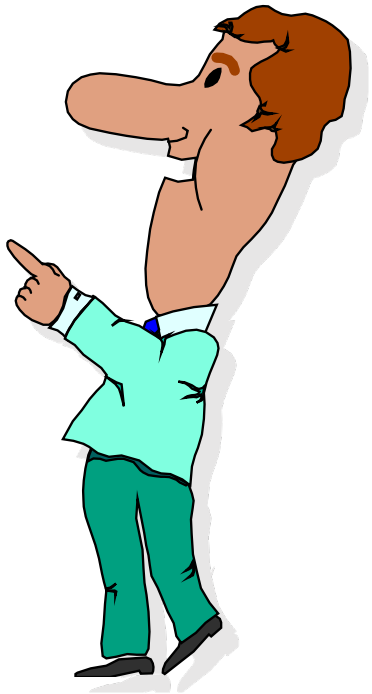
LEVELS (n)

↓

SUBLEVELS (l)

↓

ORBITALS (m_l)



QUANTUM NUMBERS

The shape, size, and energy of each orbital is a function of 3 quantum numbers which describe the location of an electron within an atom or ion

Types of Quantum numbers

n principal Quantum numbers ---> energy level

l (Azimuthal or subsidiary Quantum numbers ---> shape of orbital

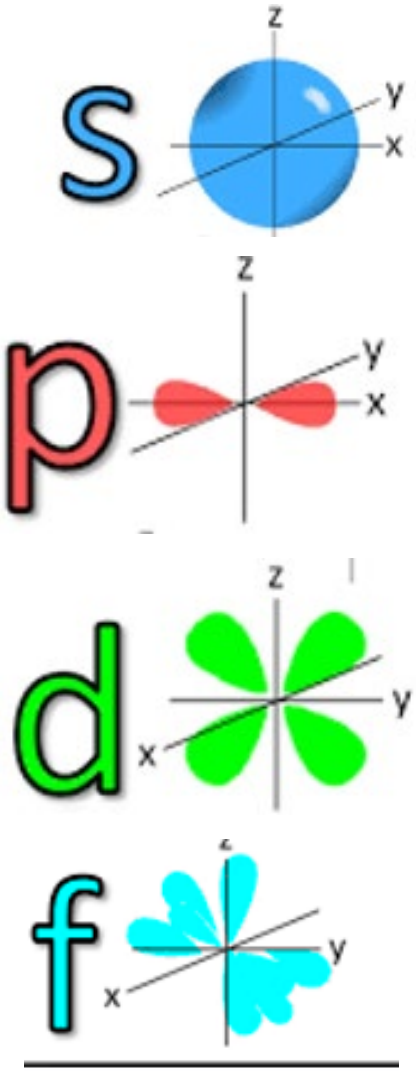
m_l (magnetic Quantum numbers ---> designates a particular suborbital

The fourth quantum number is not derived from the wave function

s (spin Quantum numbers ---> spin of the electron (clockwise or counterclockwise: ½ or – ½)

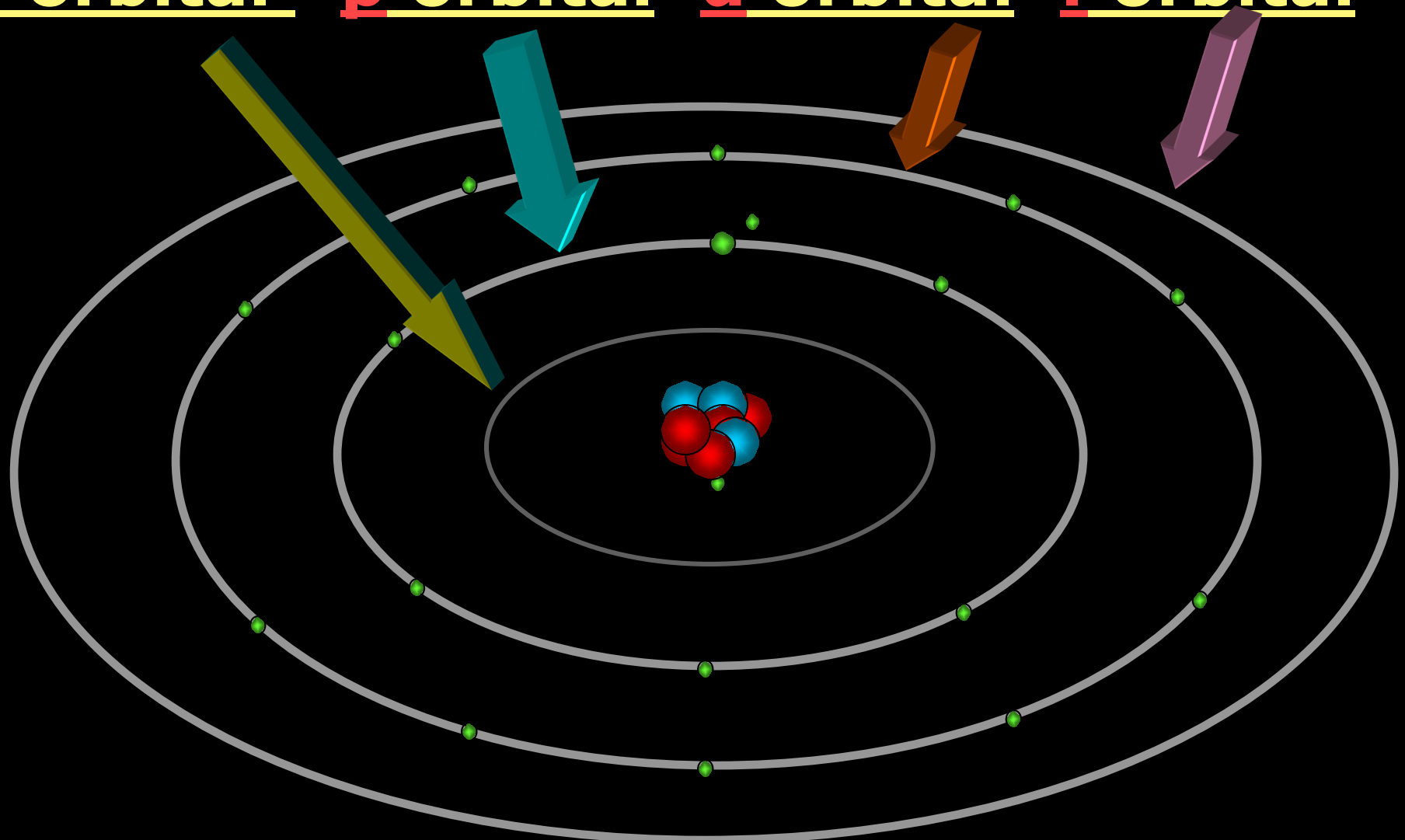
Types of Orbitals and shapes

Types of Orbital	Shape	Maximum number of electrons	Number of sub orbital
S-orbital	Spherical	2	1
P-orbital	Dumbbell	6	3
D-orbital	Double dumbbell	10	5
F orbital	diffused	14	7

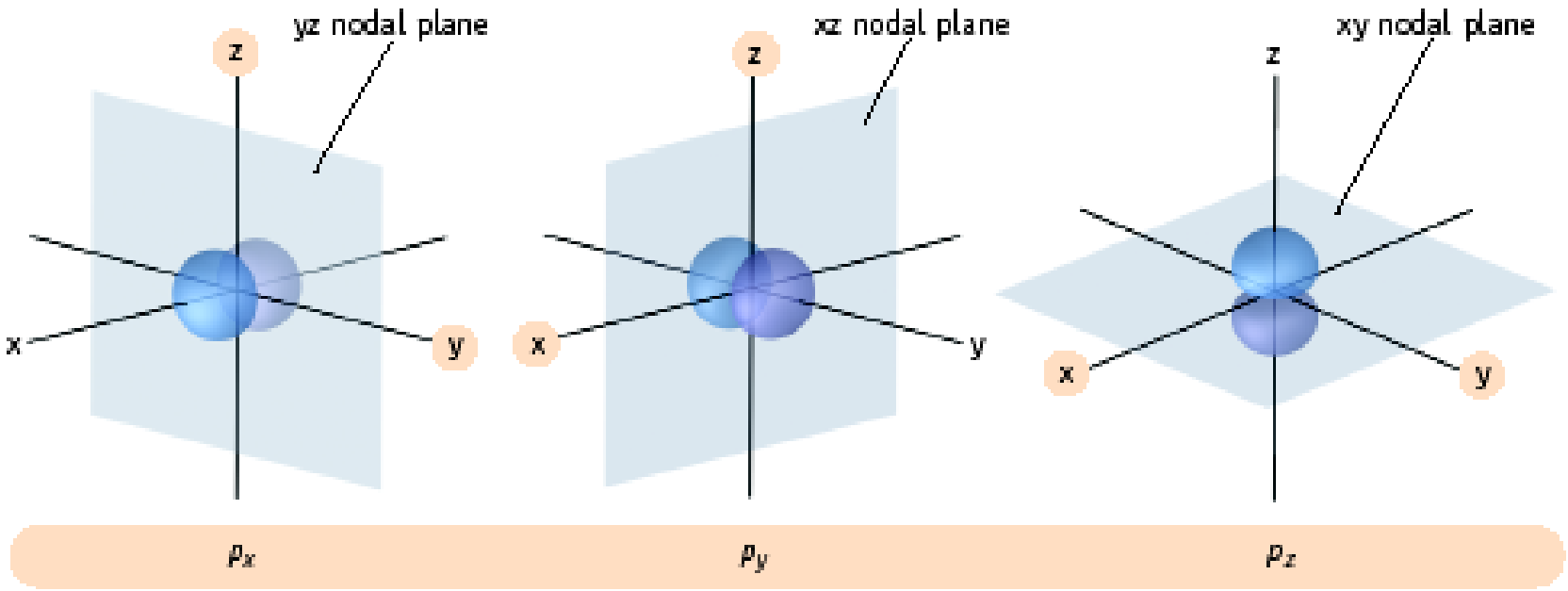


4th Shell of electrons

2	6	10	14
s orbital	p orbital	d orbital	f orbital



p Orbitals



- The three p orbitals lie 90° apart in space

Sequence of filling electron into orbitals Diagonal Rule

1 s

2 s 2p

3 s 3p 3d

4 s 4p 4d 4f

5s

(1s 2s 2p 3s 3p 4s 3d 4p)

Steps:

1. Write the energy levels top to bottom.
2. Write the orbitals in s, p, d, f order. Write the same number of orbitals as the energy level.
3. Draw diagonal lines from the top right to the bottom left.
4. To get the correct order, ***follow the arrows!***

Examples

Write the electron configuration for the following elements:

$_{6}C$ =

$_{11}Na$ =

$_{17}Cl$ =

$_{25}Mn$ =

$_{10}Ne$ =

classwork

- Write the electron configuration for the following elements:

  $_{1}H$

  $_{3}Li$

  $_{7}N$

  $_{19}K$

  $_{30}Zn$

Rules guiding electron arrangement into orbitals

- Hunds' Rule
- Aufbau's principle
- Pauli's Exclusion principle

Hunds' rule states that electrons occupy singly before pairing takes place in a degenerate orbital

Aufbau's principle states that electrons enter into orbitals in order of increasing energy (1s<2s<2p<3s<3p<4s<3d)

Pauli's exclusion principle states that two electrons of the same atom cannot have the same value for all the four quantum numbers.

Week 6.

Topic: **THE RELATIVE ATOMIC MASSES OF ELEMENTS**

Objectives

At the end of the lesson, the students should be able to;

(i) Define atomic number

(ii) Differentiate between isotopy and isotopes

(iii)Calculate the relative atomic mass of an elements

: THE RELATIVE ATOMIC MASSES OF ELEMENTS

- ***The atomic number****, z, of an element is the number of* protons or electrons *in one atom of that element*.
- Atomic number is the basic property of an element, because no two elements has the same atomic number.
- ***The mass number****, A, of an atom of an element is the sum of protons and neutrons in it*.
- Mass number = number of protons + number of neutrons

We can describe an atom of an element by writing its symbol, say ${}^{Z}_{A}\mathrm{X}$, with its atomic number(A) and mass number (z).

- ***Relative atomic mass*** of an element is the number of times the average mass of one atom of that element is heavier than one-twelfth the mass of one atom of carbon-12.

PERIODIC TABLE OF THE ELEMENTS

IA	IIA	IIIB	IVB	VB	VIB	VIIB	VIIIB			IB	IIB	IIIA	IVA	VA	VIA	VIIA	VIIIA
1 H 1.0079																	2 He 4.0026
3 Li 6.941	4 Be 9.0122											5 B 10.811	6 C 12.011	7 N 14.007	8 O 15.999	9 F 18.998	10 Ne 20.180
11 Na 22.990	12 Mg 24.305											13 Al 26.982	14 Si 28.086	15 P 30.974	16 S 32.065	17 Cl 35.453	18 Ar 39.948
19 K 39.098	20 Ca 40.078	21 Sc 44.956	22 Ti 47.867	23 V 50.942	24 Cr 51.996	25 Mn 54.938	26 Fe 55.845	27 Co 58.933	28 Ni 58.693	29 Cu 63.546	30 Zn 65.39	31 Ga 69.723	32 Ge 72.64	33 As 74.922	34 Se 78.96	35 Br 79.904	36 Kr 83.80
37 Rb 85.468	38 Sr 87.62	39 Y 88.906	40 Zr 91.224	41 Nb 92.906	42 Mo 95.94	43 Tc (98)	44 Ru 101.07	45 Rh 102.91	46 Pd 106.42	47 Ag 107.87	48 Cd 112.41	49 In 114.82	50 Sn 118.71	51 Sb 121.76	52 Te 127.60	53 I 126.90	54 Xe 131.29
55 Cs 132.91	56 Ba 137.33	57-71 La-Lu	72 Hf 178.49	73 Ta 180.95	74 W 183.84	75 Re 186.21	76 Os 190.23	77 Ir 192.22	78 Pt 195.08	79 Au 196.97	80 Hg 200.59	81 Tl 204.38	82 Pb 207.2	83 Bi 208.98	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra (226)	89-103 Ac-Lr	104 Rf (261)	105 Db (262)	106 Sg (266)	107 Bh (264)	108 Hs (277)	109 Mt (268)	110 Uun (281)	111 Uuu (272)	112 Uub (285)		114 Uuq (289)				

57 La 138.91	58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm (145)	62 Sm 150.36	63 Eu 151.96	64 Gd 157.25	65 Tb 158.93	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.04	71 Lu 174.97
89 Ac (227)	90 Th 232.04	91 Pa 231.04	92 U 238.03	93 Np (237)	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (262)

Thus, the atoms of carbon and chlorine can be written as:

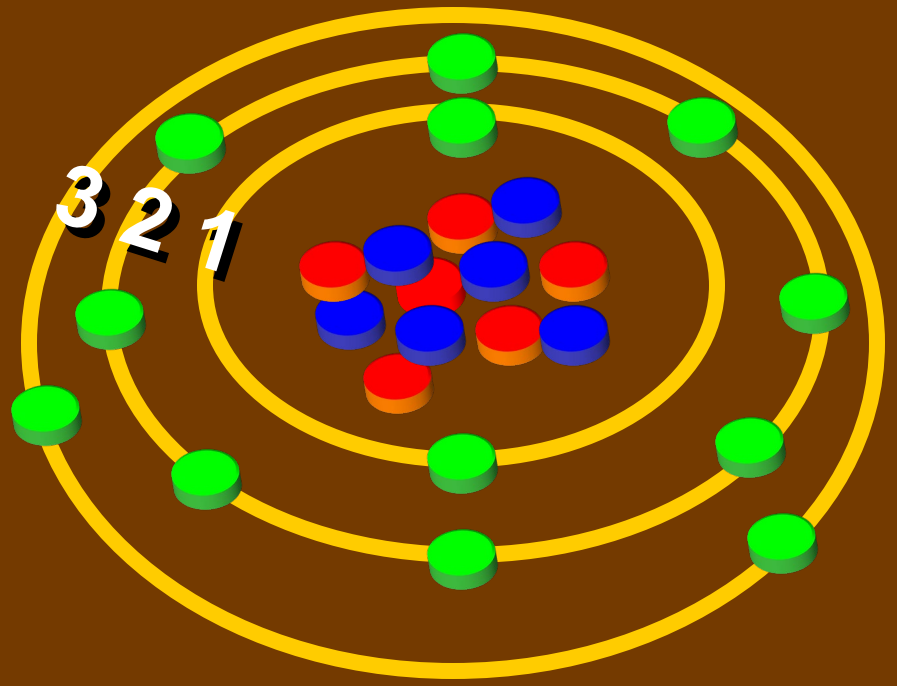
$^{12}_{6}C$ and $^{35}_{17}Cl$ respectively.

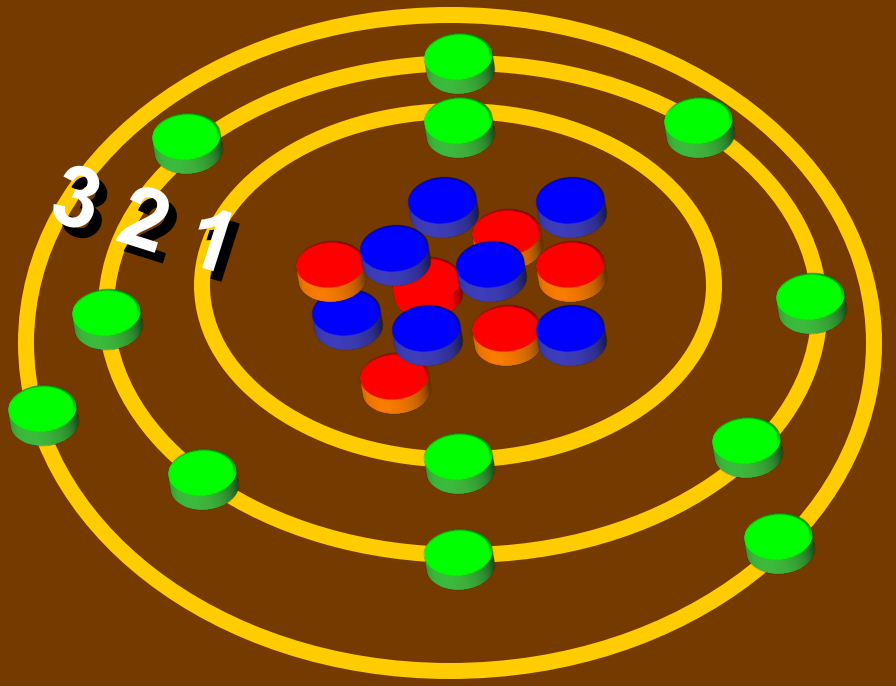
Isotopy. *Isotopy is a phenomenon whereby atoms of an element exhibit the same atomic number but different mass numbers*. The atoms are called isotopes.

Isotopes are atoms of the same element with the same number of protons or atomic number but different mass number.

- The difference in mass numbers is as a result of different number of neutrons in their nuclei.
- Examples of elements that exhibit isotopy are: Carbon $^{12}_{6}C$, $^{13}_{6}C$ $^{14}_{6}C$
- Chlorine $^{35}_{17}Cl$, $^{37}_{17}Cl$, Hydrogen, $^{1}_{1}H$, $^{2}_{1}H$, $^{3}_{1}H$. e.t.c.

Isotopes





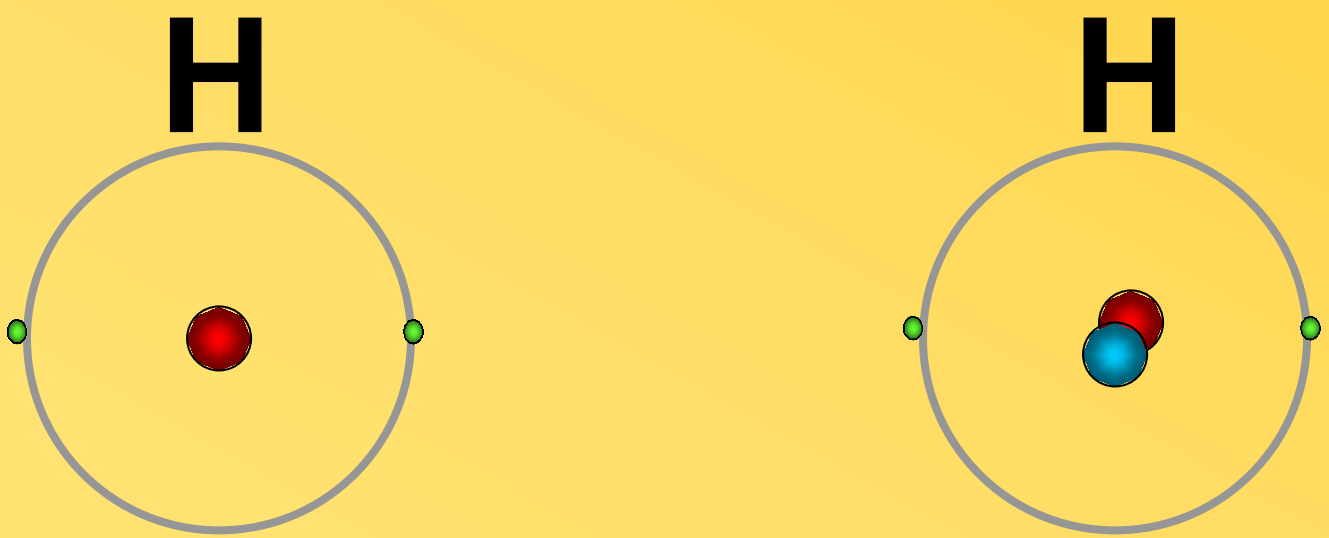
12 6
C

Legend
Proton
Neutron
Electron

13 6
C

Isotopes

Atoms of the same element (same number of protons) with a *different* number of neutrons.



Calculation of Relative atomic mass R.A.M.

- Given that the relative abundance of the two isotopes ${}^{y}_{a}X$, ${}^{z}_{a}X$ are p1% and p2% respectively, the relative atomic mass of element X is calculated as shown.

$$M_r = \frac{(y\ x\ p1)+(z\ x\ p2)}{100}$$

- Similarly, relative abundance of the two isotopes ${}^{y}_{a}X$, ${}^{z}_{a}X$ could be in ratios r_1 and r_2 respectively, the relative atomic mass of element X is calculated as shown.

$$M_r = \frac{(y\ x\ r_1)+(z\ x\ r_2)}{r_1+r_2}$$

NB. P1 and p2 are percentages and add up to 100.

- Relative atomic mass has no unit.
- Note: practically all elements exhibit different levels of isotopy. This is the reason why relative mass of elements are not whole numbers.
- The mass of an atom is measured by an instrument called mass spectrometer.

Worked examples

(i) If 100 atoms of element X contains 70 atoms of ^{9}X and 30 atoms of ^{11}X, calculate the relative atomic mass of X

(ii)An element X with relative atomic mass 16.2 contains two isotopes ${}^{16}_{8}X$ with relative abundance 90% and ${}^{m}_{8}X$ with relative abundance 10%. The value of m is

Open test 5 minutes

- Chlorine has two isotopes $^{35}_{17}\mathrm{Cl}$ and $^{37}_{17}\mathrm{Cl}$ with relative abundances 75% and 25% respectively.
- (i) calculate the number of neutrons in each isotope
- (ii) Calculate the relative atomic mass of chlorine

Compounds

- *A compound is a substance which contains two or more elements chemically combined together*.
- Compounds are made from elements. Simple element like water contains two elements chemically combined with sets of properties that are completely different from those of the constituent elements.

Examples of compounds and their constituents.

1. Water	Oxygen; hydrogen
2. Sugar(sucrose)	Oxygen, carbon, hydrogen.
3. Sodium chloride.	Sodium; chlorine
4. Marble	Calcium; oxygen; carbon.
5. Clay	Aluminum; silicon; oxygen; hydrogen.
6. Sand	Silicon; oxygen

Mixtures:

- *A mixture is a substance which contains two or more substances that are not chemically combined*. Unlike compounds, constituents of a mixture retain their individual properties. This is the reason why constituents of mixtures can be separated by physical methods.
- **Example of some mixtures and their constituents**.

• Soil	sand, stones, humus, water, air etc.
• Blood	water, blood cells, dissolved materials.
• Sea water	water, salt, air, dissolved materials, etc.
• Air	nitrogen, oxygen, CO_2, water vapour, etc.

Differences between compounds and mixtures.

Mixtures.	Compounds.
1. the constituents can be separated by physical methods.	The constituents cannot be separated by physical methods
2. Mixtures may vary widely in composition by mass.	They are fixed in composition by mass.
3.properties are sum of those individual constituents	properties different from those of the individual constituents.
4. They cannot be represented by chemical formula	They can be represented by chemical formula

Relative Molecular Mass:

The relative molecular mass, M_r of an element or a compound is the number of times the average mass of one molecule of it is heavier than 1/12th, the one atom of carbon-12.

The relative molecular mass of an element or compound is the sum of the relative atomic masses of all atoms in one molecule of that substance.

This is relative molecular mass expressed in gram per mole

Example:

Calculate the relative molecular mass of limestone, $CaCO_3$. (Ca=40;C=12;O=16).

Solution:

One molecule of $CaCO_3$ has 1 atom of Ca, 1 atom of C and 3 atoms of O. so,

M_r. = (1x 40)+(1x12)+(3x16) = 100gmol^{-1}.

Class work

Calculate the relative molecular mass of the following compounds

(i) NaCl (ii)$CuSO_4$

(iii) $Al_2(SO_4)_3$ (iv) Na_2CO_3

[Na =23, Cu=64, S=32, O=16, Cl =35.5, Al =27]

Class work

- Calculate the relative molecular mass of the following compounds

i. NaCl

ii. $CuSO_4$

iii. $Al_2(SO_4)_3$

iv. Na_2CO_3

- Na =23, Cu=64, S=32, O=16, Cl =35.5, Al =27,

IUPAC NOMENCLATURE OF INORGANIC COMPOUNDS

- The **IUPAC nomenclature of inorganic chemistry** is a systematic method of naming inorganic chemical compounds, as recommended by the International Union of Pure and Applied Chemistry (IUPAC)
- **Ions**: *An ion is any atom or group of atoms(radicals) which possesses an electric charge*. There are two types of ions:

1. **Cation**: an ion with a positive charge.
2. **Anion**: an ion with a Negative charge.

- H^{+} Hydrogen ion
- Na^{+} Sodium ion
- Mg^{+2} Magnesium ion
- Ca^{+2} Calcium ion
- Ag^{+} Silver ion

Cu^{+} Copper (I) ion
Al^{+3} Aluminium ion
Zn^{+2} Zinc ion
Cu^{+2} Copper (II) ion
Fe^{+2} Iron (II) ion
Fe^{+3} Iron (III) ion

Valency : is the combining power of an element. It has no charge and it helps in constructing the formulae of compounds.

Radicals : These are group of atoms carrying charges that keep their identity and react as a single unit.

Oxidation number of an element is the electrical charge it appears to have both in free and combined states, as determined by a set of rules

Radical	IUPAC name
i. NO_3^-	trioxonitrate (V)
ii. NO_2^-	dioxonitrite (III)
iii. ClO^-	oxochlorate (1)
iv. ClO_3^-	trioxochlorate (V)
v. CrO_4^{2-}	tetraoxochromate (VI)
vi. $Cr_2O_7^{2-}$	heptaoxodichromate (VI)
vii. $C_2O_4^{2-}$	oxalate
viii. CN^-	cyanide
ix. MnO_4^-	permanganate
x. ClO_4^-	perchlorate
xi. HCO_3^-	hydrogentrioxocarbonate (IV)
xii. CO_3^{2-}	trioxocarbonate (IV)

Radical	IUPAC name
• PO_4^{3-}	tetraoxophosphate (V)
• Cl^-	chloride
• S^{2-}	sulfide
• P^{3-}	phosphide
• NH_4^+	ammonium
• H_3O^+	hydronium
• OH^-	hydroxide
• O^{2-}	oxide
• SO_4^{2-}	tetraoxosulphate (VI)

Naming Compounds

- Write the formula of the following compounds:

a) Sodium trioxocarbonate (IV)

b) Copper (I) oxide

c) Aluminium tetraoxosulphate (VI)

d) Copper (II) chloride

Rules for determining oxidation number

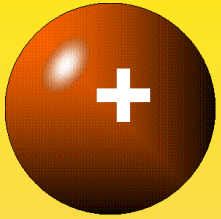
1. All elements in the uncombined state have an oxidation number of Zero e.g. CL_2, Na, P_4 all have oxidation number of zero.
2. The oxidation number of a simple ion has the same size and sign as the charge of the ion e.g. Zn^{2+} = +2, Ag^{+} = +1
3. When an ion consists of more than one element, its oxidation number is the sum of the oxidation states of all the elements in the ion e.g. NH_4^{+} i.e.

   oxidation no. of N + 4[oxidation no of H] = +1

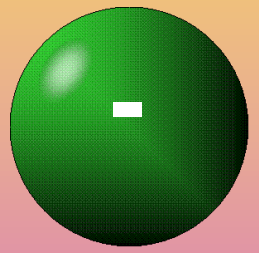
   (-3) + 4(+1) = +1

4. The sum of oxidation numbers of the elements in a compound is zero e.g. NaCl = 0 [Na =+1: Cl = -1] therefore NaCl= Na+Cl = 0

5. The oxidation number of H is +1 except in hydrides where it is -1 and that of oxygen is -2 except in peroxides where it is -1

Cation 

an ion with a positive charge.

Anion 

an ion with a Negative charge.

Cation

an ion with a positive charge.

H^+	Hydrogen ion
Na^+	Sodium ion
Mg^{+2}	Magnesium ion
Ca^{+2}	Calcium ion
Ag^{+2}	Silver ion

Anions

F^{-1}	Fluoride
Cl^{-1}	Chloride
Br^{-1}	Bromide
I^{-1}	Iodide

The Halogens

SEPARATION TECHNIQUES

- Learning Outcomes:
- - define mixtures;
- - mention properties of mixtures;
- Mention types of separation techniques and types of mixtures separated by each.

SEPARATION TECHNIQUES

- **Types of Separation Techniques**:

Technique:	**To separate**…
Sieving	solids of different sizes.
Sublimation	solids which sublime from other solids.
Decantation,	insoluble solids from liquids.
Filtration, centrifugation.	Separate solid particles from solutions
Evaporation,	soluble solid from solution
Crystallization;	Obtain solids which are unstable to heat from solution
Fractional crystallization;	Solid from a solution
Precipitation.	Separating mixtures of different solubilities in a solvent
Distillation	solvents from its solution
Fractional distillation	miscible liquids of different boiling points
separating funnel	separate immiscible liquids.
Chromatography	separate mixtures of coloured substances

• Evaporation,	soluble solid from solution
• Crystallization;	Obtain solids which are unstable to heat from solution
• Fractional crystallization;	Solid from a solution
• Precipitation.	Separating mixtures of different solubilities in a solvent
• Distillation	solvents from its solution
• Fractional distillation	miscible liquids of different boiling points
• separating funnel	separate immiscible liquids.
• Chromatography	separate mixtures of coloured substances

1**.Sieving**: This method is used to separate solid particles of different sizes.

Apparatus: sieve with a mesh of a particular size.

Procedure: the mixture is placed on the sieve and shake or is stirred.

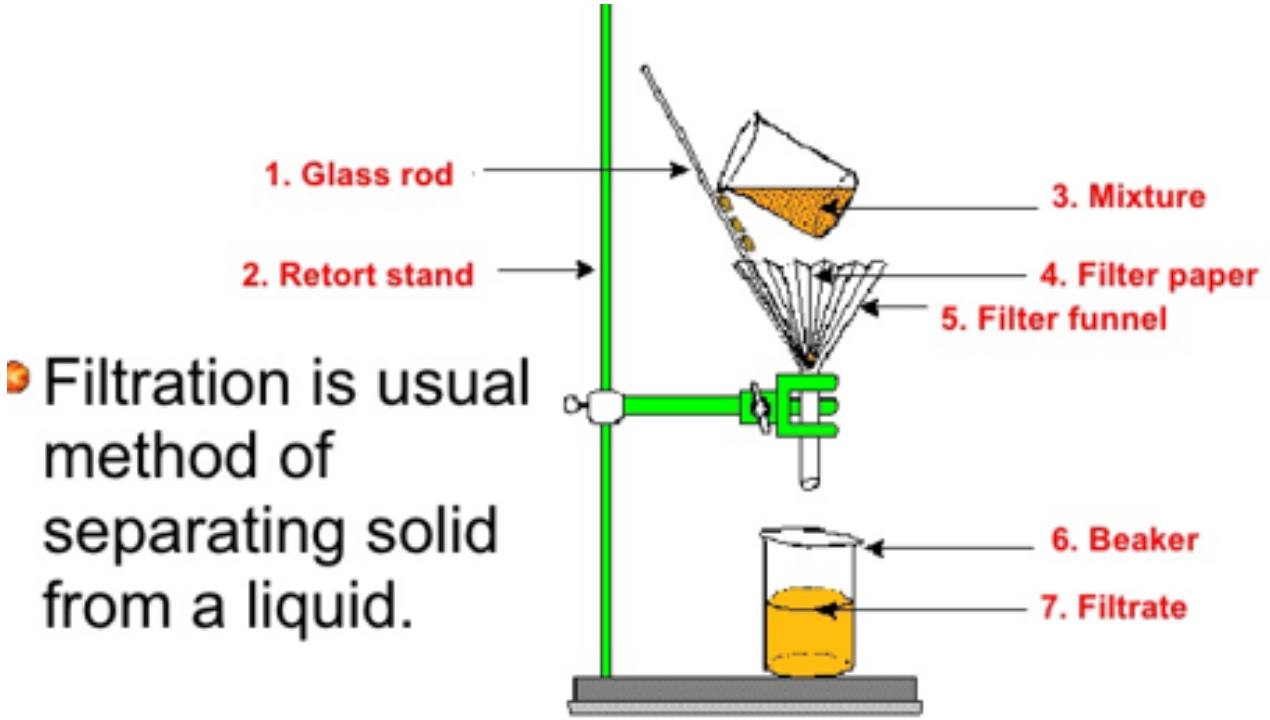
Result: particles of the size of the sieve pass through the sieve while the bigger particles remain on the sieve.

Industrial application: the method is applied in mining industries, garri industries in West Africa.

- 2. **<u>Magnetic separation</u>**: This is used to separate magnetic substances from non-magnetic particles.
- *Apparatus*: magnetic separator.
- *Procedure*: the mixture is poured on the separator.
- *Result*: magnetic particles are separated from non-magnetic ones.
- *Application*: applied in extraction of iron, tin etc.

3.**Filtration**: This method is used to separate insoluble solids from liquids.

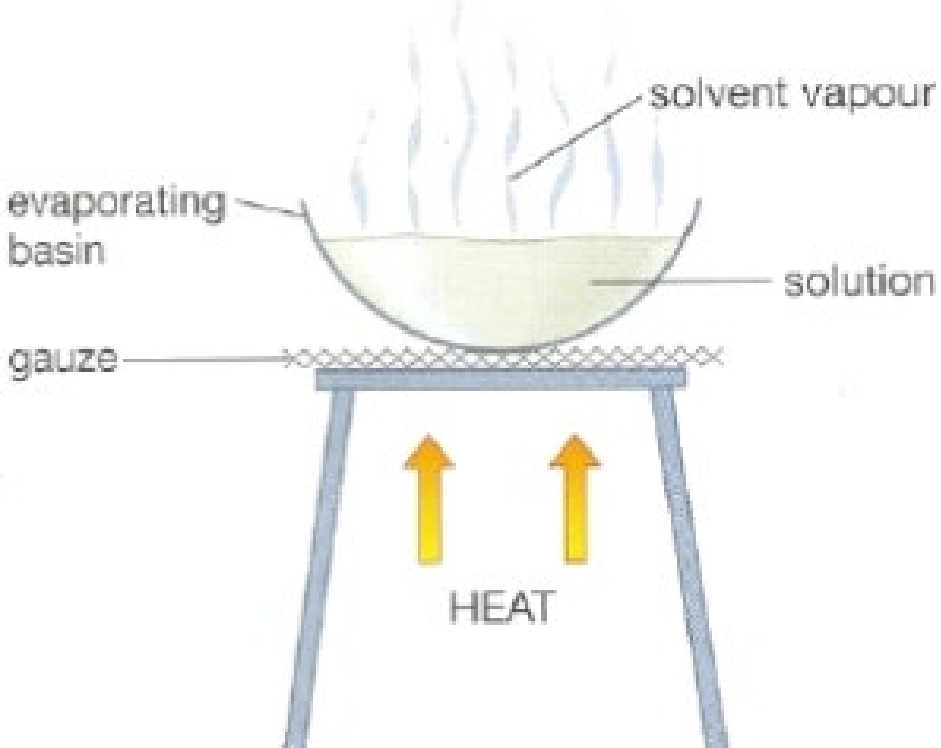
- *Apparatus*: funnel, conical flask, filter paper, stirrer, retort stand etc.
- *Procedure*: set up the apparatus as shown in the diagram.
- *Result*: the liquid portion passes through the filter paper as ***filtrate*** while the insoluble solid remains on the filter paper as ***residue***.
- Application: Water purification, breweries and bottling industries.



4. **Evaporation to dryness**: This method is used to recover soluble solute from solution by heating the solution until the solvent dries up.

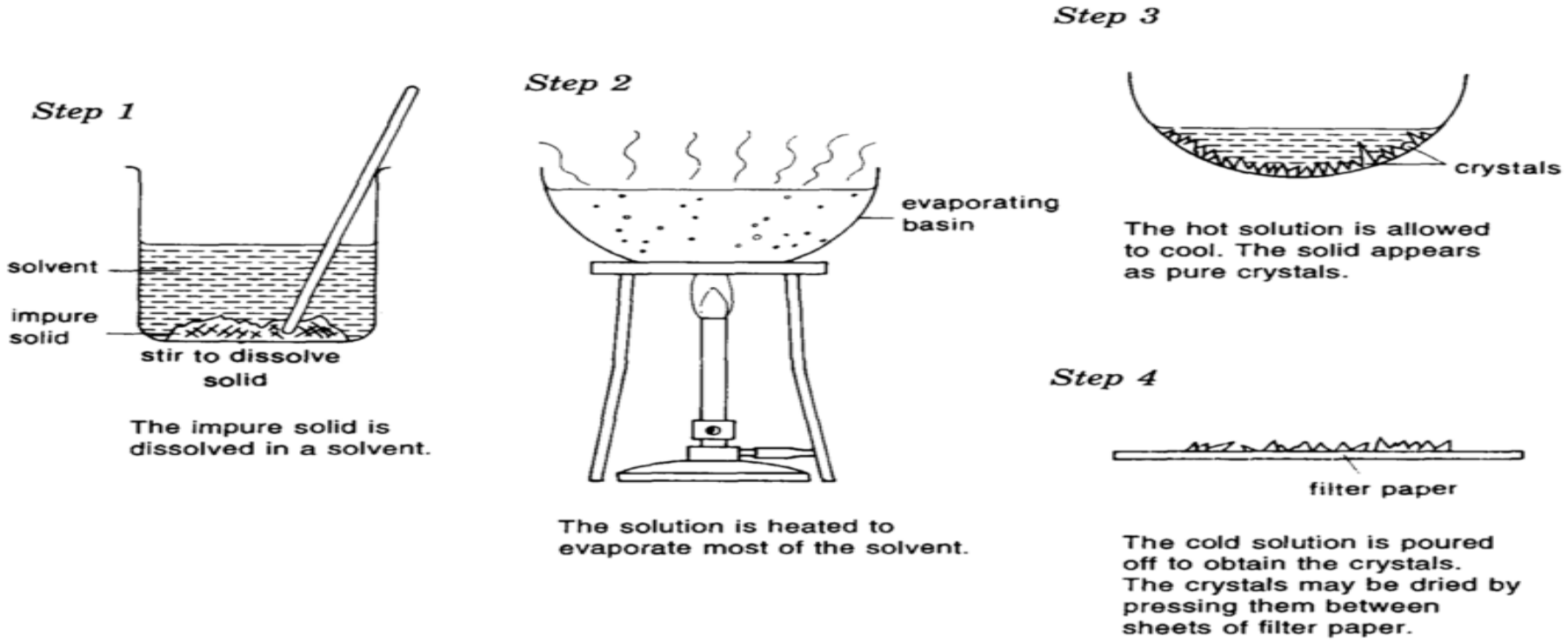
- *Apparatus*: evaporating dish, tripod stand, Bunsen burner, wire gauze, water/sand bath.
- *Procedure*: put the solution in the evaporating dish. Place the dish on a beaker in which there is some water. Put the beaker with the dish on the tripod stand and heat gently
- *Result*: the liquid portion(solvent) dries up leaving the solid(solute) behind in the dish.
- Application: used in salt making.

Note:- *this method is not suitable for separating salts(substances) that are easily decomposed(broken down) by heat.*
- The water bath brings about steady rate of evaporation.



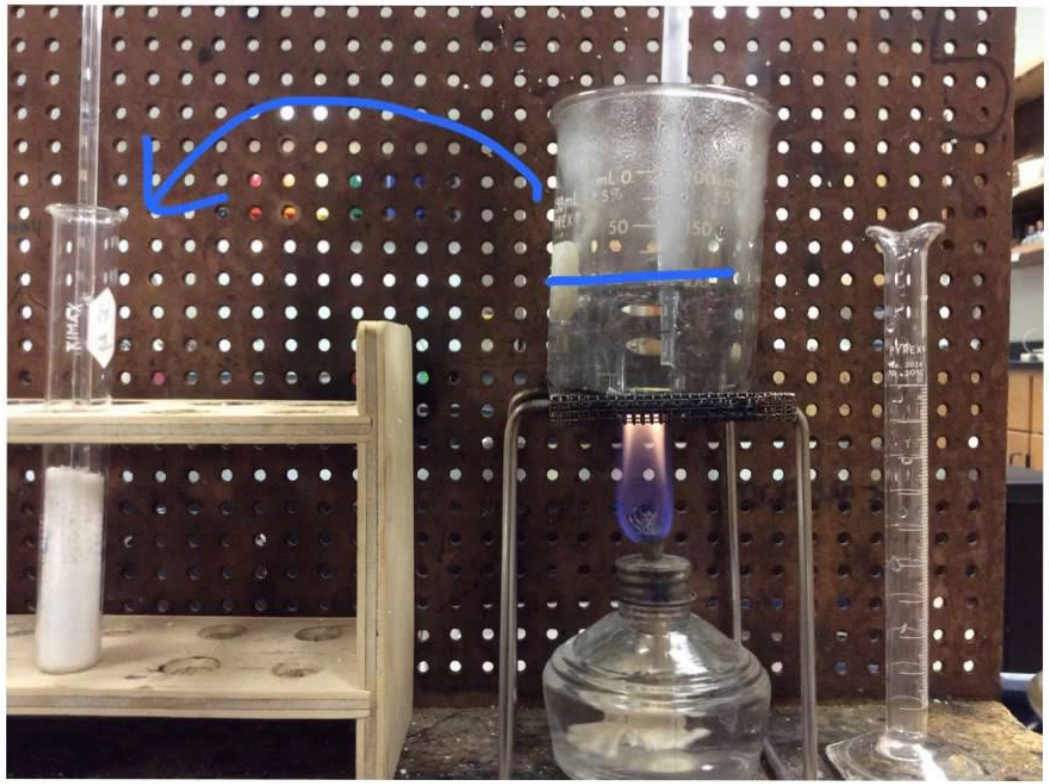
5. **Crystallization**: crystallization is used to separate salts which decompose easily on heating, from their solutions.

- *Apparatus*: same as for evaporation to dryness.
- *Procedure*: the solution is first heated to evaporate some of the solvent (concentration). The solution becomes saturated. When this is cooled, crystals of the solute begins to form. Filter the crystals and dry between filter paper.



- **To induce formation of crystals**:
- *- scratch inside of the vessel containing the solution or*
- *- add pure sample of the same salt as seed (seeding)*.
- *Result*: the salt (solute) crystalizes out and is obtained by filtration.
- *Application*: this method is used in drugs and sugar industries (where purity is very important).
- **Note**: *this method produces pure salts, usually with water of crystallization*.

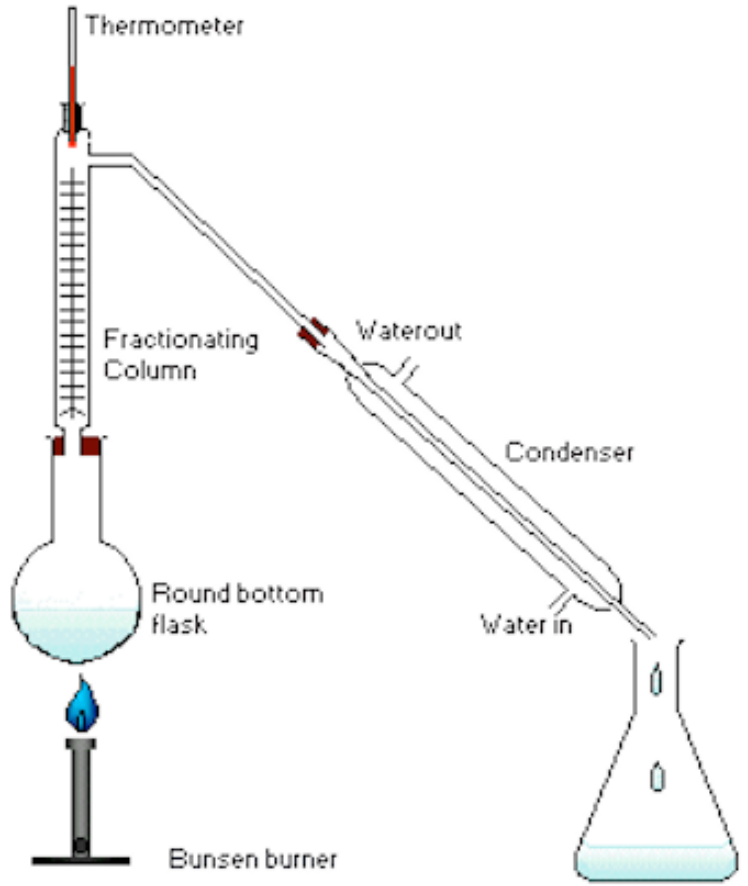
- 6. **<u>Fractional crystallization</u>**: This method is used to separate two or more solutes present in the same solution with roughly equal amount.
- **Procedure**: The method is the same as ordinary crystallization. However, since the solutes have different solubility at different temperatures, during cooling, each solute crystallizes out at different temperatures.



7. **Distillation**: Simple distillation is best used to obtain a liquid solvent from a liquid solution (miscible).

- **Procedure**: The solution is heated in a distillation flask to which a condenser is attached. The vapour of the liquid
- with the lower boiling point vapourises, passes through the condenser and is then converted to liquid again.

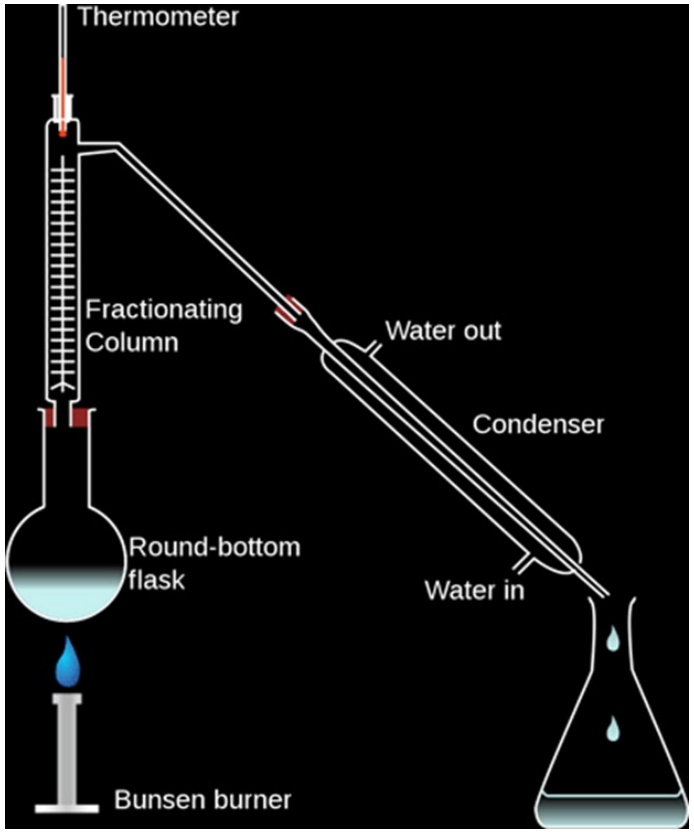
Apparatus: distillation flask, Liebig condenser, Bunsen burner, tripod stand, wire gauze, beakers, thermometer.



Fractional Distillation (For Miscible Liquids):

Fractional distillation is a method of separating a mixture of two or more liquids provided that they have different boiling points:

- Application: It is used in refining crude oil, Separation of air into its components



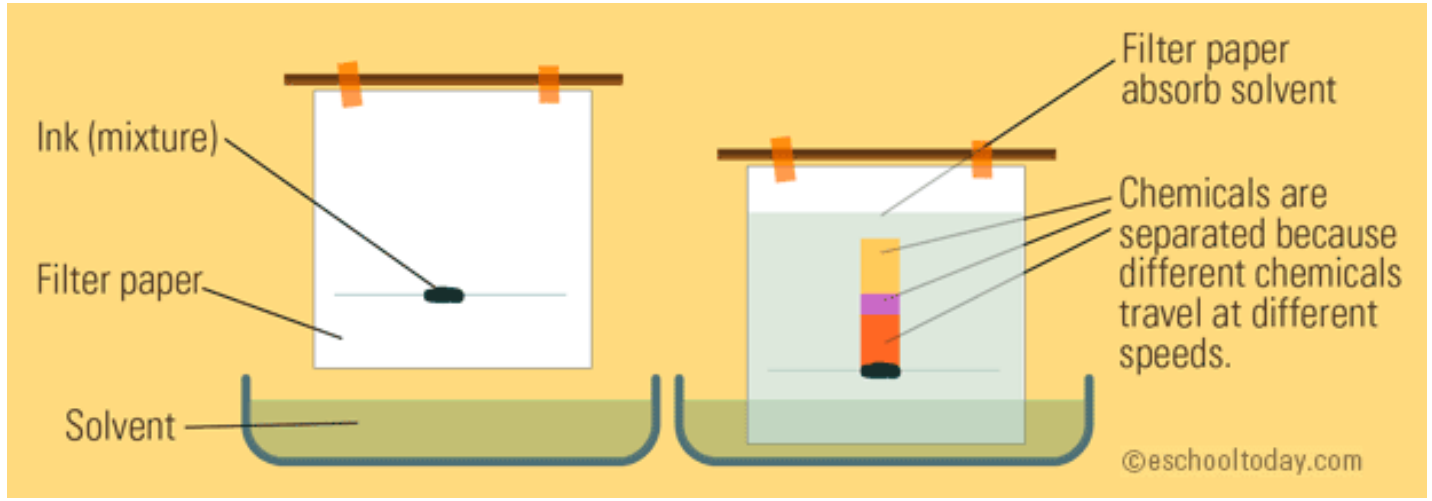
Chromatography: This is the method used to separate complex mixtures especially, colored mixtures.

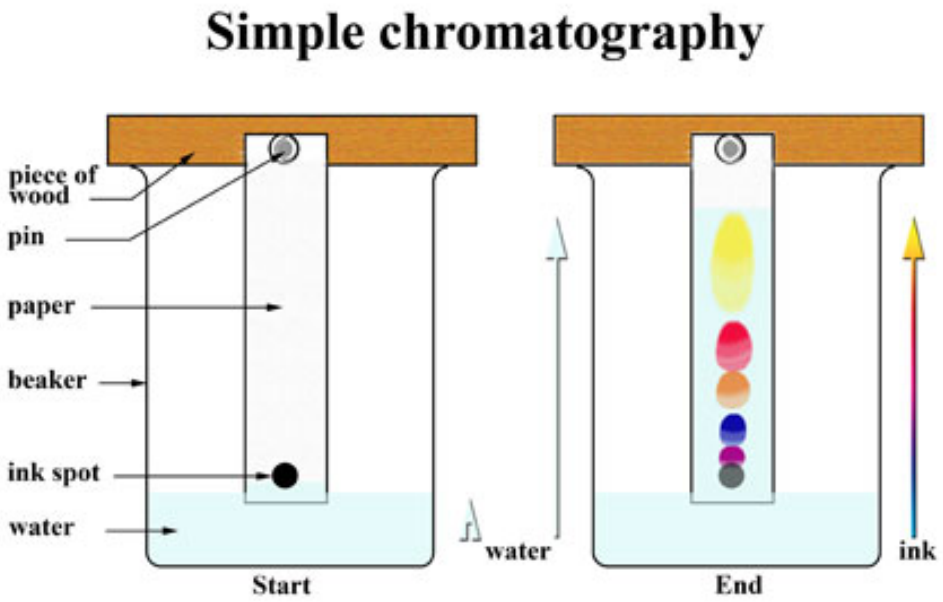
Types of Chromatography: The types of chromatography are:

Gas chromatography, Column chromatography, Paper chromatography and Thin layer chromatography.

Paper chromatography: This is the simplest type. It is usually used to separate mixture of colored solids e.g.. dye.

Apparatus: piece of filter paper, test tube, split wooden cork, solvent, stationary phase.





- Procedure: Introduce a drop of the colored mixture into the slight line with the aid of a capillary tube; allow to dry. Insert the filter paper into a solvent in a boiling tube (the filter paper is held in the split wooden cork which is also used to stopper the tube. Allow to stand for sometime.
- Result: As the solvent rises, the components of the solute are carried along the paper (stationary phase). The components are deposited as spots on the paper each depending on its rate of adsorption.
- Application: The method is used for complete separation of solute components and chemical analysis.

Sublimation

- If we have a mixture of two solids, one of them undergoes sublimation we can easily separate them by heating the mixture using a Bunsen burner.
- One solid might melt while the other one will directly sublime into a gas. This process must be done in a fume cupboard in order to collect the gas.
- Examples of substances that sublime are: ammonium chloride, Iodine, Camphor