STRUCTURE OF ATOM

The word atom is a Greek word meaning indivisible. Atom is an ultimate particle, which cannot be further subdivided into simpler substances. Ancient Indian Greek philosophers thought that all matter consists of extremely small particles.

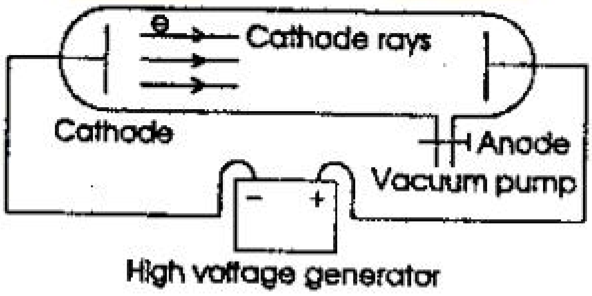
John Dalton (1803) proposed atomic theory on the basis of experiments, provided the concept of matter. But Dalton's model could not explain why atoms of element differ in their masses. Then three fundamental particles i.e., electron, proton and neutron which are recognized to be constituent of atoms,

Cathode rays-Discovery of Electrons

Scientists William Crookes 1879, Julius Plenckar 1889 studied the electrical conduction through gases at low pressures. A discharge tube is a long glass tube having two metal plats sealed at each end. The metal plates are known as electrodes. The plate which is connected to the positive terminal of the battery is known as anode (positive electrode) and the electrode which is connected to the negative terminal of the battery is called cathode (negative electrode). The discharge tube had a side tube through which air and other gases from the tube is pumped out by a vacuum pump. The following observation were made.

(i) When the pressure inside the discharge tube is at 1 atmosphere and 10,000 volts, DC is applied to the electrode; electricity did not flow through the air in the discharge tube.

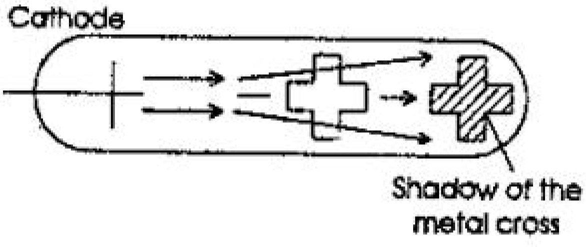
(ii) When the pressure inside the discharge tube is reduced to 10^{-4} atomsphere with high voltage, electricity began to flow through the air, an invisible rays moved from negative electrode to positive electrode and the rays were called cathode rays.



Properties of Cathode rays

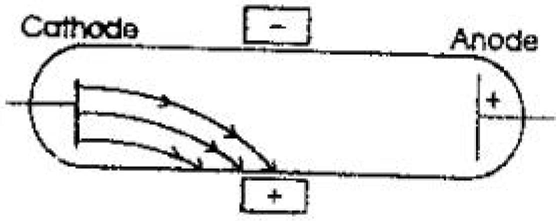
(1) They travel in straight line away from the cathode with high velocity.

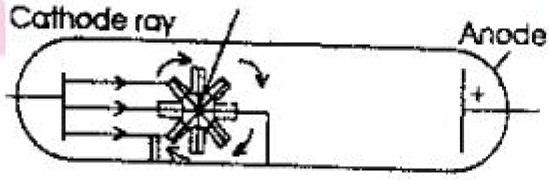
(2) A shadow of metallic object placed in the path is cast on is walls opposite to the cathode.



(3) They produced green glow when strike the glass walls beyond anode. Light is emitted when they strike fluorescent zinc sulphide screen.

(4) They produce heat energy and deflected by electric and magnetic field. These are deflected towards the positively charged plate indicating cathode rays are negatively charged particle. A cathode raysproduced mechanical effect, when a small pin wheel is placed in then, the blades of the wheel rotates. Showing cathode rays are beam of particles having mass and kinetic energy.





(5) The nature of cathode rays does not depend on the nature of gas taken in the discharge tube on material of the cathode.

(6) In 1897. J.J. Thomosn determined the e/m value (charge / mass) of the cathode rays obtained from different gases and found to be exactly showing that atoms of all kind contain the same negative particles. The negative charged particles present in the cathode rays are called electrons.

(7) The charge on single electron was found to be – 1.602 x 10^{-19} coulomb. As electron had the smallest charge knows; it was thus designated as unit negative charge. This means that the electron has one unit negative charge – 1 (minus one).

(8) Mass of electron was determined as 9.100 x 10^{-21} g or 9.10 x 10^{-23} kg is about $\frac{1}{1840}$ of the mass of hydrogen atoms. As the mass of hydrogen atom is 1 amu (1 atomic mass unit), the relative mass of electron is $\frac{1}{1840}$ amu.

Positive rays – Anode rays – Discovery of proton,

After the discovery of electrons, scientists started looking for positively charged particles because matter is electrically neutral under ordinary conditions. Goldsiein 1886 discovered positive particles. He used cathode with several holes (perforations) in the discharge tube. When high potentials were applied between electrodes, in addition to cathode rays, but also a new type rays were produced simultaneously from anode moving towards cathode and passed through the holes or canals of the cathode. These were named as Canal rays and also as anode rays as originated from anode.

Properties of anode rays (or positive rays)

1. Anode rays travel in straight lines as cathode rays.
2. Anode rays produced mechanical effects i.e. rotated the light pin paddle placed in their path.
3. Anode rays re positively charged. They were deflected toward the negative plate of the electric field.
4. The nature of anode rays depend on the gas taken in the discharge tube i.e., positive particles are different for different gases.

Characteristics of a proton

The $\frac{e}{m}$ ratio was maximum when hydrogen gas was taken in the discharge tube. This shows that the positive ion formed from hydrogen is lightest. This particle was named as proton by Rutherford in 1911 (i). Its **charge** was found to be equal in magnitude but opposite in sign to that of electrons + 1.602×10^{-19} coulomb. i.e. Proton carries unit positive charge and the relative charge of a proton is + (plus one).

(ii) Mass: The mass of a proton is
1.672×10^{-24} g or 1.672×10^{-26} kg

When the high voltage applied to the gas at low pressure, the electrical energy split the gas atoms into negatively charged particles, electrons and positively charged particles. These negative and positive particles conduct electricity at low pressures.

Discovery of neutron

Rutherford (1920) suggested that in an atom a third type of fundamental particle which should be electrically neutral and possessing mass nearly equal to proton are proposed the name for such fundamental as neutrons. In 1932 Chadwick bombarded beryllium with α particles when penetrating radiations which were not affected b electric and magnetic field, which where called neutrons. The nuclear reactions is written as

$${}^{9}_{4}Be + {}^{4}_{2}He \rightarrow {}^{12}_{6}C + {}^{1}_{0}n$$

The mass of neutron was 1.675×10^{-24} g nearly equal to the mass of proton. All atoms except hydrogen are compose of these three fundamental particles.

The properties of three fundamental particles are tabulated as

Property	Electron	Proton	Neutron
Symbol	$e, {}^{0}_{-1}e$	$p, {}^{1}_{1}p, {}^{1}_{1}H,$	$n, {}^{1}_{0}n$
Mass mg	9.109×10^{-28}	1.6726×10^{-24}	1.675×10^{-24}
Relative mass amu	0.000549 $\frac{1}{1840}$ amu	1.00727 1 amu	1.00866 1 amu
Charge (coulomb)	-1.60×10^{-19}	$+ 1.60 \times 10^{-19}$	0
Relative charge	- 1	+ 1	0
Location in the atom	Outside the nucleus in orbits	In the nucleus	In the nucleus

Rutherford Experiment – Discovery of nucleus.

After the discovery of electrons, protons and neutrons, the question arose how these particles were arranged in an atom. The Rutherford's alpha particle scattering experiment led to the discovery of a small positively charged nucleus at the centre of the atom containing all the protons and neutrons. Alpha particle is a positively charged particle having 2 units of positive charge and 4 unit of mass. It is actually a helium ion. He^{2+}, α particles are emitted by radioactive elements like radium. They penetrate through matter to small extent.

In 1911, Rutherford directed a beam of α particle against a thin foil of gold. The gold foil was surrounded b a circular fluorescent zinc sulphide screen whenever an α particle struck the ZnS screen it produced a flash of light. He found that

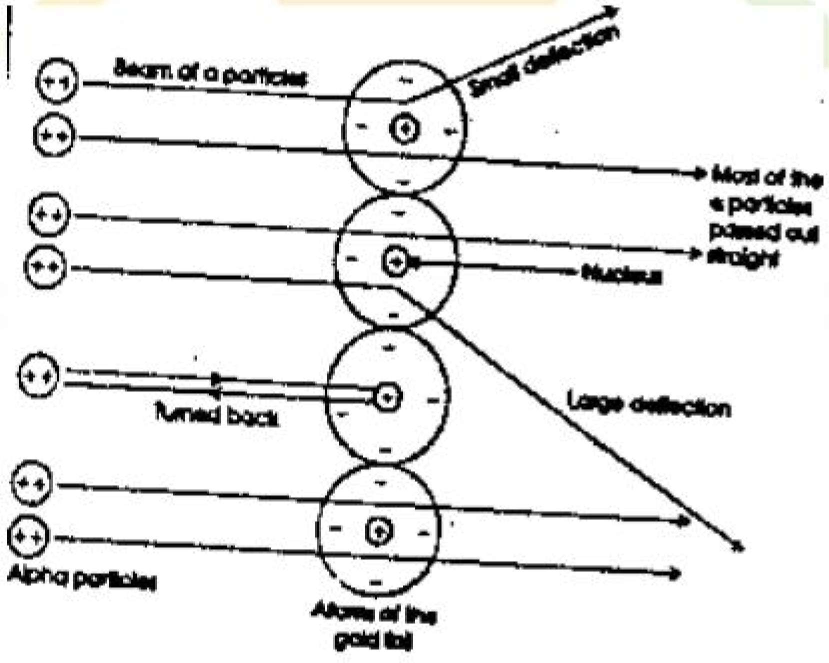
(i) Most of the particles passed straight through the gold foil without any deflection.
(ii) A few α particles are deflected through a small angle and a few are deflected through large angles.
(iii)A very few α particles completely rebound on hitting the gold foil and turn back just as a ball rebounds on hitting hard ball.

Following conclusions were drawn from the above observations.

(i) As most of the α particles went undeflected, straight, that there must be very large empty space in an atom.

(ii) A few of the α particles were deflected from their original path through small and large angles shows that the positive charge is concentrated and the space occupied by this positive charge is very mall in the atom. The positively charged heavy an atom is called nucleus present in the centre of the atom.

(iii)A very few of the α particles suffered strong deflections and even returned back along their path indicated that the nucleus is rigid and α particles recoil due to direct collision with the heavy positively charged mass.



Scattering of α particles by atoms of gold foll.

Rutherford's nuclear model of atoms

On the basis of scattering of α particles experiments, Rutherford proposed a model of the atom which I known as nuclear atomic mode. According to this model, an atom consists of a positively charged, dense, very small nucleus containing all the protons and neutrons. The nucleus s surrounded b negatively charged electrons. The electrons are revolving round the nucleus at very high oppositely charged nucleus. A the atom is electrically neutral, the number of electrons in an atom is equal to the number of protons in it. The electrons, holds the atom together. Nucleus has a radius of the order 10^{-13} cm and the radius of electronic orbit is the order of 10^{-8} cm (atomic diameter)

$$\frac{\text{Radius of the atom}}{\text{Radius of the nucleus}} = \frac{10^{-8}}{10^{-13}} = 10^{+5}$$

The size of atom is 100,000 times 10^5 the size of the nucleus. The radius of nucleus is proportional to the cube root of the mass number of (A) of the atoms.

Radius of atomic nucleus = $r_o(A)^{1/3}$ where $r_o = 1.33 \times 10^{-13}$ cm and A is the mass number of the element.

Radius of ^{27}Al, ^{64}Zn atoms are given as below.

$$\text{Radius of } ^{27}Al = 1.33 \times 10^{-13}\ (27)^{\frac{1}{3}}$$
$$= 1.33 \times 10^{-13} \times 3$$
$$= 1.99 \times 10^{-13} \text{ cm}$$

$$\text{Radius of } ^{64}Zn = 1.33 \times 10^{-13}\ (64)^{\frac{1}{3}}$$
$$= 1.33 \times 10^{-13} \times 4$$
$$= 5.32 \times 10^{-13} \text{ cm}$$

The sub atomic particles that are present inside the nucleus of an element are called nucleon. The are protons and neutrons. The total number of nucleon present in atom is called the mass number of the atom represented as A.

Mass number of an element = Total number of protons + Total number of neutrons
$A = Z + n$

Atomic number of element (Z) Mosley Experiment: John Mosley (1912-13) determined X-ray frequency element and found out that $\sqrt{v}\ a\ (Z - b)$ where v = frequency of X-ray of element, Z = atomic number of the element and a and b are constants.

Atomic number of an element is Z is equal to number of protons present in the nucleus of the atom. So,

(Z) Atomic number of an element
= serial number of the element in the periodic table
= + charge of the nucleus of the atom
= Number of protons present in the nucleus of the atom
= Number of electrons present in the neutral of the atom.

Chemical reaction takes place between atoms of different elements i.e. chemical reaction I the rearrangement of electrons present in the last and in the penultimate orbits only.

Thus atomic number of an element does not change during a chemical reaction, it remains the same.

Atomic number of sodium is 11 ($_{11}Na$). It means that 11 protons are present in the nucleus of sodium atom and 11 electrons are present in various orbits of the neutral sodium atom.

Atomic number of uranium is 92 written as $_{92}U$ containing 92 proton in uranium nucleus and 92 electrons in the shells outside the nucleus.

Mass number of an element A

An atom consists of protons, neutrons and electrons; since the total mass of electrons present of an atom is negligible, the real mass of an atom is determined by protons and neutrons only. The total number of protons and neutrons in an atom of an element is known as its mass number symbolized as A. Mass number of an element is a whole number never a fractional value.

Mass number is also equal to the total number of nucleons (subatomic particles present inside the nucleus of atoms) particles present inside the nucleus of atoms) present in the nucleus of the atom. Atomic mass of an element corrected to the atom. Atomic mass of an element corrected to the nearest whole number will be the mass number of the element. The atomic mass of chlorine is 35.46 and mass number of protons + Number of neutrons.

$A = Z + n$

Or number of neutrons in an atomic nucleus = Mass number of the atoms – Atomic number
$n = A - Z$

The atomic number and mass number of the element are indicated in the symbol of the element are indicated in the symbol of the element like $^{A}_{Z}E$ or $^{12}_{6}C$, $^{35}_{17}Cl$, $^{238}_{Z92}U$. From that, the number of neutrons are calculated as.

Element	No, of protons (Z)	No. of electrons (Z)	No. of neutrons (A – Z)
$^{12}_{6}C$	6	6	$12 - 6 = 6$
$^{35}_{17}Cl$	17	17	$35 - 17 = 18$
$^{238}_{92}U$	92	92	$238 - 92 = 146$

Defects Drawback of Rutherford model of atom,

An important defect or drawback of Rutherford model of an atom is that it does not explain the stability of an atom.

According to electromagnetic theory, *a* charged particle which move under the influence of attractive force, it must radiate energy (or loose energy) continuously in the form of electromagnetic radiations. So, the electron (negatively charged particle) moves in an attractive farce (created by protons present in the nucleus), it must emit radiations continuously. That is electron should lose energy it must be attracted more strongly b the nucleus due to which electron will come more close to the nucleus. Finally electron must fall into the nucleus thereby making the atom unstable. But atom is stable and it does not collapse, it means the electrons do not fall into the nucleus, thus Rutherford atomic model does not explain the stability of the atom.

Bohr's atomic model

To overcome the objections of Rutherfords model of atom, and to explain the stability of an atom. Niels, Bohr 1913 proposed new arrangement of electrons. The important theories are

(1) An atom consists of three sub atomic particles electrons, proton and neutrons. The atom is electrically neutral containing equal number of positively charged protons and equal number of negatively charged electrons.

(2) Negatively charged electrons are revolving around the nucleus at the centre of the atom containing the protons and neutrons. The force of attraction between the nucleus and the electron is equal to centrifugal force of the moving electron.

(3) The electrons revolve around the nucleus in fixed circular orbits called energy levels or shells. The energy level or shells are represented either b numbers 1, 2, 3, 4, 5, 6 etc., or by the alphabets K, L, M, N, O, P etc from the nucleus outward.

(4) Each energy level (or shell is associated with a fixed amount of energy. The shell nearest to the nucleus having minimum energy and the shell for away from the nucleus having maximum energy,

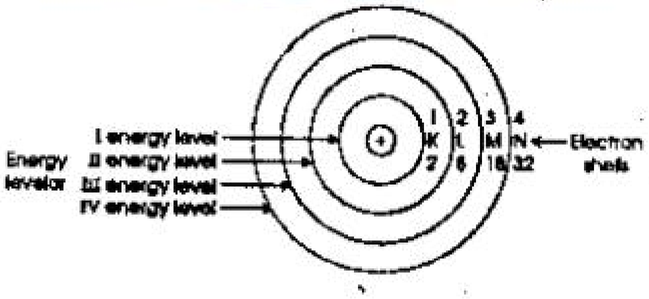
(5) An electron remains in any one of the shell or orbit, it does not loose energy. Such a state is called group state or normal state.

(6) An electron can go from a lower energy level to a higher energy level to a higher energy level if it gains the extra energy. An electron may come down from a higher energy level to a lower energy level by loosing energy.

Distribution of Electrons in Orbits

The arrangement of electrons in the various orbit round and nucleus of an atom is known as electronic configuration. The properties of the elements depend upon their electronic configuration. The main points are

1. The energy level o electrons are denoted b the numbers n = 1, 2, 3, 4, 5, 6 etc and the shells are represented b alphabets K, L, M, N, O, P etc. The energy levels or shells are represented circles around the nucleus. The shells are counted from the centre outwards. K shell, I orbit is having the minimum energy is nearest to the nucleus, L shell (II orbit) has a little more energy is little further away from the nucleus and so on. The outermost shell of atom has the highest energy and highest radius.



Electron shells maximum number of electro which can be accommodated in various orbit.

2. The maximum number of electron which can be accommodated in any orbit or shell is equal to $2n^2$, where n is the number of the orbit. The is given by two scientists Bohar and Bury(or Bohr-Bury scheme).
   Maximum capacity of electrons in 1 orbit (K-shell) = $2 \times 1^2 = 2$
   Maximum capacity of electrons in 2 orbit (L-shell) = $2 \times 2^2 = 8$
   Maximum capacity of electrons in 3 orbit (M-shell) = $2 \times 3^2 = 18$
   Maximum capacity of electrons in 4 orbit (N-shell) = $2 \times 4^2 = 32$

3. The maximum capacity of outermost orbit is 8 electrons and that penultimate (next to outermost) is of 18 electrons.

4. It is not necessary that an orbit should be completed to it maximum capacity before another starts. A new orbit always starts when the outermost orbit attains 8 electrons.

Electronic configuration of Elements

		Atomic Number	**ELECTRON DISTRIBUTION**			
Element	**Symbol**	**Z**	**1 K**	**2 L**	**3 M**	**4 N**
Hydrogen	H	1	1			
Helium	He	2	2	Maximum capacity filled ($2n^2 = 2$)		
Lithium	Li	3	2	1		
Beryllium	Be	4	2	2		
Boron	B	5	2	3		
Carbon	C	6	2	4		
Nitrogen	N	7	2	5		
Oxygen	O	8	2	6		
Fluorine	F	9	2	7		
Neon	Ne	10	2	8	Maximum capacity filled ($2n^2 = 8$)	
Sodium	Na	11	2	8	1	
Magnesium	Mg	12	2	8	2	
Aluminium	Al	13	2	8	3	
Silicon	Si	14	2	8	4	
Phosphorus	P	15	2	8	5	
Sulphur	S	16	2	8	6	
Chlorine	Cl	17	2	8	7	
Argon	Ar	18	2	8	8	Maximum capacity of outermost orbit = 8
Potassium	K	19	2	8	8	1
Calcium	Ca	20	2	8	8	2

Example: Electronic configuration of $^{24}_{12}Mg$
The atomic number of elements = 12
∴ Number of protons in the nucleus = 12
Number of neutrons = A – Z = 24 – 12 = 12
Number of electrons = Atomic number of the element = Z = 12

12 electrons are disturbed in K (1), L (2), M (3) orbits.
Number of electrons in I orbit K shell = 2
Number of electrons in II orbit L shell = 8
Number of electrons in III orbit M shell = 2
Electronic configuration of $^{24}_{12}Mg$

K L M
2 8 2

VALENCY ELECTRONS

Element react under suitable conditions and forming new products. Chemical combination is the rearrangement of electrons and getting stable electronic configuration. The electrons present in the outermost shell of atom are called as valence electrons (or valency electrons) because they decide the valency or the combining capacity of element. Only the valency electrons of atom take part in a chemical reactions because the have the highest energy.

Example: Lithium $_3$Li. The atomic number of lithium is 3. The electron configuration of Lithium is $^{K\,L}_{2\,1}$.1 electron is present in the outermost orbit. The valency electron is 1. This valency electron decides the chemical property of the lithium.

The atomic number of chlorine is 17. $_{17}$Cl. The electronic configuration of chlorine is 2, 8, 7. Valency electron of chlorine is 7.

Relationship between valency electron and chemical properties

The chemical property of an element depends mainly on the electron present in its outs most orbit (valency electrons).

Chemical properties of alkali metals: The alkali metals like Lithium, Sodium, Potassium have one valency electron in their atom. They show similar chemical properties.

Alkali Metal	Symbol	Atomic number (Z)	Electronic configuration K L M N	Number of valency electrons
Lithium	Li	3	2.1	1
Sodium	Na	11	2, 8, 1	1
Potassium	K	19	2, 8, 8, 1	1
Rubidium	Rb	37	-	1
Caesium	Cs	55	-	1
Francium	Fr	87	-	1

i.e., elements having the are number of valency electrons show similar chemical properties.

Corollary of the above statement is elements having different number o valency electrons will shown different chemical properties.

Example: Rare gases or inert gas like $_{10}$Ne 92, 8), $_{18}$Ar (2, 8, 8) $_{36}$Kr (2, 8, 18, 8), $_{54}$Xe (2, 8, 18, 8) have 8 electrons in heir valency shell. The have similar chemical properties (non-reactive)

Alkaline earth metals $_{12}$Mg (2, 8, 2), $_{20}$Ca (2, 8, 8, 2), $_{38}$Sr (2, 8, 18, 8, 2) resemble one another but differ from the chemical properties of alkali metals having (1 valency electron)

Relation between valence electron and metallic and nonmetallic nature

(1) Elements having 1, 2 or 3 valency electrons are metals (except hydrogen).
$_3Li$ (2, 1), $_{11}Na$ (2, 8, 1), $_{19}K$ (2, 8, 8, 1)
Valency electron 1 = Alkali metals
$_{12}Mg$ (2, 8, 2), $_{20}Ca$ (2, 8, 8, 2)
Valency electrons are 2 = Alkaline earth metal
$_{13}Al$ (2, 8, 3) Valency electrons are 3 = metal
(2) Elements having 5, 6, 7 valency electrons are nonmetals
$_7N$ (2, 5), $_{15}P$ (2, 8, 5), $_{33}Sb$ (2, 8, 18, 5)
Valency electrons are 5 = nonmetals
$_8O$ (2, 6), $_{16}S$ (2, 8, 6), $_{34}Se$ (2, 8, 18, 6)
Valency electrons are 6 = nonmetal

Halogens

$_9F$ (2, 7), $_{17}Cl$ (2, 8, 7), $_{35}Br$ (2, 8, 18, 7),
$_{53}$Iodine (2, 8, 18, 7) Valency electrons are 7 = nonmetal

(3) Inert gases

$_2He$ (2), $_{10}Ne$ (2, 8), $_{18}Ar$ (2, 8, 8) $_{36}Kr$ (2, 8, 18, 8), $_{54}Xe$ (2, 8, 18, 8)
Valency electrons are 8 = non-metal

ISOTOPES

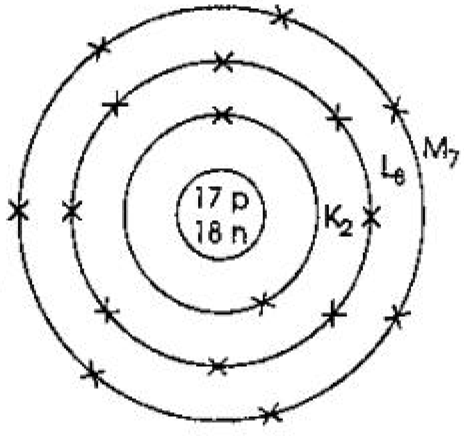
Isotopes are atoms of the same element having the am atomic number but different mass number.

E.g. ^1_1H, ^2_1H, ^3_1H
$^{12}_6C$, $^{13}_6C$, $^{14}_6C$
$^{16}_8O$, $^{17}_8O$, $^{18}_8O$
$^{35}_{17}Cl$, $^{37}_{17}Cl$

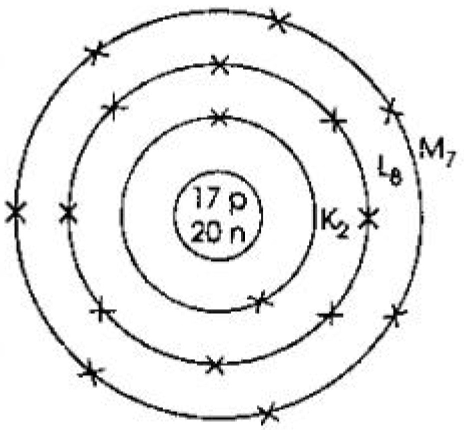
Isotopes of element have the same atomic number (Z), i.e., they contain same number of protons, same number of electrons and identical electronic configuration (and same chemical properties). They have different number of neutrons hence difference in mass number, Isotopes of chlorine are
$^{35}_{17}Cl$, and $^{37}_{17}Cl$

Both isotopes of chlorine contain 17 protons. 17 electrons electronic configuration (2, 8, 7) identical chemical properties.

Number of neutrons in
$^{35}_{17}Cl$, = Mass number – atomic number
= 35 – 17 = 18 neutrons
Number of neutrons in $^{37}_{17}Cl$
= 37 – 17 = 20 neutrons
Structure of $^{35}_{17}Cl$ $^{37}_{17}Cl$ isotope are



$^{35}_{17}Cl$ isotope



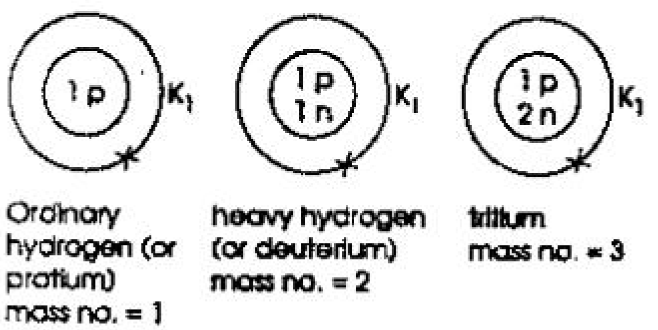
$^{37}_{17}Cl$ isotope

Isotopes of Hydrogen: Hydrogen has three isotopes having same atomic number of 1 with different mass number of 1, 2 and 3. They are designated as $^{1}_{1}H$, $^{2}_{1}H$ and $^{3}_{1}H$

The composition of three isotopes of Hydrogen is given below,

Isotope Name Proton Neutron electron hydrogen $^{1}_{1}H$ Ordinary (protium) 1 0 1 $^{2}_{1}H$ Heavy hydrogen (Deuterium) 1 1 1 $^{3}_{1}H$ (Tritium) 1 2 1

The structure of three isotopes of hydrogen is given as



Isotopes of Carbon: Te isotopes of carbon are three having the same atomic number of 6 with different mass number of 12, 13, 14 with 6, 7 and 8 neutron respectively.

$^{12}_{6}C$, $^{13}_{6}C$, $^{14}_{6}C$,

Isotopes of Oxygen: Oxygen has three isotopes with the same atomic number 8 with different mass numbers of 16, 17 and 18

$^{16}_{8}O$, $^{17}_{8}O$, $^{18}_{8}O$

About elements have only one isotope e.g. $^{19}_{9}F$, $^{23}_{11}Na$, $^{27}_{13}Al$, $^{31}_{15}P$ etc. Tin has 10 isotopes (maximum number of isotopes possessed by an element).

Uranium has two isotopes $^{235}_{92}U$ and $^{238}_{92}U$.

Similarities of isotopes

1. Isotopes of an element have the same atomic number.
2. Isotopes of an element have same number of electrons.
3. Isotopes have same electronic configuration.
4. The chemical properties of isotopes are identical
5. All the isotopes of an element occupy same place in the periodic table. (Greek word isotope, iso = same, tope = place)

Dissimilarities or Difference in isotope

1. Isotopes of an element have different mass number.
2. Isotopes of an element have different number of neutrons.
3. The physical property of an element are different 9epecially property related to mass.

The atomic weight of an element

The mass of an element is the average mass of its isotopic constituents.

Ordinary chlorine contains two isotopes

(1) $^{35}_{17}Cl$	75.4%
(2) $^{37}_{17}Cl$	24.6%
Total	100%

Hence the atomic mass of chlorine

$= \frac{75.4\times35+24.6\times37}{100} = \frac{142}{4} \simeq 35.49$

Isotopes of elements whole number of nucleons (17 protons and 18 neutrons. 20 neutrons in $^{37}_{17}Cl$ and $^{37}_{17}Cl$) but atomic mass is average mass of the amount present hence atomic mass/atomic weight of an element is fractional.

RADIOACTIVITY

Discovery of radioactivity: In 1895. Henri Becquerel was studying the effect of sunlight on phosphorescent compounds. During a period of cloudy days, He left uranium salt with photographic paper covered with black paper. He found that the photographic paper were 'affected' by uranium salt. He called the property of the uranium compound as "radioactivity". Radium, polonium, uranium and then compounds are found to be radioactive. Radioactivity (radiating activity) is a process in which nuclei of certain element undergo spontaneous disintegration. Al these substance which have the tendency to emit the radiations are called radioactive materials. Radioactivity is a nuclear phenomenon.

Radioactivity is due to unstability of nucleus of atom. When a nucleus of an atom contain more number of neutron that what I normally found in nature, the nucleus becomes unstable and emit radiation.

The neutron to proton ratio in radioactive nuclei is greater than 1.6 : 1. In $^{238}_{92}U$ Isotope

Neutron to proton ration = $\frac{146}{92} \simeq 1.6$.

Characteristics of radioactive radiation

(1) Radioactive radiation affect the photographic paper like light, it darkens the photographic paper.

(2) Radioactive radiation falling on zinc sulphide coated o a screen, produces white splashes of light called scintillations.

(3) Radioactive radiations increases the heat.

(4) Radiations after living cells.

(5) These radiation ionize gas in their path.

Nature of radioactive radiation

The invisible radiations emitted by radioactive elements consists of three types

(1) Alpha particles (α-rays)
(2) Beta particles (β-rays)
(3) Gamma (γ-rays)

	Property	α-rays (particles)	(β-rays)	(γ-rays)
(1)	Charge	2 positive charges	Unit negative charge	No charge
(2)	Attraction on Charged plate	Attracted towards the negative electrode	Attracted towards bond the positive electrode.	Not affected by electrifiers
(3)	Mass	4	0	0
(4)	Identity	Helium nuclei $^4_2He^{2+}$	Electrons $_{-1}^{0}e$	Electromagnetic radiations of low wavelength, high frequency, high energy
(5)	Penetrating Power	low (α-rays)	More penetrating than	High
	Ratio	1	100	10,000
(6)	Ionising power	highest 10,000	low 100	least 1

Examples of radioactive disintegration

Naturally occurring carbon contain three isotopes $^{12}C_6$, $^{13}C_6$ and $^{14}C_6$.

$^{14}C_6$ contains 8 neutrons and 6 protons. It is radioactive emit β radiations when a neutron of a nucleus becomes a proton and gases of electron is given out with high velocity. After β activity, the radioactive element is converted into new element with increases of one atomic number.

$^1_0n \rightarrow {}_{+1}^{1}H + {}_{-1}^{0}e$ (α-rays)
$^{14}_6C \rightarrow {}_{+7}^{14}N + {}_{-1}^{0}e$ (β-rays)

Nature of radioactive radiation

Heavy naturally occurring radioactive elements may give out α particle, β-rays and γ radiations. Finally they become non-radioactive lead isotope. Uranium 238 emits α particle and gives an element whose atomic number is decreased b two and a decrease of atomic mass of four $^{238}_{92}U \rightarrow ^{4}_{2}He + ^{234}_{90}Th$

Gamma radiation is the conversion of extra energy of radioactive element is given out as Gamma radiation. It is electromagnetic radiation with low wavelength, high frequency and high energy.

Half-life radioactive elements: $\left(\frac{t_1}{2}\right)$

When a radioactive element disintegrate, they form new elements with emission of α and β particles. The rate at which atom disintegrate or decompose depends on the mass of radioactive element. Due to low mass of radioactive substance is left the disintegration becomes slow, the decomposition is never complete. Theoretically the total life of a radioactive element is infinite.

Rutherford introduced a constant known as half life period denoted by $t_{\frac{1}{2}}$. It is defined as the time during which half the amount of a given sample radioactive substance disintegrates.

Energy radioactive element has a definite value of half life period. Half period vary from 10^9 years to a fraction of a second.

	Half-life period $t_{\frac{1}{2}}$
$^{235}_{92}U$	4.5×10^9 years
$^{230}_{90}Th$	8.3×10^4 years
$^{14}_{6}C$	5700 years
$^{234}_{90}Th$	24 days
$^{214}_{84}Po$	1.5×10^{-4} seconds
$^{131}_{32}I$	8 days
$^{32}_{15}P$	14.3 days

If the half-life period of an element is $t_{\frac{1}{2}}$ and if the initial amount of radioactive substance contain N_0- atoms/mass

After one half period $\left(\frac{t_1}{2}\right)$ it becomes

$$= \frac{N_0}{2} = \frac{1}{2} \text{ of initial amount}$$

After 2 half periods $\left(\frac{2t_1}{2}\right)$ it becomes

$$= \frac{N_0}{4} = \frac{1}{4} \text{ of initial amount}$$

After 3 half period $\left(\frac{^{3t}1}{2}\right)$ it becomes

$$= \frac{N_0}{8} = \frac{1}{8} \text{ of initial amount}$$

After n half period $\left(\frac{^{nt}1}{2}\right)$

$$= \left(\frac{1}{2}\right)^n n_0 = \left(\frac{1}{2}\right)^n \text{ of initial amount}$$

Uses of radioactivity

1. The radioactive isotopes are used as tracer in medicine to detect the presence of tumours, blood clot etc. in the body.

2. Radioactive isotopes are used for the treatment of cancer.

3. Radioactive isotopes are used to detect leakage in underground pipe lines carrying gas or oil.

4. Radioactive isotopes are used to study the effect of fertilizers on the growth of plants.

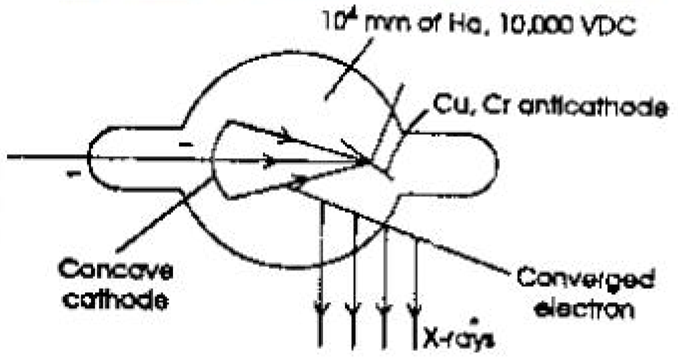
5. $^{235}_{92}U$ used in nuclear reactors to produce electricity.

6. To determine the age of fossils. (Carbon dating)

X-rays

X-rays are electromagnetic radiation of very short wave length. X-rays were discovered by Roentgen in 1896. It is an accidental discovery.

X-rays are productive in high vacuum, with 10000 V using high melting metals like copper or tungsten as anti cathode.



Properties of X-rays

1. They travel in straight lines.
2. They are not affected by electric or magnetic field.
3. They are electromagnetic radiation of low wave length, high frequency and high energy.
4. They penetrate through lighter material stopped by denser substances.

Uses of X-rays are used to locate fracture of bones. X-rays penetrate through $CaCO_3$ or Ca_3PO_4 of bones. By passing X-ray through the fractured portion of the body and keeping a photographic plate below the broken part, then th photographic plate is developed to locate the tracture.

ASSIGNMENT 6

SECTION – A

I. Write an explanation on answer to these question in a few sentences.

1. Atomic mass of most of the elements are fractional.
2. What are cathode rays?
3. What is vitriol?
4. What is the maximum number of electrons that can be accommodated in various electron shells?
5. The atomic number of elements are 7 and 16, find the living system?
6. Which is the most harmful radioactive rays to the living system?
7. How X-rays differ from visible light rays.
8. Which isotope is used as a fuel in nuclear reaction?
9. Name three metals that will not form amalgam.
10. What is common with electron and β-rays?

II. Fill in the blanks with suitable words.

11. The number of atoms present in 1 mol of atoms are _________________ .
12. 11.2 L of Helium at STP contain _______________ atoms.
13. The instrument used to detect the radioactivity of a substance is __________ .
14. The instrument used to detect the radioactivity of a substance is ______________ .
15. The anode rays obtained from hydrogen gas consists of particles called _________ .

SECTION – B

Multiple choice questions

1. What is **wrong** about anode rays?
   (1) They $\frac{e}{m}$ ratio is constant
   (2) They are deflected by electric and magnetic field
   (3) They are produced by ionization of molecules of residual gas
   (4) They do not originate from anode

2. Which of the following statements is **wrong** about cathode rays?
(1) Cathode rays originate from cathode.
(2) Charge and mass of particles present does not depend on the material of the cathode.
(3) The ratio of charge/mass $\left(\frac{e}{m}\right)$ of the particles is much higher than that of the anode rays.
(4) Charge and mass of the particles constituting the cathode rays depend on the nature of gas.

3. α particles are ………….. times heavier than neutron.
(1) 2 (2) 3 (3) 4 (4) 2.5

4. Bohr's orbits called stationary states because
(1) electrons are stationary
(2) their orbits have fixed radil
(3) the electrons in them have fixed energy
(4) the nucleons remain in the nuclei and are stationary

5. Maximum number of electrons which can be accommodated in the N orbit of an element are
(1) 8 (2) 16 (3) 32 (4) 2

6. The uranium (Mass number 238 and Atomic number (92) emits an α-particle, the product has the mass number and atomic number.
(1) 236 and 92 (2) 234 and 90
(3) 238 and 90 (4) 236 and 90

7. The atomic mass of an element is 23 and its atomic number is 11. The number of protons, electrons and neutrons respectively present in the atom of the element are
(1) 11, 11, 12 (2) 12, 12, 11
(3) 11, 12, 11 (4) 12, 11, 12

8. Rutherford's experiment which established the nuclear model of atom used a beam of
(1) β-particles which impinged on a gold foil and got absorbed
(2) γ-rays which impinged on a gold foil and ejected electrons
(3) helium atom which impinged on a meal foil and got scattered
(4) helium nuclei which impinged on gold foil and got scattered

9. Hydrogen atom contains
(1) electron, proton and neutron
(2) only proton
(3) proton and electron
(4) proton and electron

10. The composition of tritium $^{3}_{1}H$ is
(1) 1 electron, 1 proton, 1 neutron
(2) 1 electron, 2 protons, 1 neutron
(3) 1 electron, 1 proton, 2 neutrons
(4) 1 electron, 1 proton, 3 neutrons

11. Isobars are formed when emission of ………. takes place.
(1) 1 α and 1 β particle
(2) 2 α and 1 β particle
(3) 1 β mission
(4) 1 α mission

12. Atoms with same mass number but having different nucleus are called
(1) Isotopes (2) Isotones
(3) Isobars (4) Isochores

13. When the difference between mass number and atomic number of atoms of two or more elements are same, the atoms are known as
(1) Isotopes (2) Isotones
(3) Isotones (4) Nuclear isomers

14. Which of the following properties are different for neutral atoms of isotopes of the same element?
(1) Mass
(2) Atomic number
(3) General chemical reaction
(4) Number of electrons

15. Radioactivity is due to
(1) stable electronic configuration
(2) unstable electronic configuration
(3) stable nucleus
(4) unstable nucleus

16. Which one of the following is the electronic configuration of noble gas?
(1) 2, 8, 7 (2) 2, 9, 1
(3) 2, 8, 18, 8 (4) 2, 8, 2

17. Rutherford's experiment on scattering of α-particles showed for the first time than the atom has
(1) electrons (2) protons
(3) nucleus (4) neutrons

18. Which one is not equal to 1 mol?
(1) 6×10^{23} molecules
(2) 22.4L of a gas at STP
(3) 31 g of phosphorus
(4) 32 g of oxygen

19. The electronic configuration of an element is 2, 8, 2. The element is
(1) a metal (2) a non-metal
(3) a metalloid (4) an inert gas

20. Which of the following compounds contains the highest percentage of nitrogen?
(1) $Ca(NO_3)_2$ (2) $CaCN_2$
(3) $(NH_4)SO_4$ (4) NH_2CONH_2

SOLUTIONS TO ASSIGNMENT 6

SECTION A

I.

1. The atomic mass of an element is the average mass of its isotopic constituents, Hence average mass value becomes fraction.

2. Cathode rays are a stream of negatively charged particles called electrons shot out from the cathode of a discharge but when an electric current is passed through a gas at very low pressure.

3. The element sulphur has another name. It is also called as vitriol.

4. The maximum number of electrons that can be accommodated in K, L, M, N etc., shells are 2, 8, 18, 32 respectively.

5. Electronic distribution
   ^{7}N is 2, 5 – valence electrons are 5
   Electronic distribution
   ^{16}S is 2, 8, 6 valence electrons are 6

6. Gamma ray (γ rays) have high penetrating power, hence it is harmful to the living system.

7. Visible light rays have long wavelength (λ) low frequency (ν) and low energy. X-rays have low wavelength, high frequency and high energy. It can pass through light density materials like paper, flesh etc., but cannot pass through bones or metals.
   $$\lambda = \frac{\text{wavelength of light}}{\text{frequency}}\frac{c}{\nu}, E = \frac{hc}{\lambda}$$
   Where h is Planck's constant.

8. $^{235}_{92}U$

9. Iron (Fe), tungsten (W) and platinum (Pt)

10. Both electron and β-rays have same charge and mass unit – ve charge with mass of $\frac{1}{1840}$ of a proton. β rays are formed by the conversion of a neutron of nucleus into proton and electron with high velocity. Electrons are present around the nucleus of an atom in orbits.

II.

11. Avogadro number, $N_A = 6.022 \times 10^{23}$

12. 3.011×10^{23} atoms.
13. CO2

14. Geiger counter

15. Protons

SECTION B

1. (1)	**2.** (4)	**3.** (3)	**4.** (3)	**5.** (3)
6. (2)	**7.** (1)	**8.** (4)	**9.** (3)	**10.** (3)
11. (3)	**12.** (3)	**13.** (3)	**14.** (1)	**15.** (3)
16. (3)	**17.** (3)	**18.** (3)	**19.** (1)	**20.** (4)