

SUBJECT:- CHEMISTRY

TOPIC:- PERIODICITY OF ELEMENTS

CLASS:- SS 2

OBJECTIVE:- *At The End Of The Topic The Students Should Be Able To:*

1. Name some chemists associated with the periodic table;
2. Define the modern periodic law;
3. Identify the main features of the periodic table;
4. Sketch periodic table for the first twenty elements;
5. List some common members of the various groups;
6. Explain the trend in properties of the elements.

DEVELOPMENT

In the early days, it had been noted that elements resembled one another in their chemical properties e.g. sodium and potassium, magnesium and calcium.

Many chemists tried to classify the known elements:- some of them are :- Lavoisier(1789), Dobereiner(1829), Newlands(1865) and Mendeleev V 1869. The discovery of the electronic structure of the elements helped in establishing the periodic table.

MODERN PERIODIC LAW

The modern periodic law states that the properties of elements are a periodic function of their atomic numbers.

MAIN FEATURES OF THE PERIODIC TABLE

The modern form of the periodic table is divided into Eight (8) vertical columns known as **groups** and Seven (7) horizontal rows known as **periods**.

PERIODICITY OF THE FIRST TWENTY ELEMENTS

GROUP/ PERIOD	GROUP							
	I	II	III	IV	V	VI	VII	O
PERIOD 1	1+ I							He 2
PERIOD 2	Li 2,1	Be 2,2	B 2,3	C 2,4	N 2,5	O 2,6	F 2,7	Ne 2,8
PERIOD 3	Na 2,8,1	Mg 2,8,2	Al 2,8,3	Si 2,8,4	P 2,8,5	S 2,8,6	Cl 2,8,7	Ar 2,8,8
PERIOD 4	K 2,8,1	Ca 2,8,8,2						

GROUPS

The vertical columns of elements called groups are numbered from 0 -7. The elements in the same group have the same number of electrons in the outermost shell (valence electrons).

Elements in the same group have similar chemical properties.

PERIODS

The horizontal row of elements called periods are numbered from 1 -7. All the elements in the same periods have the same number of electron shells. However the number of valence electrons of the elements in the same period increase by one across the period.

The 1st three elements in same period-groups 1 – 3 are metallic while those of groups 4 – 7 are non-metallic.

Among the elements in period 6 and 7 are the elements of the lanthanide and actinide series.

GROUP 1 (ALKALI METALS)

Common elements in group 1 are sodium and potassium. They are univalent with one electron in the outermost shell. They ionize readily and form electrovalent bonds. They are good reducing agents and easily donate the electron in its outer shell. They are good conductors of electricity. $\text{Na} \longrightarrow \text{Na}^+ + \text{e}^-$.

REACTIONS:- They react vigorously in cold water to form alkalis. Hydrogen gas is liberated. $2\text{Na}_{(s)} + 2\text{H}_2\text{O}_{(l)} \longrightarrow 2\text{NaOH} + \text{H}_2$

Their trioxonitrate(V) salts decompose with difficulty on heating to form the dioxonitrate(II) salt and oxygen; $2\text{KNO}_{3(s)} \longrightarrow 2\text{KNO}_{2(s)} + \text{O}_{2(g)}$.

Sodium and potassium trioxocarbonate(IV) are the only soluble trioxocarbonate(IV) and **do not** decompose on heating.

GROUP II (ALKALINE EARTH METALS)

Members in this group include: Beryllium, Magnesium and Calcium. They have two electrons in their outermost shell. They form electrovalent bonds, donating two electrons. $\text{Ca} \longrightarrow \text{Ca}^{2+} + 2\text{e}^-$.

REACTIONS:- Calcium reacts with cold water slowly. Magnesium reacts with steam. Hydrogen Gas is produced. Calcium forms the hydroxide while Magnesium forms the oxide. $\text{Ca} + 2\text{H}_2\text{O}_{(l)} \longrightarrow \text{Ca(OH)}_2 + \text{H}_2$; $\text{Mg} + \text{H}_2\text{O}_{(g)} \longrightarrow \text{MgO} + \text{H}_2$.

Their trioxonitrate(V) decompose readily on heating to produce the oxide, oxygen and nitrogen(IV) oxide, (NO_2). $2\text{Ca(NO}_3)_2 \longrightarrow 2\text{CaO} + \text{O}_2 + 4\text{NO}_2$.

Their trioxocarbonate(IV) are insoluble in water and readily decompose on heating. $\text{MgCO}_3 \xrightarrow[\Delta]{\text{heat}} \text{MgO} + \text{CO}_2$.

GROUP III: B, Al, Ga, In, Tl

Common elements are Boron and Aluminum. They are trivalent and form electrovalent bonds. $\text{Al} \longrightarrow \text{Al}^{3+} + 3\text{e}^-$.

REACTIONS:- Aluminum does not react with water in any form. Aluminum oxide is insoluble in water. The oxides and hydroxides are amphoteric in nature – they have acidic and basic properties.

As acids, they react with bases to form normal salts. $\text{Al}_2\text{O}_3 + 3\text{H}_2\text{SO}_4 \longrightarrow \text{Al}_2(\text{SO}_4)_3 + 3\text{H}_2\text{O}$.

Normal Salt.

As a base, $\text{Al}_2\text{O}_3 + 2\text{NaOH} + 3\text{H}_2\text{O} \longrightarrow 2\text{NaAl}(\text{OH})_4$ or $\text{Al}(\text{OH})_3 + \text{NaOH} \longrightarrow \text{NaAl}(\text{OH})_4$
Sodium tetrahydro aluminato(iii)

Aluminum trioxonitrate(v) decompose on heating to give the oxide, oxygen and nitrogen(iv)oxide. $4\text{Al}(\text{NO}_3)_3 \longrightarrow 2\text{Al}_2\text{O}_3 + 3\text{O}_2 + 2\text{NO}_2$.

GROUP IV: C, Si, Ge, Sn, Pb

Common elements are Carbon and Silicon. They are tetravalent and exhibit covalency.

REACTION:- Carbon does not react with water but Silicon reacts with steam.

$\text{Si}_{(s)} + 2\text{H}_2\text{O}_{(g)} \longrightarrow \text{SiO}_{2(s)} + 2\text{H}_2$ Both form oxides when heated in air $\text{C} + \text{O}_2 \longrightarrow \text{CO}_2$ $\text{Si} + \text{O}_2 \longrightarrow \text{SiO}_2$.

Silicon and its oxides dissolve in hot conc. Alkali to yield trioxosilicates(IV).

$\text{Si}_{(s)} + 2\text{NaOH} + \text{H}_2\text{O} \longrightarrow \text{Na}_2\text{SiO}_3 + 2\text{H}_2$, $\text{SiO}_{2(s)} + \text{NaH} \longrightarrow \text{Na}_2\text{SiO}_3 + \text{H}_2\text{O}$.

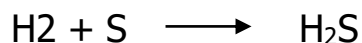
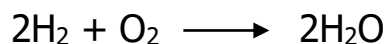
GROUP V: N, P, As, Sb, Bi

Common elements are nitrogen and phosphorus. They are non metals and show two common valences – 3 and 5. They are electron acceptors and form several oxides of Nitrogen = N_2O , NO , NO_2 , Phosphorus, P_2O_5 , P_4O_{10} . All oxides are acidic and will dissolve in order to form acids.

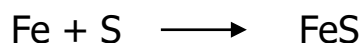
$2\text{NO}_2 + \text{H}_2\text{O} \longrightarrow \text{HNO}_2 + \text{HNO}_3$

GROUP VI: O, S, Se, Te, Po

Common elements are oxygen and sulphur. They are non-metals and electron acceptors. They combine directly with hydrogen to form H_2O and H_2S

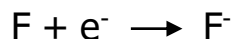


They are oxidizing agents



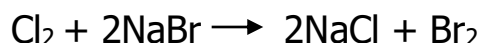
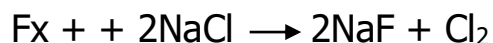
GROUP VII: HALOGENS

The elements in the group are called the halogens (Salt formers). They exist as diatomic molecules – F_2 , Cl_2 , Br_2 , I_2 . They are non-metals and very reactive. They are electron acceptors and very oxidizing.



F and Cl are gases at room temperature

They are colored. F is yellow, Cl is greenish yellow, Br is a volatile brown liquid, is dark grey/violet. Oxidizing power decreases down the group.



GROUP O: He, Ne, Ar, Kr, Xe, Rn

Members include Helium, Neon, Argon, Krypton, Xenon and Radon. They are called inert, rare or noble gases. They have the maximum number of electrons in their outer shell. They are mono atomic.

TRANSITION ELEMENTS

They exist between groups II and three. They include Sc, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn. They are metallic in character. Their characteristics include high boiling and melting point, variable oxidation states, coloured ion complex ions, magnetic properties, catalytic activities.

ELECTRONIC CONFIGURATION AND PERIODIC TABLE

The elements in groups I and II have their last electron in the S orbital. They are called S-block elements. Group III-7 and O elements have their last electron in the P. orbital, hence called P-block elements.

The transition elements have their last electron in the d-block and hence called the d-block elements. The lanthanide and actinide series are referred to as f-block elements.

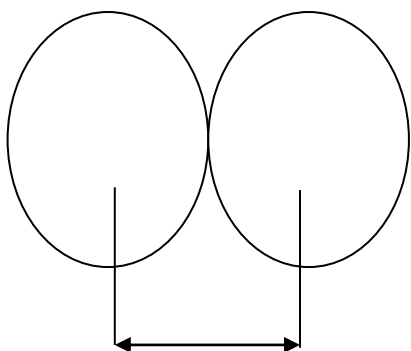
TREND IN PERIODICITY OF PROPERTIES OF ELEMENTS

By periodicity we mean the regular pattern in which the physical and chemical properties of the different elements present themselves in the periodic table. The trends to be considered include Atomic radius, ionic radius, ionization energy, electron affinity and electronegativity.

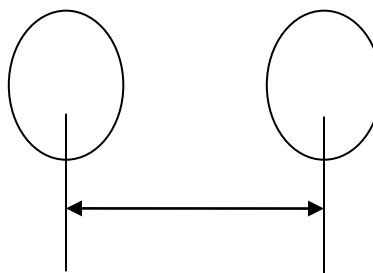
ATOMIC RADIUS

The atomic radius is half the internuclear distance between two identical atoms that are covalently bonded. (Covalent radius).

Van der Waals radius is half the internuclear distance between two atoms not covalently bonded. Generally van der Waals radius)



Covalent radius



Van Der Waals radius

Nm ⁻³	L1	Be	B	C	N	O	F
	0.123	0.089	0.082	0.077	0.070	0.066	0.064
	Na	Mg	Al	Si	P	S	Cl
	0.156	0.136	0.125	0.117	0.110	0.104	0.099.

DOWN THE GROUP

The atomic number increases, the number of shells also increases and this leads to an increase in atomic radius.

ACROSS THE PERIOD:- electrons are being added to the shell at about the same distance from the nucleus, and protons are being added to the nucleus. Therefore the electrons are attracted and being pulled towards the nucleus. Hence atomic radius decreases across the period.

IONIC RADIUS

When a metal loses electron positive ions are formed (Cationic radius) Non-metals form ions by gain of electrons. Generally Cationic radius is less than atomic radius.

Anionic radius is greater than the atomic radius; as electrons are gained and the effective nuclear charge decreases.

For ions in the same group, the ionic radius increases down the group.

For isoelectronic ions (ions having the same number of electrons but different proton numbers, the ionic radius decreases as the atomic number increases (effective nuclear charge increases (Ne, Na⁺, Mg²⁺, Al³⁺).

IONIZATION ENERGY

Ionization energy is the energy required to remove an electron from the outermost shell of a gaseous atom. $M_{(g)} \longrightarrow M^+_{(g)} + e^-$.

The 2nd ionization energy is the energy required to remove the most loosely bonded electron from a singly (univalent) charged ion.



Ionization is affected by:

1. The distance of the outermost electrons from the nucleus. As the distance increases the attraction of the positive charge/nucleus to the negative, electrons decreases and ionization energy decreases.

2. The size of the effective nuclear charge. As the size of the effective nuclear charge increases, its attraction for the outermost electron increases i.e ionization energy increases.
3. The screening effect of inner most electrons.

DOWN THE GROUP:- The ionization energy decreases, there is an increase in atomic radius and hence a decrease in effective nuclear charge. There is also shielding of inner electrons from the outermost electrons – it is easier to remove outer electrons.

ACROSS THE PERIOD:- Ionization energy increases from left to right as the atomic radius decreases and attraction between the nucleus and the outermost electron increases as the electron is added to the same shell.

ELECTRON AFFINITY

Electron affinity means electron loving. Electron affinity is the energy released when a gaseous atom in its lowest energy state adds on an electron. Process is opposite to ionization energy. $\text{Cl}_{(g)} + e^- \longrightarrow \text{Cl}^-$ EA. - -ve.

Electron affinity increases (becomes more negative) across the period from left to right. This is because of the increase in effective nuclear charge across the period which makes an electron to be added to the same shell to be strongly attracted to the nucleus down the group.

ELECTRONEGATIVITY

Electronegativity refers to the tendency or ease with which an atom bonded in a molecule attracts an electron to itself. Electronegativity is measured in Pauling unit.

Electronegativity generally increases across the period from left to right and decreases down the group. Fluorine is the most electronegative element.

Quantitatively, Electronegativity = $\frac{\text{Effective Nuclear Charge}}{\text{Covalent Atomic Radius}}$.

Electronegativity increases across the period as there is increase in effective nuclear charge and decrease in atomic radius.

DOWN THE GROUP:- Electronegativity decreases as the effective nuclear charge decreases and atomic radius increases.

SUMMARY OF PERIODICITY OF PROPERTIES

ATOMIC PROPERTY	TREND DOWN THE GROUP	TREND ACROSS THE PERIOD
Nuclear Charge	Decreases	Increases
Screening Effect	Increases	Decreases
Atomic Radius	Increases	Decreases
Ionic Radius	Increases	Decreases
Ionization Energy	Decreases	Increases
Electron Affinity	Decreases	Increases
Electronegativity	Decreases	Increases
Electropositivity	Increases	Decreases
Reducing Power	Increases	Decreases
Oxidizing Power	Decreases	Increases

SUBJECT: CHEMISTRY**TOPIC: RADIOACTIVITY****CLASS: SS 2**

OBJECTIVES: At the end of the topic the students should be able to

1. Define radioactivity;
2. Give the types of radiation;
3. State characteristics of radioactivity;
4. Explain the processes of detection of radiation;
5. List the types of radioactivity;
6. Define half life;
7. State some importance of radioisotopes;
8. Differentiate between nuclear fission and nuclear fusion.

PREVIOUS KNOWLEDGE: Students have studied the atomic particles and charges that makeup the atom.

HISTORY

In 1896 Becquerel observed that a crystal of uranium salt spontaneously emitted radiation which could penetrate through an opaque material to affect a photographic plate.

Later in 1898, Pierre and Marie Curie detected some radioactivity in thorium, polonium and radium.

Radioactivity is the spontaneous emission of radiation by an element.

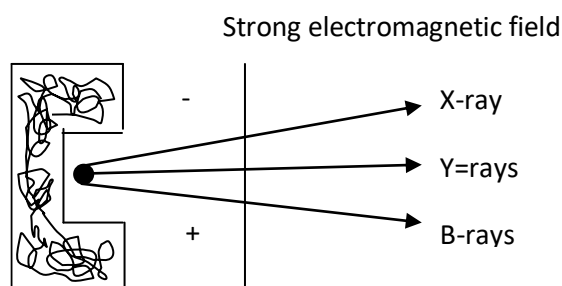
Such an element is called a radioactive element. An element may have stable and radioactive isotopes of ^{12}C of ^{14}C .

Radioactive elements include $^{238}_{92}\text{U}$, $^{234}_{90}\text{Th}$, $^{234}_{92}\text{U}$, $^{236}_{88}\text{Ra}$, $^{218}_{84}\text{Po}$

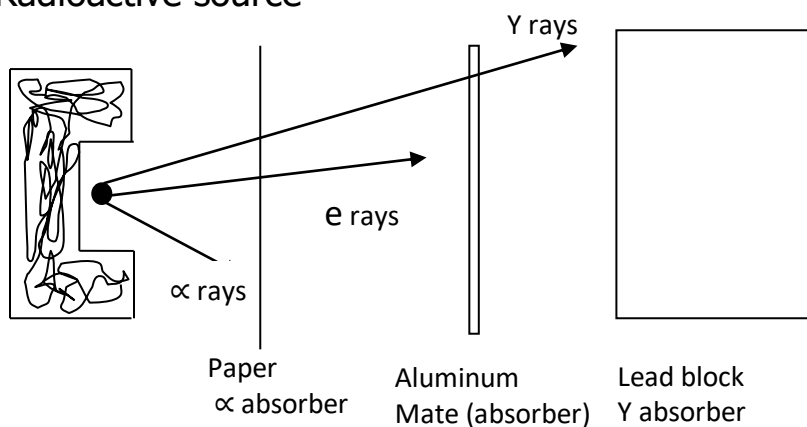
TYPES OF RADIATION (FROM RUTHERFORD EXPERIMENT)

1. **ALPHA-RAYS (xrays)** (1) These are fast moving streams of positively charged particles, each having a mass of 4 and atom number of 2. The α particle is actually helium nucleus, ^4_2He .
(2) They are reflected towards the negative plate in an electrostatic field (3) they have low penetrating power (4) they travel in air but are stopped by a thin sheet of paper or aluminum foil.
(3) They ionize gases through which they pass.

2. **BETA RAYS (c)** (1) These are fast moving streams of electrons. (2) They are negatively charged and have a small mass (3) They are deflected towards the positive plate in an electrostatic field. (4) each particle has a mass number of 0 and a charge of -1 (-1^0e) (5) Beta rays are more penetrating than α rays $\frac{2}{2}^3m$ in air (6) The ionizing power is not as strong as that of α particles
3. **GAMMA RAYS** (1) They have very high penetrating power (2) They are not deflected by magnetic or electric fields and so are not charged (3) they are not particles but electromagnetic waves length. They travel with the speed of light and can penetrate about 100m through air or pass through 0.5m of Iron. They can cause fluorescence in substances like zinc sulphide.



Radioactive source



CHARACTERISTICS OF RADIOACTIVITY

1. A radioactive substance emits radiation continually and spontaneously.
2. Temperature and pressure have no effect on the rate at which radiation is emitted.
3. The radiation can penetrate through opaque matter (unlike visible light)
4. It affects photographic plates (like visible light).
5. It ionizes gases through which it passes causing glow or fluorescence on some substances like zinc.

6. A lot of energy is released during radioactivity. The energy released is about a million times as great as that liberated during chemical reaction. The energy is called nuclear energy.

SUMMARY OF PROPERTIES OF α , β , & γ RAYS

Property	α -Ray	β Ray	γ Ray
Nature	${}^4_2\text{He}$	electrons ${}^{-1}_0\text{e}$	Electromagnetic Waves
Electrical energy	+2	-1	nil
Mass	4units	$\frac{1}{1840}$ units	nil
Velocity	speed of light	3-90% Sp of light	speed of light
Relative penetration	1	100	10,000
Absorber	thin paper	metal plate	lead block

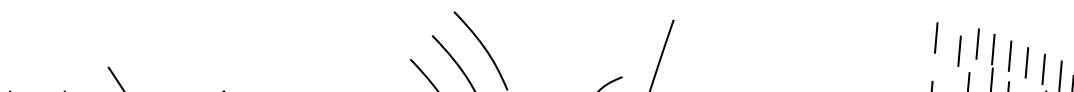
DETECTION OF RADIATION

The detection of radioactive emission is based on the ionization which these rays cause along their path. Alpha rays cause much ionization. (β) rays is less and γ very little. Ionization is caused by these rays when they strike off the outer electrons from atoms through which they pass. Devices for detecting radiation include (1) scintillation counter, (2) Diffusion Cloud Chamber. (3) Geiger Muller Counter.

(1) SCINTILLATION COUNTER

Contain materials glow or fluorescence when exposed to radiation e.g. Zinc. The glow is made up of tiny flashes of light or scintillations. These may be seen under a microscope or counted with a suitable device.

(2) DIFFUSION CLOUD CHAMBER: This is used for detecting the actual paths followed by individual particles. These ionizing particles are allowed to pass through a gas which has been supersaturated with water vapour. The ions formed in the track of the ionizing particles act like dust. As a result the path of the particle is revealed as a visible vapour trail the tracks could be photographed.



α Particles

β particles

γ particles

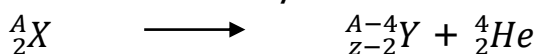
GEIGER MULLER COUNTER: The device is used for detecting the path of ionized gaseous molecules produced by radiations. It is a glass tube containing two electrodes maintained at a PD of about 1000volts. The path is detected by clicks from a loud speaker or movement of the needle of a rate meter.

RADIOACTIVE DISINTEGRATION

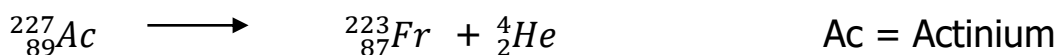
When a certain quantity of a radioactive material disintegrates spontaneously the word decay is used. During disintegration, a radioactive atom emits either an alpha or a beta particle. The disintegrating nucleus undergoes a change and becomes the nucleus of a different element. The new nucleus is called the daughter nucleus and the process is called the transmutation of an atom.

TYPES OF RADIOACTIVITY

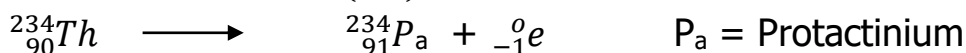
1. Loss of Alpha particle (α Decay) This reduces the atomic number of the atom by 2 and its mass by 4 units



Parent nucleus Daughter nucleus



2. **LOSS OF BETA PARTICLE:** (${}^0_{-1}e$) Here the atomic number of the new atom increases by one unit and the mass number remains unchanged.

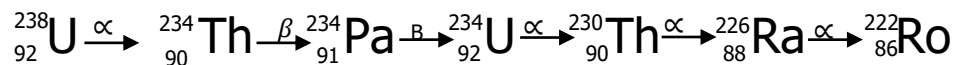


3. **K-CAPTURE (EMISSION OF POSITRON):** This happens with nuclei that have too many protons relative to their number of neutrons. The effect is a change of a

proton to a neutron within the nucleus. The mass number remains constant but the atomic number reduces by one (1).

RADIOACTIVE DECAY SERIES

Sometimes the nuclei of the new elements formed (daughter nucleus) during radioactivity decay are themselves unstable and will undergo further disintegration. The series continues until a stable nucleus is finally produced e.g.



NUCLEAR STABILITY & RADIOACTIVITY DECAY

The nuclei of a radioactivity element tend to disintegrate spontaneously because they are unstable. The stability of an atomic nucleus is related to the ratio of neutrons to protons. Atoms with neutron proton ratio of < 1 or > 1.5 tend to be unstable, and undergo decay. Generally most naturally occurring light elements have stable nuclei.

RATE OF RADIOACTIVITY DECAY

Elements decay at different rates. Some stay for many before decaying, some disappear in few seconds.

The number of atoms of radioactivity element that distinguish per unit time is a constant fraction of the total number of atoms of the element present. The fraction is called the decay constant (λ).

$$\lambda = \frac{\text{no of atoms disintegrating per unit time}}{\text{no of atoms in the source.}}$$

HALF LIFE

Observation shows that no matter the mass of radioactivity isotope one starts with, it takes a definite length of time for half of that mass to disintegrate. This length of time is known as the half time of the radioactivity element.

The half life of a radioactivity element is the time taken for half of the total number of atoms in a given sample of the element to decay.

IMPORTANCE OF HALF LIFE

Half life is a measure of the stability of the element. If the half life is a thousand years such isotope is more stable than one whose half life is a few days. E.g. ^{238}U has a half life of 4.5×10^9 years but ^{14}Na has a half life of 15hrs.

QUESTION

1. If it takes 15hrs for 10g of Na – 24 in 20g of the isotope to decay, how long does it take 0.5g out of 1g of the isotope to disappear – (15hrs).
2. 10g of a radioactivity isotope with a half life of 2hrs is left in a cupboard at 8:00am, what mass of it remains at 6:00pm the same day.

Between 8:00am to 6:00pm there are 5(2hrs) intervals,

$$(10\text{hrs})^{10/2} = 5.$$

$$1^{\text{st}} \text{ 2hrs } 10/2 = 5 ; 2^{\text{nd}} \text{ 2hrs } 5/2 = 2.5 ; 3^{\text{rd}} \text{ 2hrs } 2.5/2 = 1.25 \propto 4^{\text{th}} 1.25/2 = 0.625; 5^{\text{th}} \\ = 0.625/2 = 0.3125\text{g}.$$

Or mass left = $Q_0/2^n$ n = no of half lives

Q = original quantity

$$= 10/2^5 = \frac{10}{32} = 0.3125\text{g}.$$

3. The half life of molybdenum is 67.0 hours. How much of a 1.0mg sample of $^{99}_{42}\text{Mo}$ remains after 335hours.

$$\text{Mass left} = Q/2^n \text{ No of half lives} = \frac{335}{67} = 5 \\ = 1/2^5 = \frac{1}{32} = 0.03125\text{g}.$$

- B. ^{32}P has a left life of 14days. Calculate the time taken for a given amount of ^{32}P to decay to $1/8$ of its original number.

Take quantity to be 20. $1/8$ of 20 = 2.5

$$20 \xrightarrow{1^{\text{st}}} 10 \xrightarrow{2^{\text{nd}}} 5 \xrightarrow{3^{\text{rd}}} 2.5$$

$$= 14 \text{ days} \times 3 = 42 \text{ days}.$$

4. If after 76 days, 20g of a radio nuclei x is found to have decayed such that only 5g of x remains, what is the half life of x.

From 20g to 5gm these are 2 stages

$$\therefore 76/2 = 38 \text{ days each}$$

Half life = 38 days.

RELATIONSHIP BETWEEN DECAY CONSTANT AND HALF LIFE

$$t_{\frac{1}{2}} = \frac{0.692}{\lambda} \quad t_{\frac{1}{2}} \text{ in seconds.} \quad \lambda = \text{decay constant.}$$

BIOLOGICAL EFFECT OF RADIATION

Exposure to radioactive materials has harmful effects on human life. Mild doses of radiation can cause changes in cell structure and body chemistry – Anaemia, cancer, genetic changes are common. Heavy doses lead to death. Care should be taken in handling radioactive materials. The best shields against radiation are blocks of iron or lead.

USES OF RADIOISOTOPES

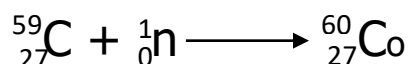
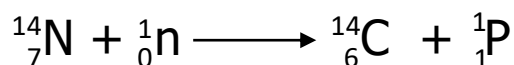
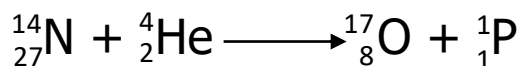
1. **APPLICATION IN MEDICINE:-** Y-rays are used to kill cancerous cells in the treatment of cancer. ($^{60}_{27}\text{Co}$). Radioactive ^{131}I is used to treat thyroid diseases while radioactive phosphorus- ^{32}P is used to treat leukaemia (too many white blood cells causing weakness). Heart pace makers can be powered by nuclear batteries for about 10yrs.
2. **STERILIZATION:-** γ -rays kill germs and other harmful bacteria when used to irradiate objects. Hence used in sterilizing surgical equipment to avoid contamination.
3. **INDUSTRIAL USE:-** Used to monitor the thickness of materials like metals, plastics etc. by detecting for variations in the intensity of radiation passing through the material. Can also be used to trace leakages in pipes by adding a radioisotope to the flowing liquid and testing for radioactivity along the pipe. (tracers).
4. **AGRICULTURAL USES:-** Used in agricultural research to induce mutation (Genetically modified crops) in plants and animals to obtain new improved varieties with desired characteristics of early maturity, higher yield etc.
5. **APPLICATION IN RESEARCH:-** They are used to follow the course of chemical reactions mechanism. They are used as tracers in research – assimilation of potassium by plants, assimilation of CO_2 in photosynthesis.
6. **DATING TECHNIQUES:-** The presence of long live U – 238 with a half life of 4.5×10^9 years in the earth's crust is utilized to estimate the age of rocks. Radiocarbon dating is used to determine the age of organic remains to produce ^{14}C . We have $^{14}_7\text{N} + {}^1_0\text{n} \longrightarrow ^{14}_6\text{C} + {}^1_1\text{P}$. ^{14}C has a half life of 5760 years. If a tree is cut down, check the quantity of ^{14}C in air, and check that on the tree. If half then tree come down about 5760 years ago.
7. **NUCLEAR PLANTS:-** The energy from nuclear reactions can be used to generate electricity – used in submarines etc.
8. **PRODUCTION OF ATOMIC BOMB:-** From the reactions of nuclear elements.

NUCLEAR ENERGY

During nuclear reactions there is evolution of a large quantity of heat. The heat could be converted to good use.

ARTIFICIAL TRANSMUTATION (INDUCES RADIOACTIVITY)

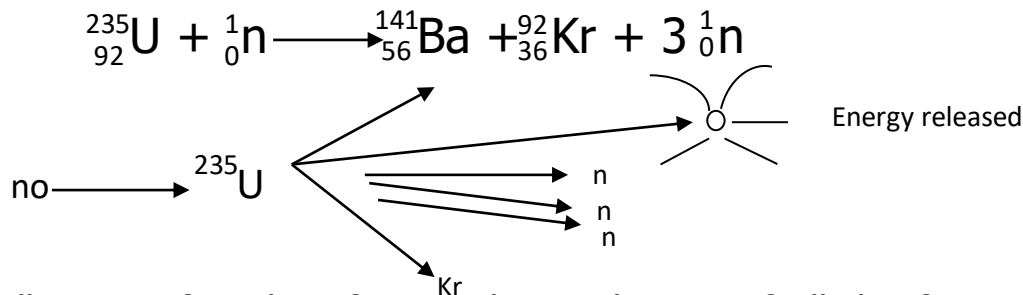
It is possible to carry out artificial transmutation by bombarding various elements with fast moving atomic particles like neutrons, protons α -particles etc.



Many of the products formed are isotopes which do not exist naturally. Many isotopes like curium, plutonium, and lawrencium have been made by this process – used in medicine, etc.

NUCLEAR FISSION

This is a process in which the nucleus of a heavy element is split into two nuclei of nearly equal mass with a release of energy.



In all cases of nuclear fission, the total mass of all the fragments and neutrons released differs from the original mass of the element and the mass of the bombarding neutron. The difference in mass is converted to energy.

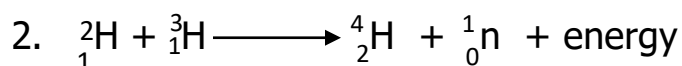
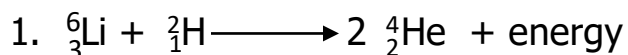
The neutrons produced could bombard other parent atoms to produce more energy, more neutrons and initiate chain reaction. This is the principle of atomic bomb, electricity for ships etc.

An atomic explosion results when just the right amount of fissionable material is brought together to be split by neutrons in a chain reaction. This is called the

critical mass of the atomic bomb. In nuclear plants the neutrons could be controlled by use of moderators e.g. graphite but not atomic bomb.

NUCLEAR FUSION

This is a process in which two or more light nuclei fuse or combine to form a heavier nucleus with a release of energy and radiation.



Reaction 2 is the bases for hydrogen or fusion bomb.

The reaction takes place at a higher temperature.

The power of the bomb is due to the energy released and the small loss in mass and partly due to the large quantity of γ -radiation produced.

ENERGY OF THE SUN

Thermonuclear reactions are believed to be the source of energy of the sun and stars. These reactions mainly involve the nuclear fission of hydrogen nuclei to form helium nucleus with liberation of energy.

DIFFERENCES BETWEEN CHEMICAL AND NUCLEAR REACTIONS

CHEMICAL REACTION	NUCLEAR REACTION
1. Outermost electrons are involved.	Protons and neutrons are involved.
2. Can be easily controlled.	Cannot be easily controlled.
3. Temperature & Pressure affect Chemical reactions.	Temperature and pressure have no effect on nuclear reactions.
4. Energy is released in small Amounts.	Energy is released in large amounts.

DIFFERENCES BETWEEN NUCLEAR FUSION AND NUCLEAR FISSION

FISSION	FUSION
1. Involves the process of splitting heavy nucleus into two small nuclei Of nearly equal mass.	Involves the combination of two or more light nucleus into a heavier nucleus.
2. A considerable amount of energy Is released during the process.	A great amount of energy is released during the process.

TOPIC: WATER

CLASS: SS 2

ABILITY: MIXED

OBJECTIVE: At the end of the topic the students should be able to:

1. Identify some types of water;
2. Draw the water cycle;
3. Describe the process of treating town water supply;
4. Define hardness in water;
5. Write equations for removal of hardness in water;
6. Define water pollution;
7. Identify sources of water pollution;
8. Define solutions and solvents;
9. Differentiate between true and false solutions.

DEVELOPMENT

WATER

OCCURRENCE: Water occurs in vast quantities all over the world in water bodies. It does not occur in its pure form in nature.

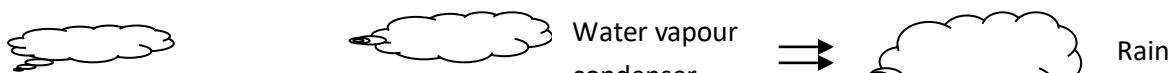
TPYES OF WATER

There are two major types of water: Natural and treated

1. **RAIN WATER:** Purest form of water. It is formed as a result of the condensation of water vapour in the atmosphere.
2. **SPRING WATER:** This is rain water which sinks through the porous soil layers but collects above an impervious layer. It is a good source of drinking water; with mineral salt.
3. **WELL WATER:** This is stagnant water. It contains a lot of clay, mineral salts and dead organisms.
4. **RIVER WATER:** Formed when spring or other running water come together.
5. **LAKES, SEA, OCEAN:** These form reservoirs for rivers and other running waters. They contain all sorts of substances including bacteria, mineral salts, air etc.

WATER CYCLE

All the different types of natural water are in constant circulation forming a gigantic water cycle. The largest collections of water are in the lakes, rivers, seas which are exposed to the atmosphere. Evaporation takes place continuously from them, and the water vapour formed condenses to water droplets in the atmosphere, form clouds and fall as rain.



TREATED WATER

Treated water is usually prepared for special purposes: Example: distilled water and pipe-borne water for townships.

DISTILLED WATER: This is the purest form of water. It is prepared by condensing water vapour or steam. The apparatus used for the purpose is Liebig condenser.

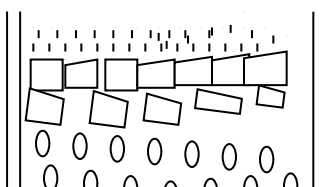
TREATMENT OF WATER SUPPLY

Water from the dams, lakes or rivers may contain high level of bacteria and undesirable micro-organisms. Hence there is the need for treatment to reduce these organisms. Also the water may contain clayed materials, mineral salt and other particles.

PROCEDURE

The procedure for treatment include:

1. Sedimentation/Flocculation/ Coagulation: By allowing the water to settle down or by use of flucculators to gather the particles or by addition of alum to coagulate the particles.
2. The water is then filtered using a filter bed
3. Aeration: Exposure to sunlight for dissolution of atmospheric oxygen which prevents anaerobic conditions that may produce foul odour. Sunlight also kills bacteria.
4. Addition of Chlorine: This acts as a germicide to kill bacteria. Others: $\text{Ca}(\text{OH})_2$ may be added to adjust the pH; fluoride may be added to prevent tooth decay and iodine may be added to prevent goiter. Water is now ready to be supplied to citizens.



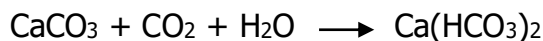
Filter BED

HARDNESS OF WATER

Water is said to be hard when it does not lather easily with soap.

ORIGIN OF HARD WATER

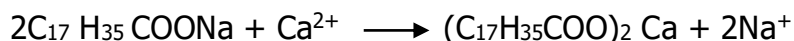
Water acquires hardness when it dissolves gypsum $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ or limestone from the soil over which it passes. Gypsum is sparingly soluble in water but limestone is not. However, the water which contains some Carbon(iv) oxide can dissolve CaCO_3 according to the equation:



Soluble

HARD WATER AND SOAP

Soap is the sodium or potassium salt of an organic acid. e.g. $\text{C}_{17}\text{H}_{35}\text{COONa}$ (Sodium Octadecanoate). When soap is added to hard water the dissolved salt in the water will react with soap to give the insoluble calcium or magnesium salts called 'scum' which stick to clothes and is difficult to rinse away.



Scum

TYPES OF HARDNESS

There are two types of hardness in water

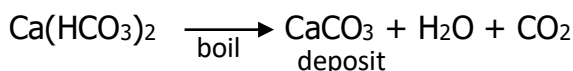
(1) Temporary hardness (2) Permanent hardness

TEMPORARY HARDNESS

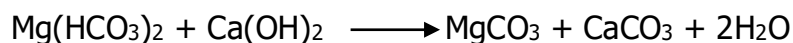
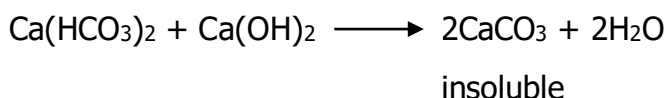
Temporary hardness is caused by the presence in water of calcium hydrogen trioxocarbonate(iv) $\text{Ca}(\text{HCO}_3)_2$ and magnesium hydrogen trioxocarbonate(iv) $\text{Mg}(\text{HCO}_3)_2$

REMOVAL OF TEMPORARY HARDNESS (SOFTENING)

(1) By Boiling – deposition of CaCO_3



(2) By adding calculated amounts of slaked lime Ca(OH)_2



(Note that if excess Ca(OH)_2 is used, this will cause hardness in water).

EFFECT OF TEMPORARY HARDNESS

i. Furring of kettles and boilers

When a kettle or boiler has been used to boil temporarily hard water for sometime there will be deposits of CaCO_3 which are fur-like.

ii. Formation of stalagmites and stalactites

These are pillars of limestone (CaCO_3) growing from the roof and floor of hot caves in area of temporary hardness. Temporary hard water flowing through the rooftop of the cave gets hot and decomposes the $\text{Ca(HCO}_3)_2$ in the water. A Calcium trioxocarbonate(iv) deposit which grows downwards from the rooftop is called a stalactite while the one growing upwards from the floor is called a stalagmite.

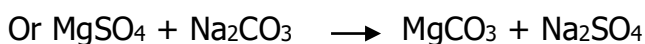
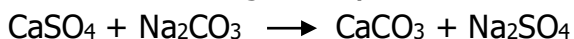
PERMANENT HARDNESS

This is caused by the presence in water of Calcium and magnesium ions in the form of soluble teraoxosulphate(vi), Chlorides – CaSO_4 , MgSO_4 , CaCl_2 etc.

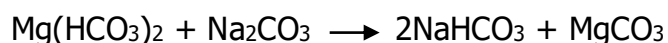
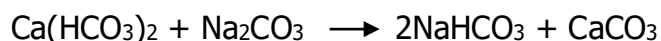
REMOVAL OF PERMANENT HARDNESS

- Not easily removed by boiling.

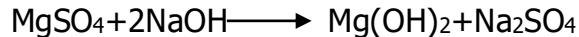
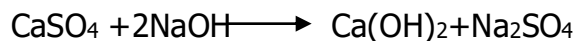
1. Addition of washing Soda (Sodium trioxocarbonate(iv))



Also removes temporary hardness



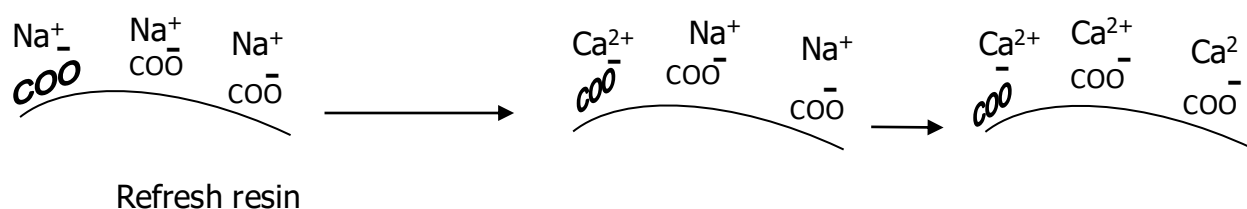
2. Addition Of Caustic Soda



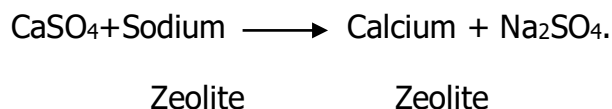
3. Distillation

4. Permutit or Zeolite or Ion-Exchange Method (resin)

An ion-exchange resin is an insoluble compound which has sodium ions (Na^+) attached to its surface. The most common types are sodium aluminium trioxosilicate(iv) (sodium zeolite) sold under the name of permutit. The resin in the form of beads is packed into a cylinder. When hard water is passed through the cylinder, calcium ions from the water take the place of sodium ions on the resin. The water flows out without Ca^{2+} .



Reaction is:



After sometime the resin is spent to regenerate it, Conc NaCl is poured through the resin. The Na^+ replaces the Ca^{2+} and the resin can be reused.

ADVANTAGES OF HARD WATER

1. Tastes better due to dissolved minerals in it
2. The calcium salts in hard water help animals to build strong bone and teeth
3. Helps animals like crabs or snails to make their shells
4. Does not dissolve lead from lead pipes
5. It is better for some manufacturing processes like the brewery industry.

DISADVANTAGES OF HARD WATER

- i. It wastes soap
- ii.
- iii. It causes furring of kettles and boilers and wastes energy during heating (far act, as insulators)
- iv. It is not suitable for dyeing and tanning as the salts interfere with the dyeing process.

WATER POLLUTION

Water pollution is the contamination of water bodies (rivers, ocean, lakes etc) as a result of human activities.

WATER POLLUTANTS

The sources of water pollution include:

- a. Sewage and garbage – human wastes, sewers, garbage;
- b. Industrial waste from industries;

- c. Agricultural waste – fertilizers, pesticides, herbicides (weed growth);
- d. Oil spillage – oil producing areas;
- e. Thermal sources – breweries, iron and steel industries increase temperature and remove oxygen from river.

BIODEGRADABLE SUBSTANCES

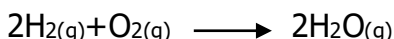
Pollutants that cannot be broken down into harmless substances are called non-biodegradables, detergents, plastics, some organic substances.

PREVENTION OF WATER POLLUTION

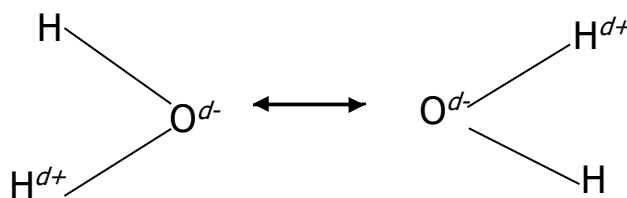
- i. Refuse should be burned or burnt in incinerators;
- ii. Sewage should be processed and converted to useful organic fertilizers;
- iii. Chemicals should be converted first to harmless substances before discharge to water;
- iv. Care should be taken to avoid oil spillage;
- v. Educate the citizenry on dangers and effects of water pollution;
- vi. Environmental protection agencies should carryout inspection of industries and ensure safety rules.

COMPOSITION OF WATER

Priestly (1781) observed that hydrogen and oxygen explode to form water vapour. Cavendish established ratio of H to O to be 2:1



Water is a polar solvent and can dissolve many substances.



PHYSICAL PROPERTIES

- a. Pure water is colourless, odourless and tasteless.
- b. It boils at 100°C at atmospheric pressure of 760mmHg.
- c. It freezes at 0°C.
- d. It has its maximum density of 1.0gcm³ at 4°C.
- e. It is neutral to litmus.

CHEMICAL PROPERTIES

1. Reaction With Metal

Na and K react rigorously with cold water to give hydrogen gas

Ca reacts slowly with cold water.


Mg and Zn react only with steam

Al and Iron need to be red hot to react with steam

Cu, Hg, Ag and Au do not react with water under any condition.

Mnemonic For Reaction

Professor
S
C



liberate H_2
with cold water
liberate H_2 slowly

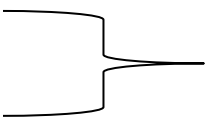
$2Na + 2H_2O \longrightarrow 2NaOH + H_2$

M
A




liberate H_2 with
steam

Z
I
L



liberate H_2 at red hot
and steam

Has
Conquered
Mercury
Stale
Government



do not liberate
 H_2 under any
condition

2. With Non Metals

$C + H_2O \longrightarrow CO + H_2$
White hot water gas.

$Cl_2 + H_2O \longrightarrow HOCl + HCl$

3. With Metallic Oxides

$Na_2O + H_2O \longrightarrow 2NaOH$
Alkaline

4. With Non-Metallic Oxides

$SO_2 + H_2O \longrightarrow H_2SO_3$
Acids

$CO_2 + H_2O \longrightarrow H_2CO_3$
Acids

TEST FOR WATER

$CuSO_4 + 5H_2O \longrightarrow CuSO_4 \cdot 5H_2O$

Anhydrous blue
white

$CoCl_2 + 6H_2O \longrightarrow CoCl_2 \cdot 6H_2O$
Blue pink

SOLUTIONS

A solution is a uniform or homogenous mixture of two or more substances.

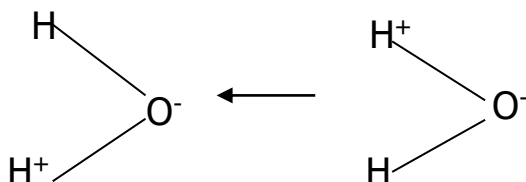
The substance that dissolves the other is called the solvent – usually water. The dissolved substance is called the solute. Solvent + Solute \rightarrow Solution

TYPES OF SOLUTIONS

- Solutions of solid in liquid e.g. NaCl in water.
- Solutions of liquid in liquid of ethanol and water – miscible liquids.
- Gas in liquid of CO₂ in water.
- Solutions of solid in solid of copper zinc to brass or copper and tin to form bronze.

SOLVENTS

The most common solvent is water. It is said to be polar because of its molecular structure. It is usually referred to as a universal solvent



When a solid substance dissolves in water the solution is said to be **aqueous**.

SUITABLE SOLVENTS FOR SOME SOLUTES

Solute	Solvent
Sodium Chloride	Water
Sugar	Water
Grease	Petrol
Sulphur	Carbon(iv) Sulphide
Rubber	Benzene
Paint	Turpentine.

Suspension:- A heterogeneous mixture of undissolved particles in a given medium.

USES OF SOLVENTS

- In laundries, some stains that cannot be removed by ordinary water could be subjected to other solvents like carbon tetrachloride, kerosene, borax (coffee)
- In manufacture of perfumes (ethanol)
- In dispensaries – iodine in ethanol
- In laboratory work – water and benzene
- Vulcanisers solution for mending patches/punctures (rubber in C₆H₆).

SUSPENSION

If chalk dust is added to water in a beaker, it will float for some time and settle at the bottom later. The particles will form sediments. The mixture is called a **Suspension**.

A suspension is a heterogeneous mixture of two substances.

In a suspension the solute particles are insoluble in the water e.g. harmatan dust, (2) fog – dust particles and water droplets, smoke etc.

Particles of suspension can be seen with the naked eyes and can be filtered.

COLLOIDS

Colloids are false solutions in which the individual solute particles are larger than the particles of the true solution but not large enough to be seen by the naked eyes.

TYPES OF COLLOIDS

In discussing colloids, the liquid solvent is known as the dispensing medium while the solid particles constitute the dispersed substances.

EXAMPLES COLLOIDS	OF	SOLVENT DISPERSION MEDIUM	OR	SOLUTE OR DISPERSED SUBSTANCES
Fog	Aerosol	Air (gas)		Water particles (liquid) or solid
Smokey		Air (gas)		Carbon particles (solid)
Foam or lather		Water (liquid)		Air bubbles (gas)
Emulation		Water (liquid)		Oil globules (liquid) – milk, hair cream, butter, paint
Sols/gels ^{conc}		Water (liquid)		Starch (solid), honey

TRUE AND FALSE SOLUTIONS

True Solution:- Solute particles dissolve and get in between the solvent particles – homogenous e.g. NaCl in water.

False Solution:- Solute particles are larger than the solvent particles e.g. starch in water.

DIFFERENCE BETWEEN FALSE AND TRUE SOLUTIONS

S/N	TRUE SOLUTION	FALSE SOLUTION
1	Solutes can pass through a filter paper	Solutes cannot pass through a filter paper
2	Solutes can diffuse through a medium	Solutes cannot diffuse through a medium
3	The solutes can exert an osmotic pressure	The solutes does not exert any observable osmotic pressure
4	The solutes can be dialyzed. Solutes can pass through a semi permeable membrane	The solutes cannot be dialyzed. The solutes cannot pass through a semi permeable membrane
5	The solutes do not scatter light – Do not exhibit tyndal effect	The solutes scatter light. They exhibit tyndal effect.

