Pakistan School
Kingdom of Bahrain

Atomic structure

Atoms consist of a massive positively charged small central part called nucleus.

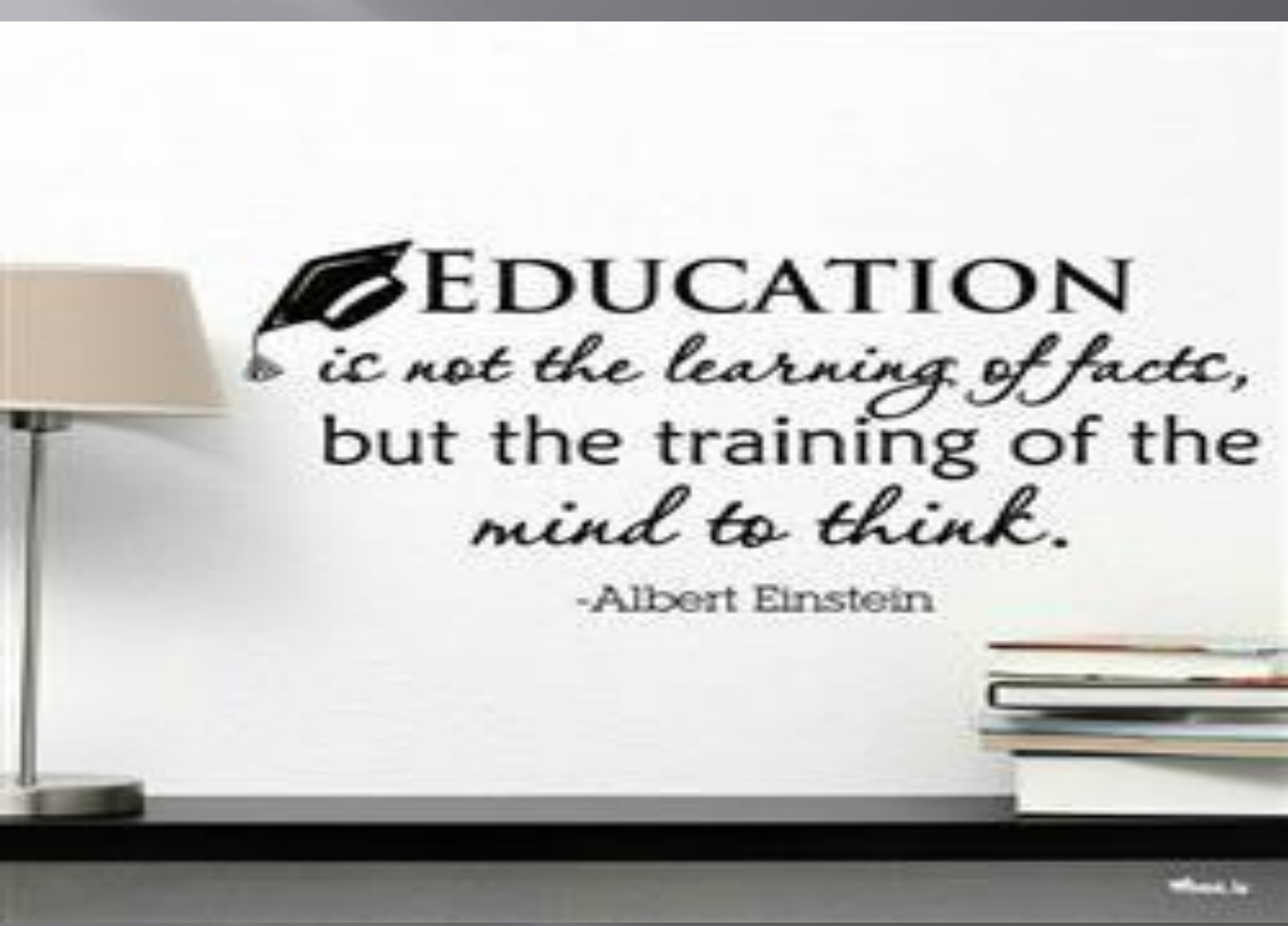
The nucleus contains protons and neutrons.

The electrons revolve around the nucleus in definite circular paths. These circular paths are called shells or orbits.

Each orbit has fixed energy. Therefore , these orbits are also known as energy shells or energy levels.

MESSAGE OF THE DAY:

When you wish good for others, good things come back to you. This is the LAW OF NATURE.


EDUCATION
is not the learning of facts,
but the training of the
mind to think.
-Albert Einstein

>> Ready for Anything

WELCOME BACK TO VIRTUAL CLASSES!

#WEAREALWAYSTOGETHER

AMERICAN

A WARM WELCOME TO ALL THE STUDENTS IN THE ONLINE CLASSES.

WE ARE GOING TO START OUR ONLINE CHEMISTRY LESSON TODAY.I HOPE YOU ALL WILL ENJOY AND LEARN.

.

RULES OF THE CLASS:

1)BE ON TIME FOR ALL YOUR CLASSES.
2)RESPECT ALL PARTICIPANTS OF THE CLASS.
3)DO NOT CREATE ANY DISTURBANCE.
4)RAISE HAND IF YOU HAVE A QUESTION.
5)PAY ATTENTION TO YOUR TEACHER.

POINTS TO PONDER:

Components of an Atom

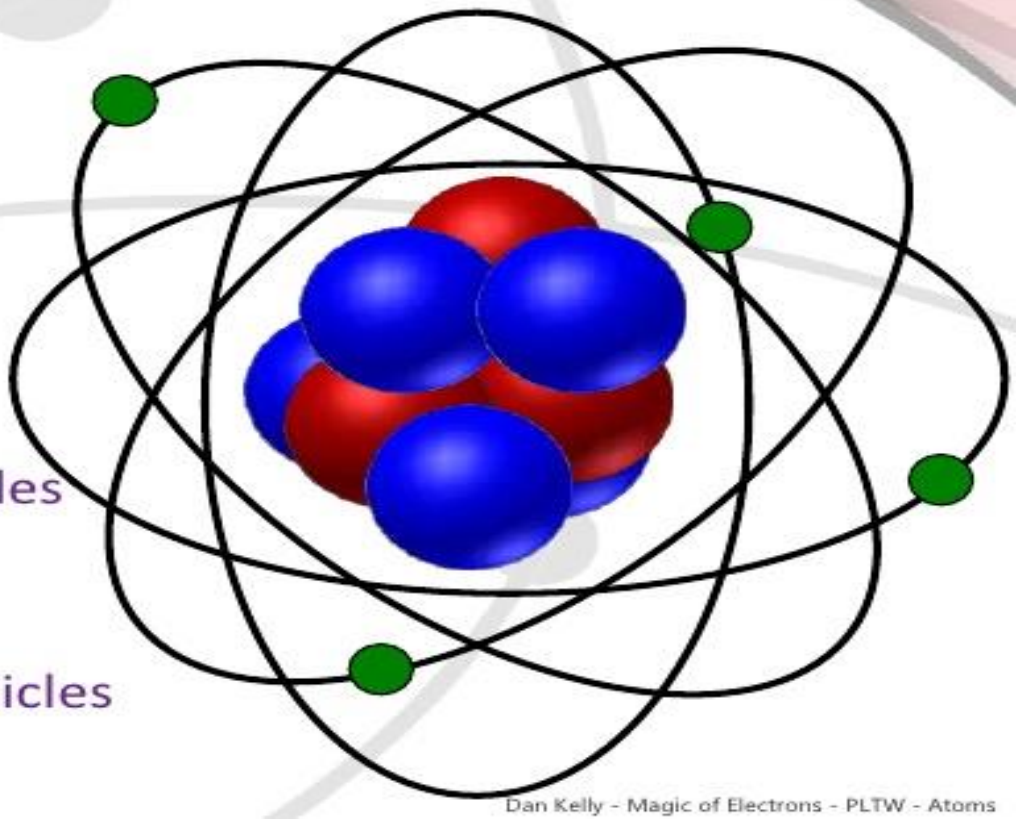
What makes up an **atom**?

At the center of all **atoms** is the **Nucleus**.

The **nucleus** contains **protons** and **neutrons.**

Protons: (+)
Positively charged atomic particles

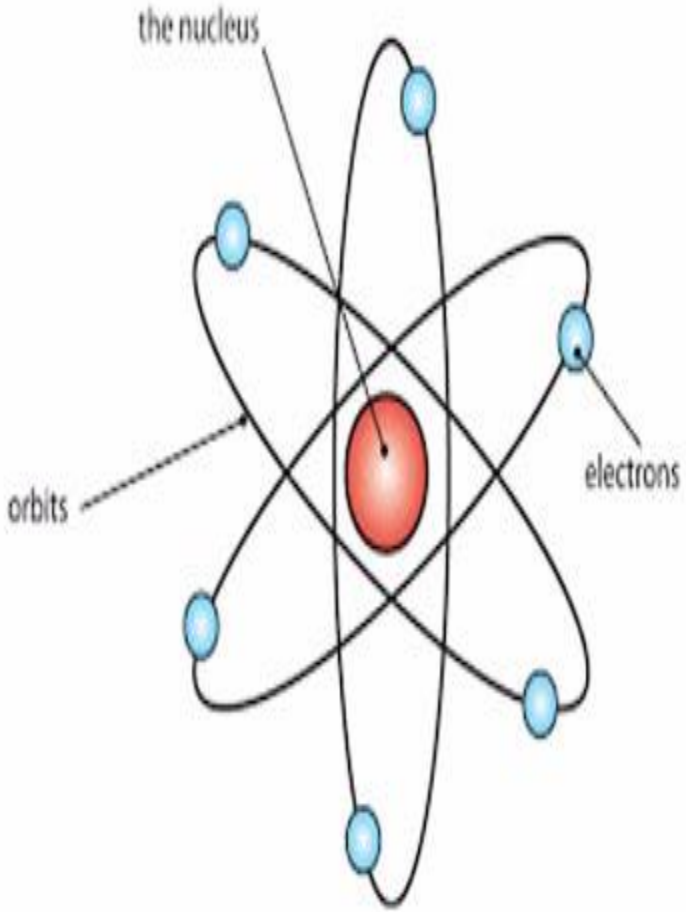
Neutrons:
Uncharged (neutral) atomic particles



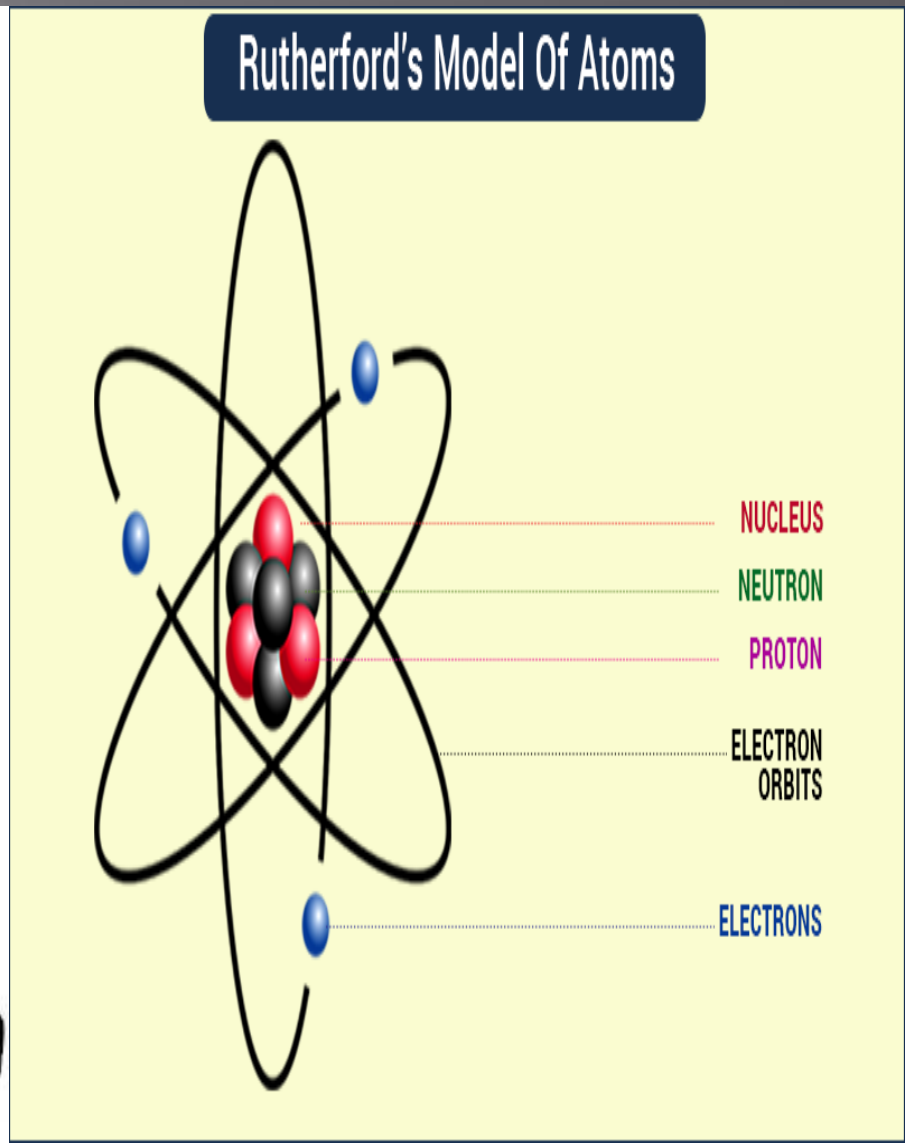
LESSON OBJECTIVES:

- BY THE END OF THIS PART OF LESSON,STUDENTS WILL BE ABLE TO:
- DEFINE ELECTRON,PROTON AND NEUTRONS?
- RUTHERFORD'S ATOMIC MODEL/EXPERIMENT.
- WRITE THE CONCLUSIONS OF RUTHERFORD'S EXPERIMENT.
- WHAT WERE THE DEFECTS IN RUTHERFORD'S ATOMIC MODEL?

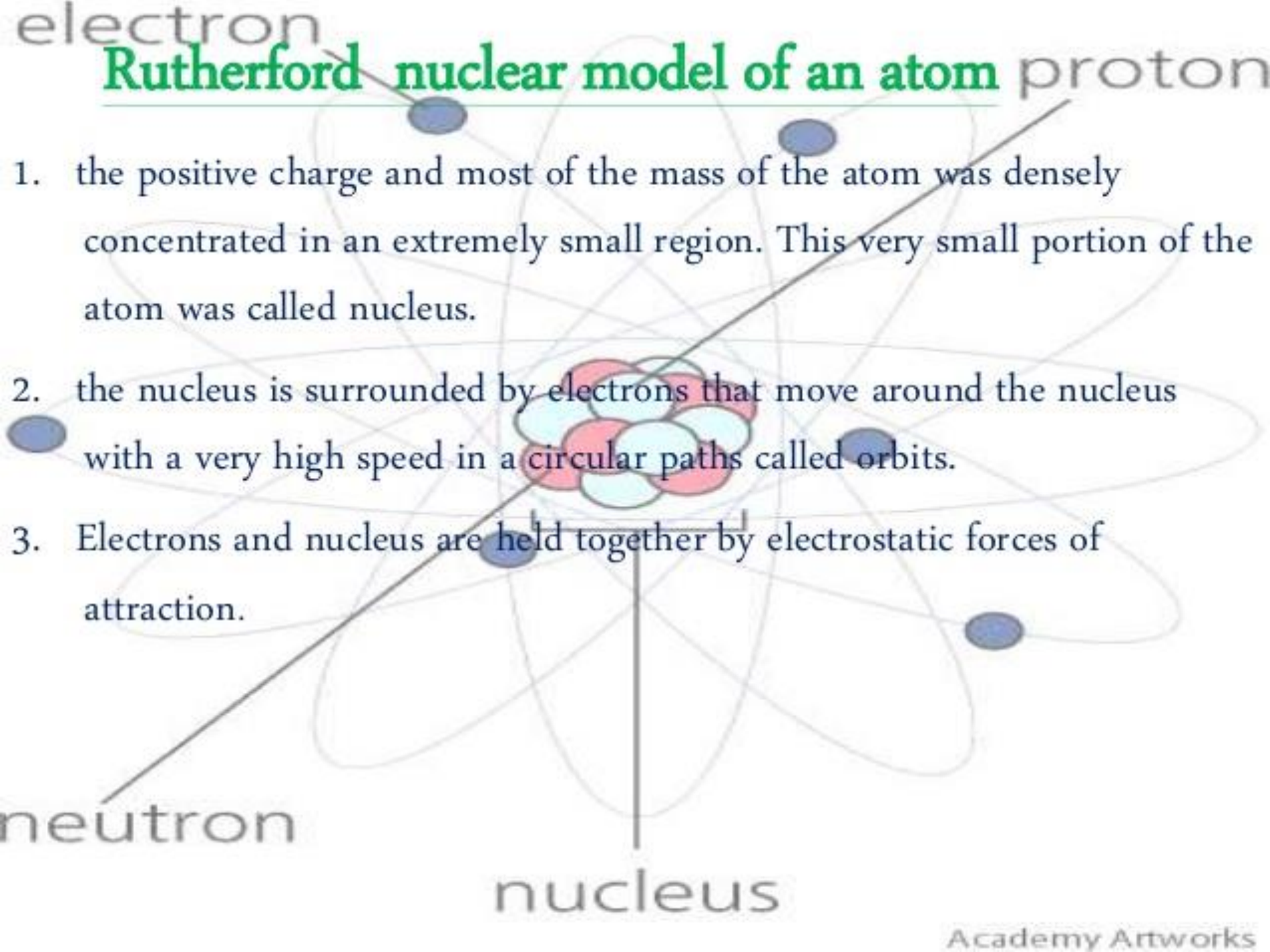
RUTHERFORD'S ATOMIC MODEL:



Rutherford's Model Of An Atom

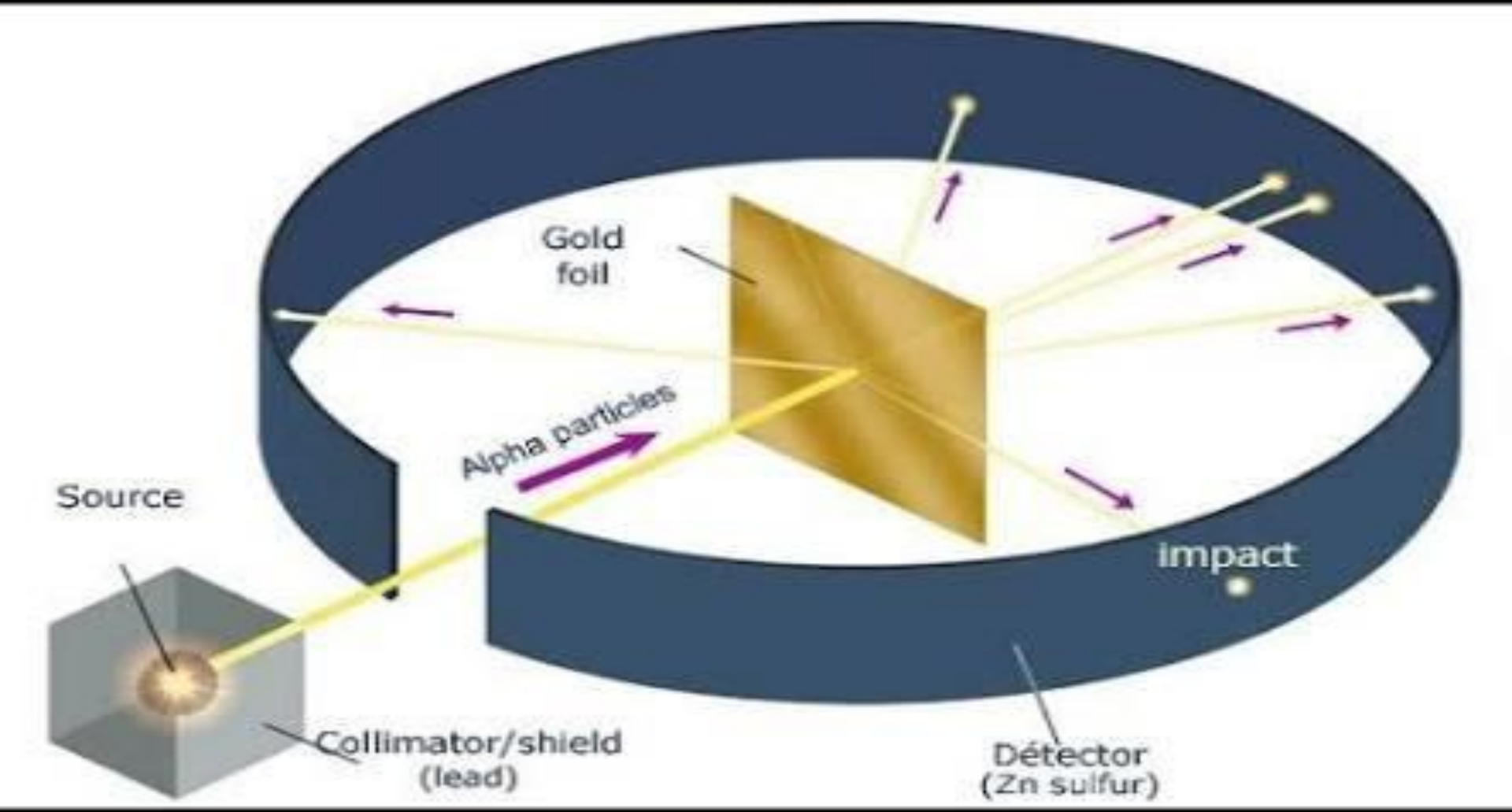


Rutherford nuclear model of an atom

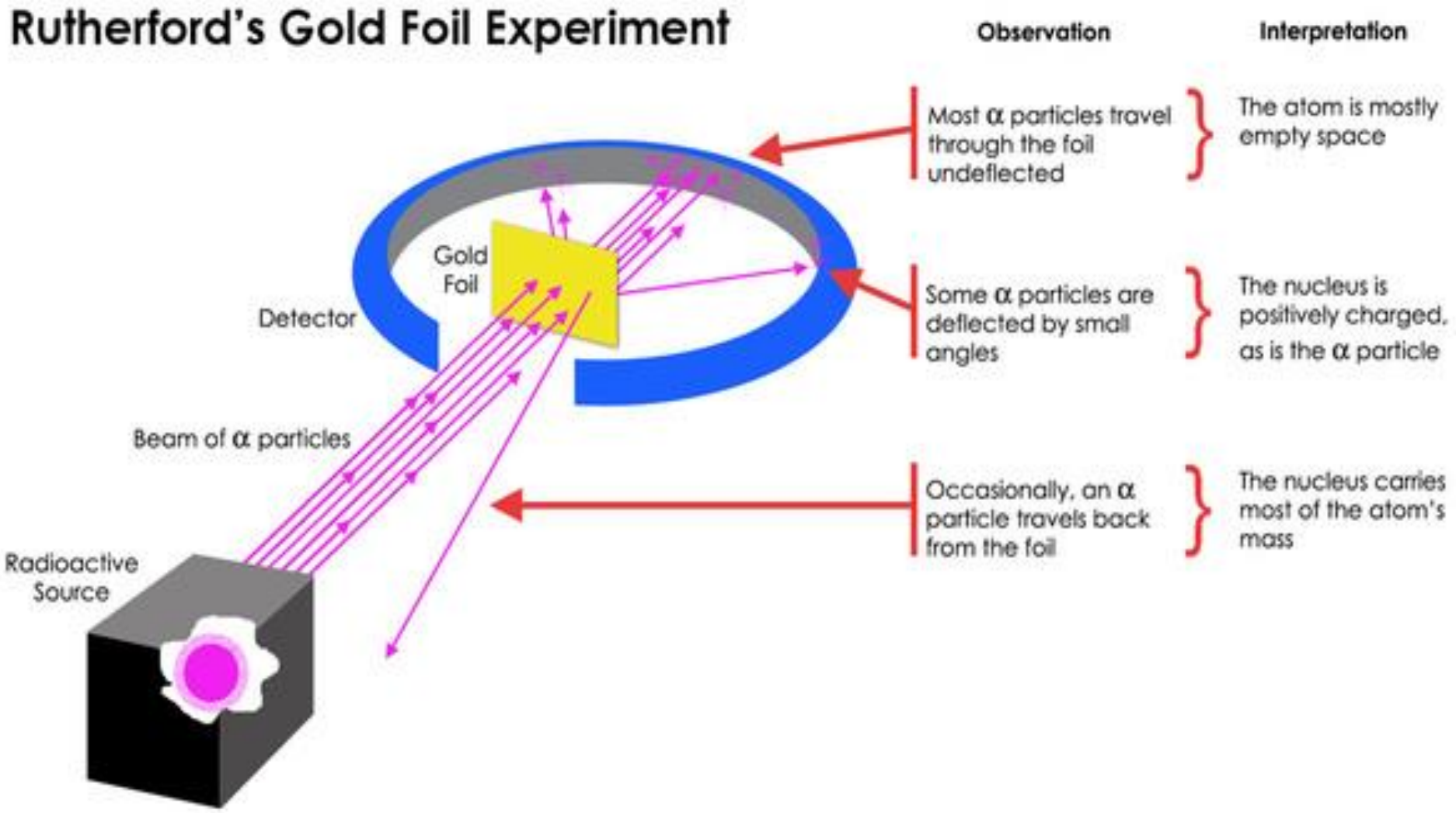


1. the positive charge and most of the mass of the atom was densely concentrated in an extremely small region. This very small portion of the atom was called nucleus.
2. the nucleus is surrounded by electrons that move around the nucleus with a very high speed in a circular paths called orbits.
3. Electrons and nucleus are held together by electrostatic forces of attraction.

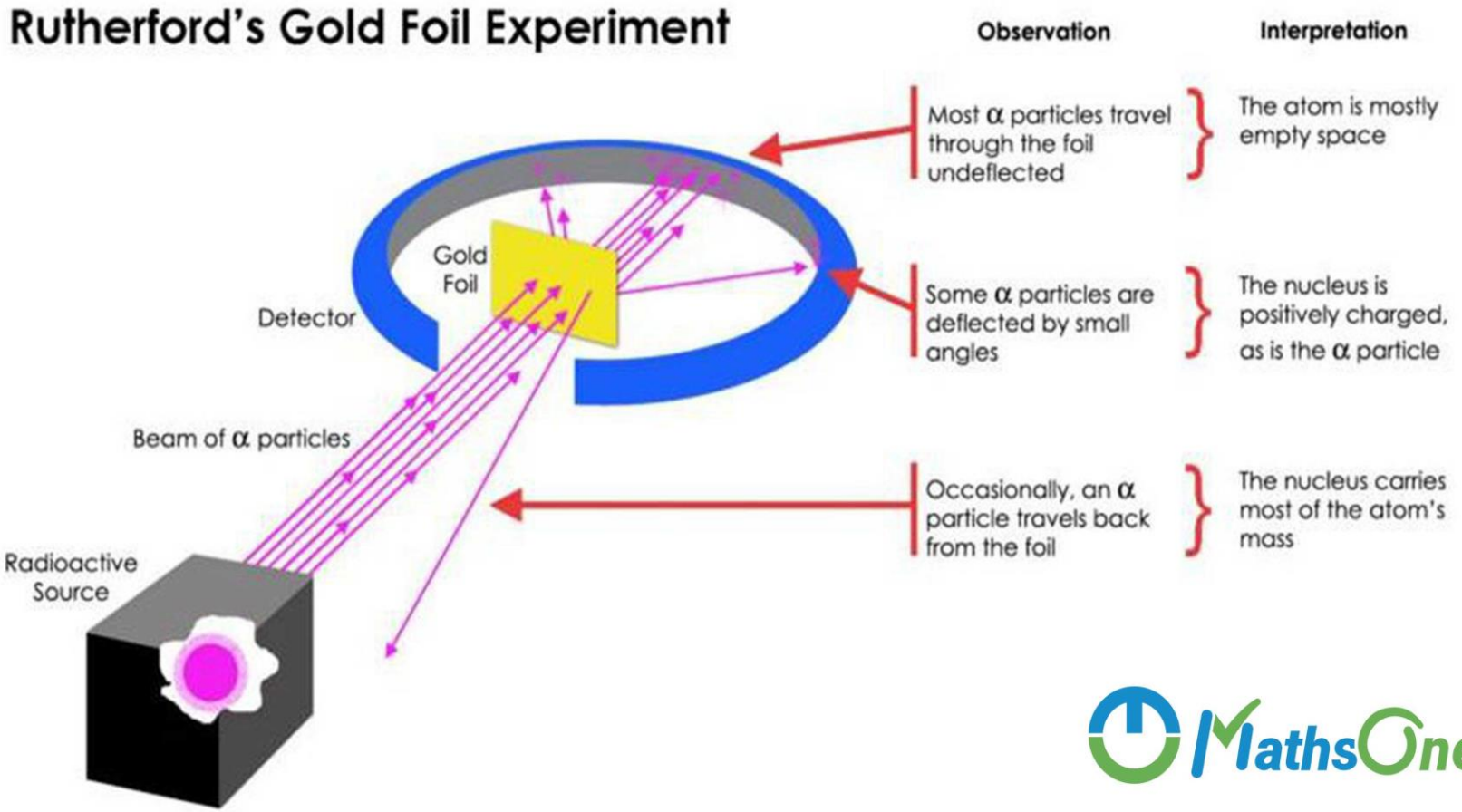
RUTHER'S EXPERIMENTS:



RUTHER'S EXPERIMENT:

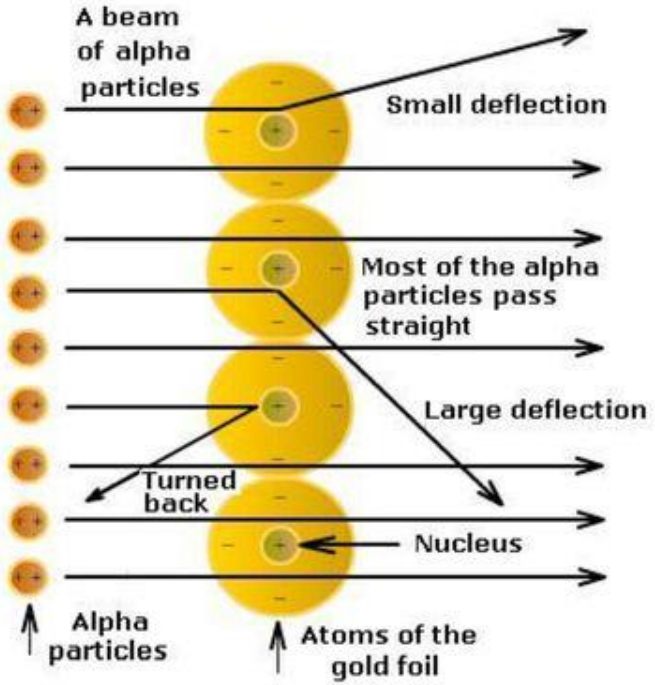


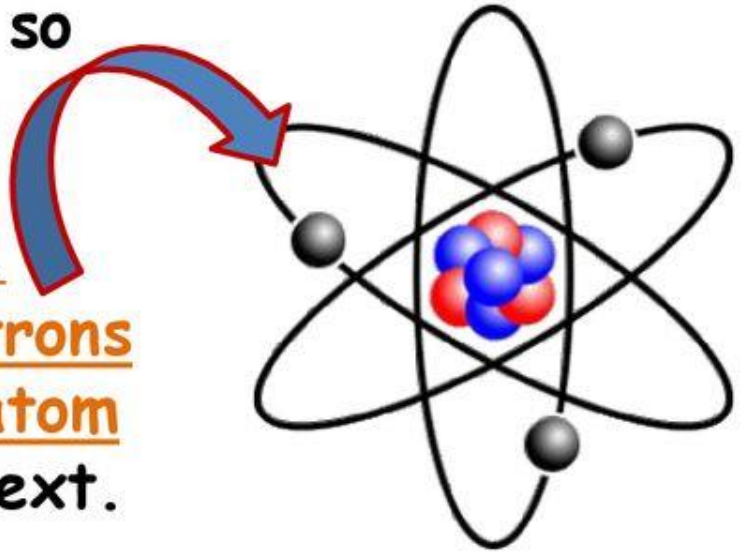
The Discovery Of The Nucleus Of The Atom



Conclusions from α scattering experiment

1. The vast majority of α particles were not deflected at all: the atom must be mostly empty space
2. Some α particles deflected through large angles: there must be a very small nucleus with a positive charge with a large electric field near to its surface.
3. Alpha particles repelled: alpha particles are positively charged so the nucleus must be positively charged in order to create an electrostatic force of repulsion.
4. Atoms are neutral overall: electrons must be on the outside of the atom separating one atom from the next.





Conclusions from Rutherford's Gold Foil Experiment (memorize this!)

- The atom contains a positively charged "**nucleus**"

- This **nucleus** contains almost all of the **mass** of the atom, but occupies a very small **volume** of the atom.

- The negatively charged **electrons** occupied most of the volume of the atom.

- The atom is mostly **empty** space.

CONCLUSIONS DRAWN BY RUTHERFORD

- Rutherford concluded from the alpha particles scattering experiment that –

a) Most of the space inside the atom is empty because most of the alpha particles passed through the gold foil without getting deflected.

b) Very few particles were deflected from their path, indicating that the positive charge of the atom occupies very little space.

Conclusions:

- ✓ Most of the atom was empty space because most of the alpha particles went straight through.
- ✓ The nucleus was positively charged because the positive nucleus repelled the positively charged alpha particles.
- ✓ The mass of the atom was concentrated in the nucleus / the nucleus is very dense (not "large or heavy") because the alpha particles were repelled straight back / at large angles

.

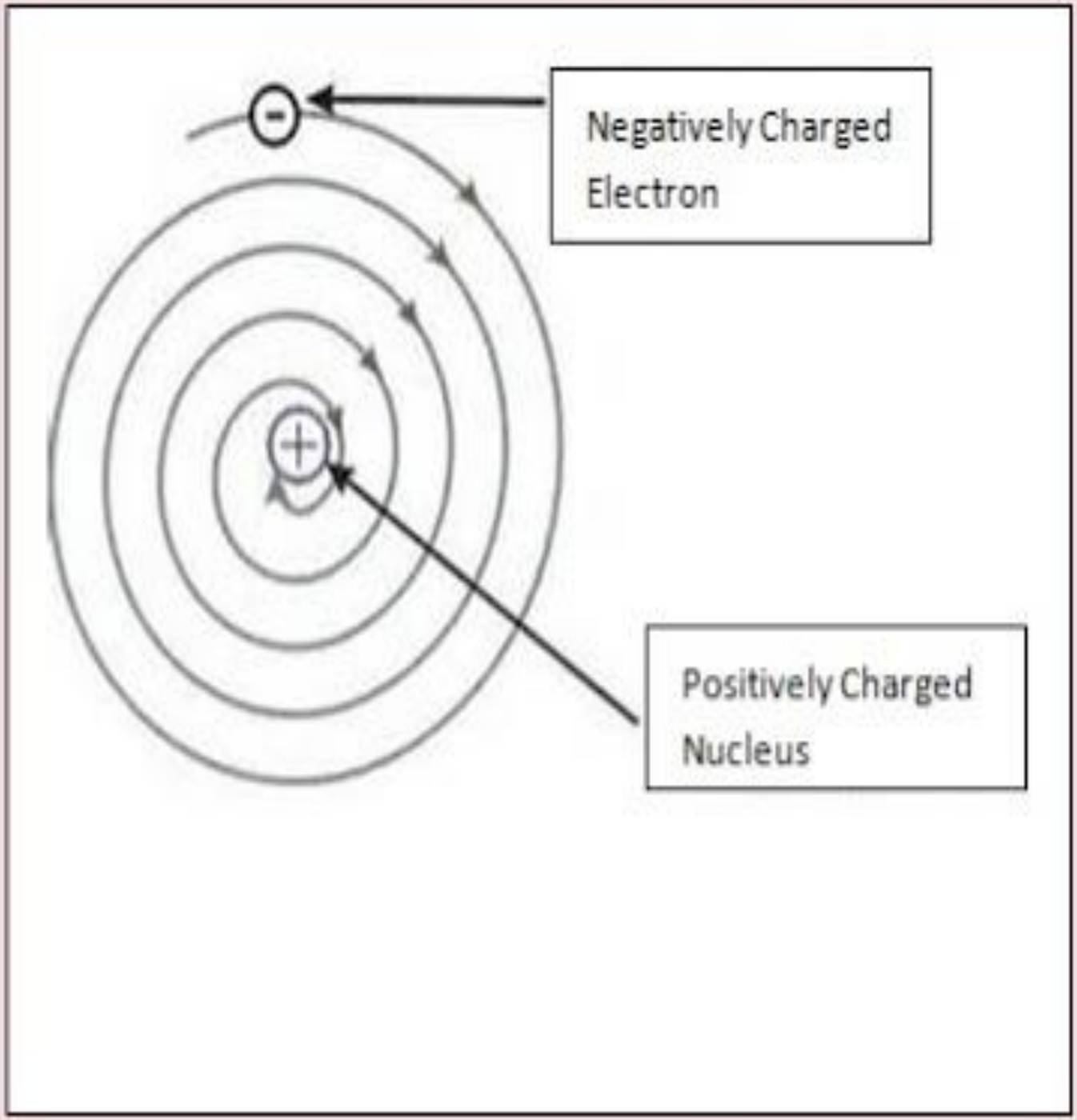
Drawbacks of Rutherford's Model

- **It could not explain the stability of the atom.** A/c to classical theory of mechanics, during uniform revolution, any body accelerates, & an accelerating charged particle must emit radiation, and lose energy. Due to the fact, the electron must emit radiation and lose energy. As a result, the electron will follow a spiral path, and ultimately fall into nucleus .So, Rutherford has given concept of unstable atom.

- The Rutherford's model of atom does not say anything about the arrangement of electrons in an atom.

Limitations of the Rutherford's Model

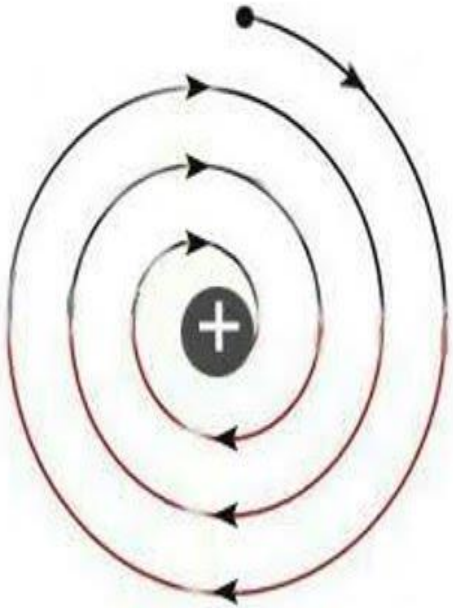
According to Rutherford's model of an atom, electrons revolve around the nucleus as planets revolve around the sun. But, electrons revolving in circular orbits will not be stable because during revolution, they experience acceleration. Due to acceleration, they will lose energy in the form of radiation arid fall into the nucleus. In such a cases the atom would be highly unstable and would collapse.



In this model, the negatively charged electron could fall into the nucleus. This does not happen actually.

Defects of Rutherford's Atomic Model

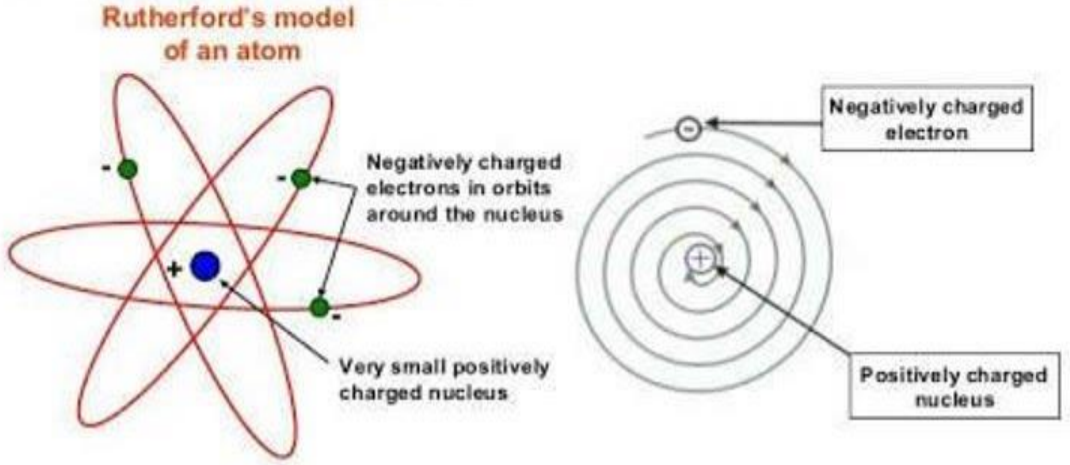
Atomic structure



continuous decrease in the energy of the electron

Defects of Rutherford's model of the atom :-

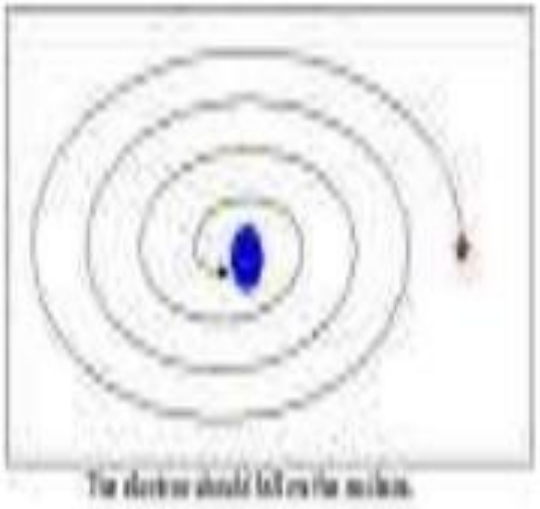
Any particle in a circular orbit would undergo acceleration and during acceleration the charged particle would radiate energy. So the revolving electrons would lose energy and fall into the nucleus and the atom would be unstable. We know that atoms are stable.



DEFECT OF RUTHERFORD'S THEORY

There were two fundamental defects in Rutherford's atomic model:

- According to classical electromagnetic theory, being a charge particle electron when accelerated must emit energy. We know that the motion of electron around the nucleus is an accelerated motion, therefore, it must radiate energy. But in actual practice this does not happen. Suppose if it happens then due to continuous loss of energy orbit of electron must decrease continuously. Consequently electron will fall into the nucleus. But this is against the actual situation and this shows that atom is unstable.



- If the electrons emit energy continuously, they should form continuous spectrum. But actually line spectrum is obtained

Topic: Theories and experiments related to atomic structure: pg 31

Q1: What are the defects of Rutherford's model of atom?

Ans:

Defect in Rutherford's atomic model:

1. According to classical physics, electrons being charged particle should emit energy continuously. The orbit of electron should become smaller and smaller until it falls into the nucleus. But it never falls because if it falls at all, the atomic structure would collapse.
2. If the electron emits energy continuously, atom should form continuous spectrum. Actually atoms give line spectrum.

CONCLUSIONS:

- **: What were the conclusions drawn by**
- **Rutherford from the following observations**
- **on the scattering experiment of α – particles?**
- **RUTHERFORD'S ATOMIC MODEL:**
- Rutherford's atomic model shows the existence
- of nucleus in the atom, nature of charge on the
- nucleus and the magnitude of charge on the
- nucleus.

EXPERIMENTS:

In his experiments, Rutherford bombarded alpha particles on very thin metallic foils such as gold foil of 0.0004cm thickness. He obtained alpha particles (He^{2+}) from a radioactive element radium or polonium. In order to record experimental observations, he made use of circular screen coated with zinc sulphide.

OBSERVATIONS

1. He observed that most of the alpha particles were pass through the foil un deflected.
2. Very few particles were deflected when passed through the foil.
3. One particle out of 1 million particles was deflected greater than 90
4. Few particles were deflected at different angles.
5. Massive alpha particles were not deflected by electrons.

CONCLUSIONS:

CONCLUSIONS DRAWN FROM THESE EXPERIMENTS

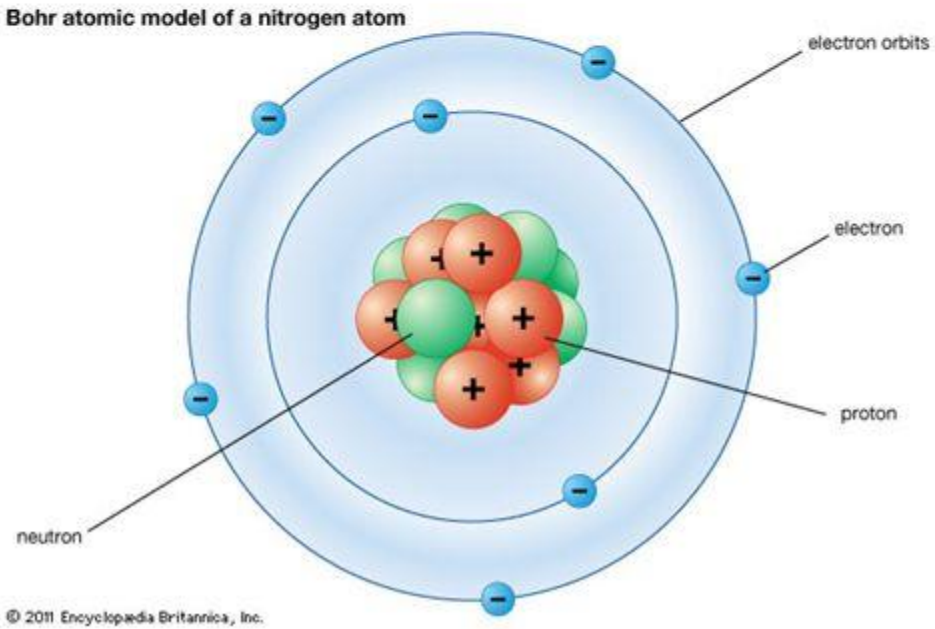
From these experiments Rutherford proposed a planetary model for an atom. He drew the following conclusions.

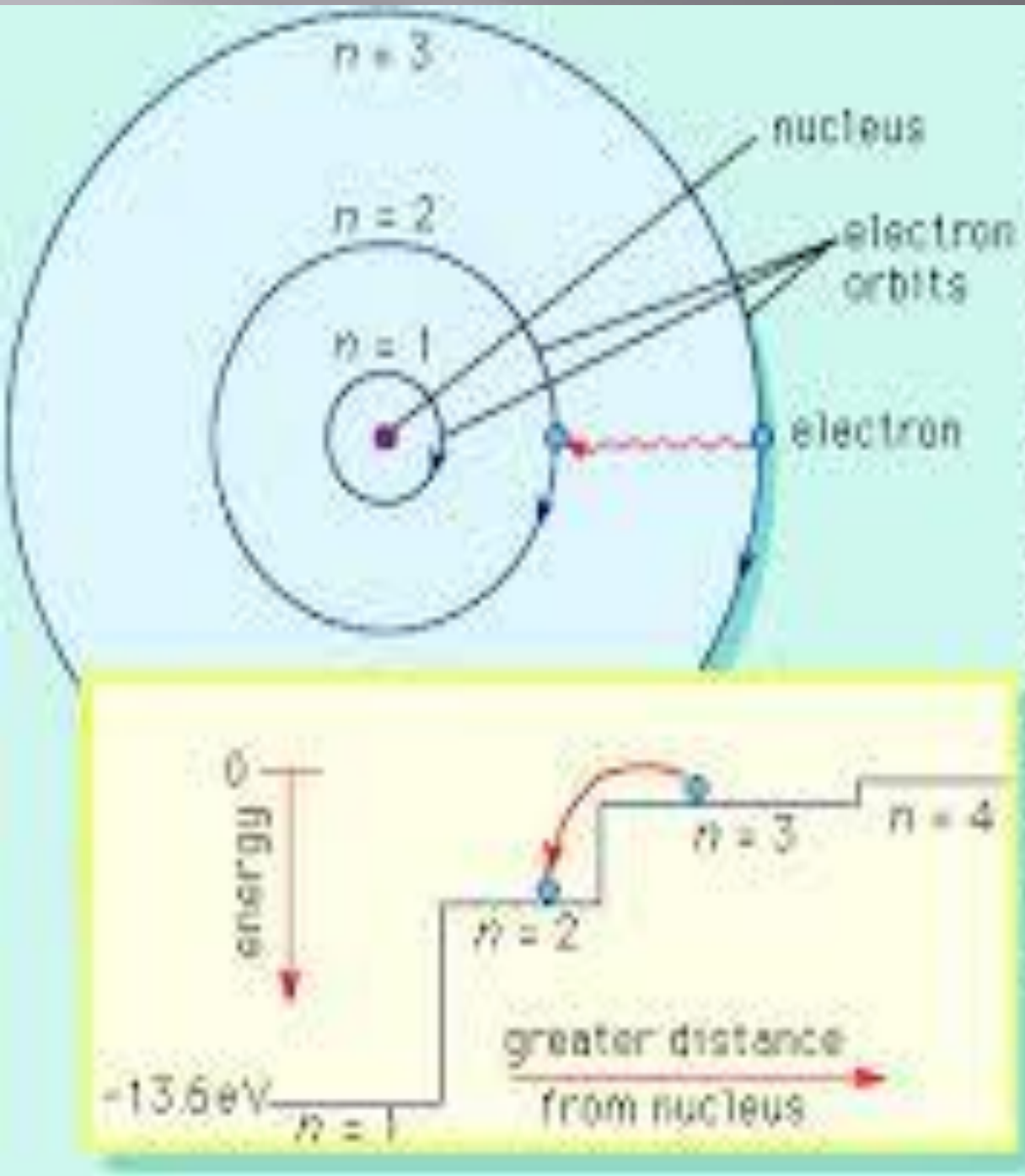
1. Since most of the α-particles pass through the foil un deflected, therefore, most of the space occupied by the atom is empty.
2. The deflection of a few particles proved that there is a centre of heavy positive charge in an atom which causes repulsion as shown in the figure. The heavy part of the atom is called its nucleus.
3. All the space outside the nucleus is occupied by the fast revolving electron. The massive α-particles are not deflected by these electrons.
4. The centrifugal force which is produced due to rotation of electrons balances the electrostatic force of attraction between the nucleus and electron. This prevents the electrons from falling into nucleus.

RUTHERFORD'S ATOMIC MODEL:

- **RUTHERFORD'S ATOMIC MODEL**
- Major portion of the atom is empty.
- The whole mass of the atom is concentrated in the center of atom called **nucleus**.
- The positively charged particles are present in the nucleus of atom.
- The electrons revolve around the nucleus in different circular orbits.
- Size of nucleus is very small as compare to the size of atom.

- Bohr's model (summary):
  - Electrons are located in defined shells, which are located certain distances from the nucleus.
  - Electrons cannot exist between the defined shells.
  - Electrons can gain energy to move to a higher shell, or they can lose energy to move down to a lower shell.
  - Electrons are more stable when they are closer to the nucleus.





The electron travels in circular orbits around the nucleus. The orbits have quantized sizes and energies. Energy is emitted from the atom when the electron jumps from one orbit to another closer to the nucleus. Shown here is the first Balmer transition, in which an electron jumps from orbit $n = 3$ to orbit $n = 2$, producing a photon of red light with an energy of 1.89 eV and a wavelength of 656×10^{-9}m.

Postulates of Bohr's theory

- An electron revolves in a circular orbit about the nucleus and its motion is governed by the ordinary laws of mechanics and electrostatics, with the restriction that its angular momentum is quantized (can only have certain discrete values)

$$\text{angular momentum} = m \cdot v \cdot r = nh/2\pi$$

m = mass of electron

v = velocity of electron

r = radius of orbit

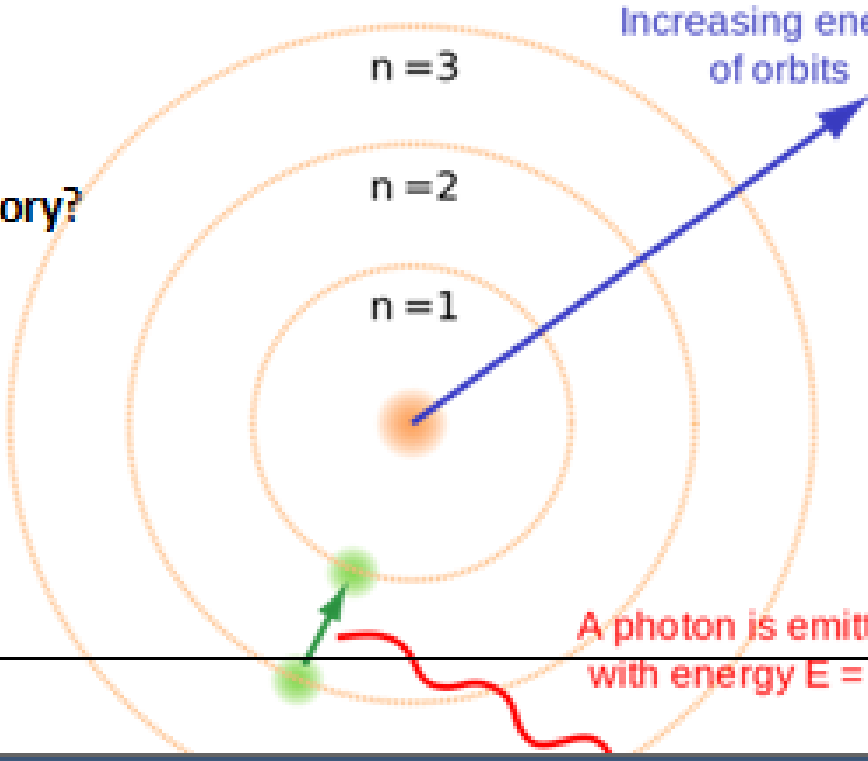
n = 1,2,3,4,...(energy levels)

h = Planck's constant

Postulates of Bohr's Atomic Model

- **Electrons revolve round the nucleus with definite velocities in concentric circular orbits situated at definite distances from the nucleus. The energy of an electron in a certain orbit remains constant. As long as it remains in that orbit, it neither emits nor absorbs energy. These are termed stationary states or main energy states.**

Topic: Theories and experiments related to atomic structure: pg 32



Q: 3 Explain the postulates of Bohr's atomic theory?

Ans:

In 1913 Neil Bohr presented his atomic model,

he introduced circular orbit concept

on basis of Plank's Quantum theory.

Main postulates of Bohr's atomic theory are:

1. Electrons revolve around the nucleus in

   circular path, which are known as

   "ORBITS" or "ENERGY LEVEL".

2. Energy of the electron in an orbit is proportional to its distance from the nucleus.

   The further the electron is from the nucleus, the more energy it has.

3. The electron revolves only in those orbits for which the angular momentum of the electron is an integral multiple of $h/2\pi$ where h = Planck's constant (6.6256×10^{-34} J.s)

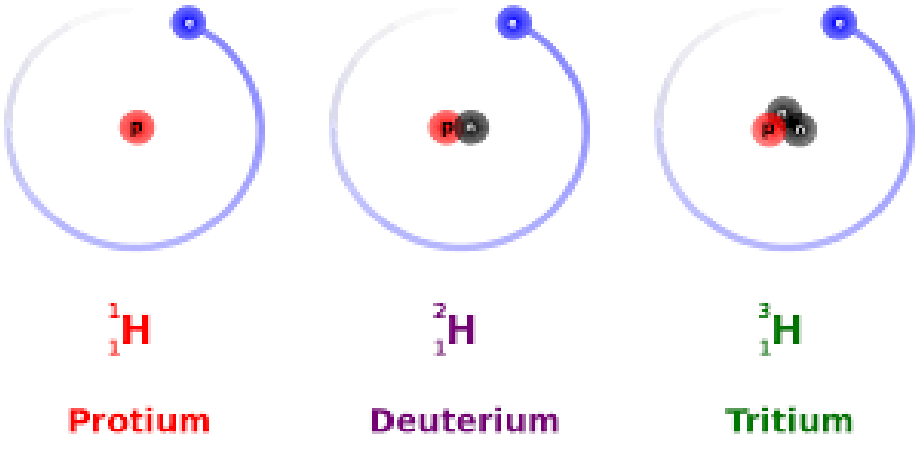
4. Light is absorbed when an electron jumps to a higher energy orbit and emitted when an electron falls into a lower energy orbit. Electron present in a particular orbit does not radiate energy.

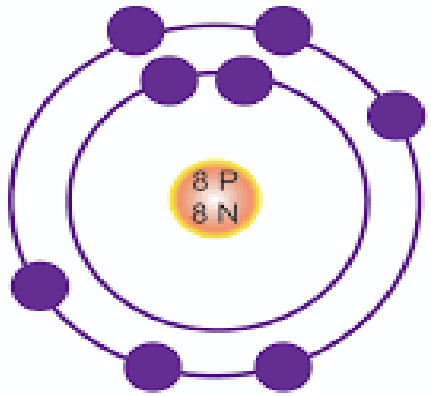
5. The energy of the light emitted is exactly equal to the difference between the energies of the orbits.

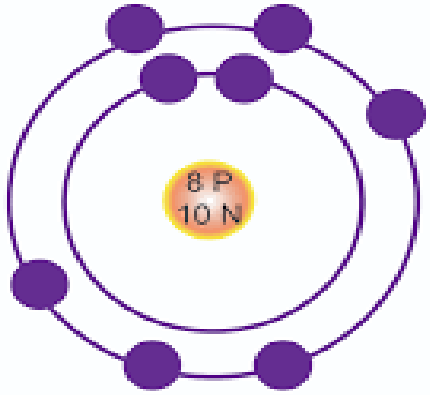
$\Delta E = E_2 - E_1$

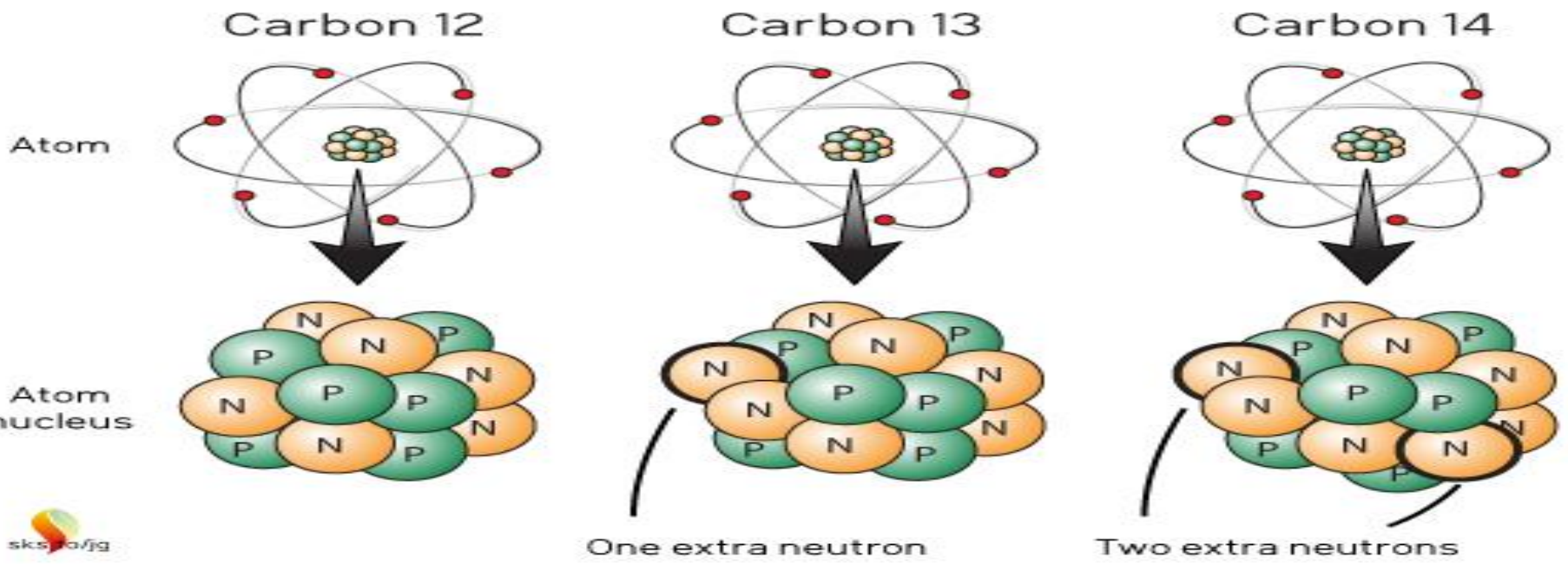
Where ΔE is the energy difference between any two orbit with energies E_1 and E_2

POINTS TO PONDER:

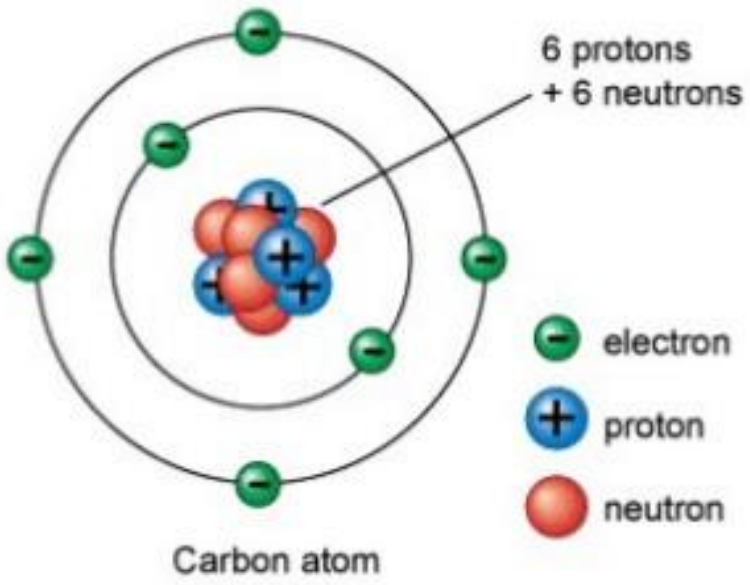








What are isotopes?



Isotopes are variations of chemical elements that have the same number of protons but different numbers of neutrons.

Topic: Isotopes : Pg. No: 33 to 36

Q4: Write about isotopes of Chlorine?

Ans: There are two isotopes of chlorine,

$_{17}Cl^{35}$, $_{17}Cl^{37}$.

The abundance in nature is

75% and 25 % respectively.

Chlorine is grayish yellow gas with sharp

Pungent Irritating smell. It is fairly soluble in water.

Q5: Write about isotopes of Uranium?

Ans: Isotopes Of Uranium

- There are three isotopes of uranium, $_{92}U^{234}$, $_{92}U^{235}$, $_{92}U^{238}$
- Natural abundance is 0.006%, 0.72%, 99.27% respectively

Q6: What are radioisotopes?

Ans: Isotopes which are produced artificially are called radioisotopes. Radio isotopes are unstable and emit radioactive rays like. Alpha, beta and gamma rays.

Or

radioactive isotope, also called **radioisotope**, any of several species of the same chemical element with different masses whose nuclei are unstable and dissipate excess energy by spontaneously emitting radiation in the form of alpha, beta, and gamma rays.

Q7: What are isotopes? Give two examples.

Ans: Isotopes:
Nuclei of the same element having same atomic number but different mass number are known as isotopes.
OR
Nuclei of same element having same number of proton but different number of neutron are knows as isotopes.

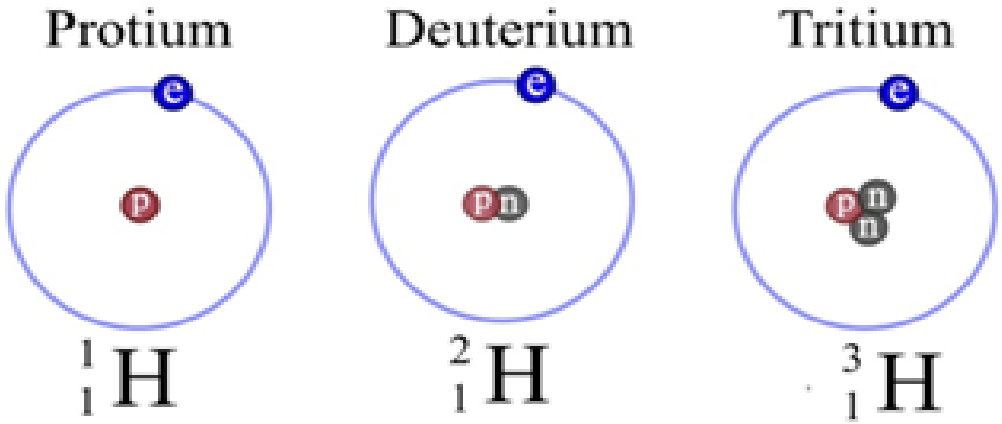
Example

- $_{17}Cl^{35}$, $_{17}Cl^{37}$
- $_{6}C^{12}$, $_{6}C^{13}$, $_{6}C^{14}$
- $_{92}U^{234}$, $_{92}U^{235}$,$_{92}U^{238}$

Isotopes Of Hydrogen

There are three isotopes of hydrogen.

- Protium
- Deuterium
- Tritium



Protium

Ordinary hydrogen is knows as protium .

- It has one electron ,one proton but it has no neutron.
- Mass number : 1
- Charge number : 1
- Symbol : $_1H^1$

Percentage in natural hydrogen: 99.98%
Deuterium

- It has one electron one proton and one neutron.
- Mass number: 2
- Charge number: 1
- Symbol: $_1H^2$ or D

Percentage In Natural Hydrogen: 0.0156%

Structure
Heavy water(D_2O) consists of deuterium isotope of hydrogen.

Tritium

- It has one electron, one proton and two neutrons.
- Mass number : 3
- Charge number : 1
- Symbol : $_1H^3$

1. It is a radioactive isotope. Not occurring naturally
2. It emits radioactive rays.
3. It is present in traces.

Isotopes Of Carbon

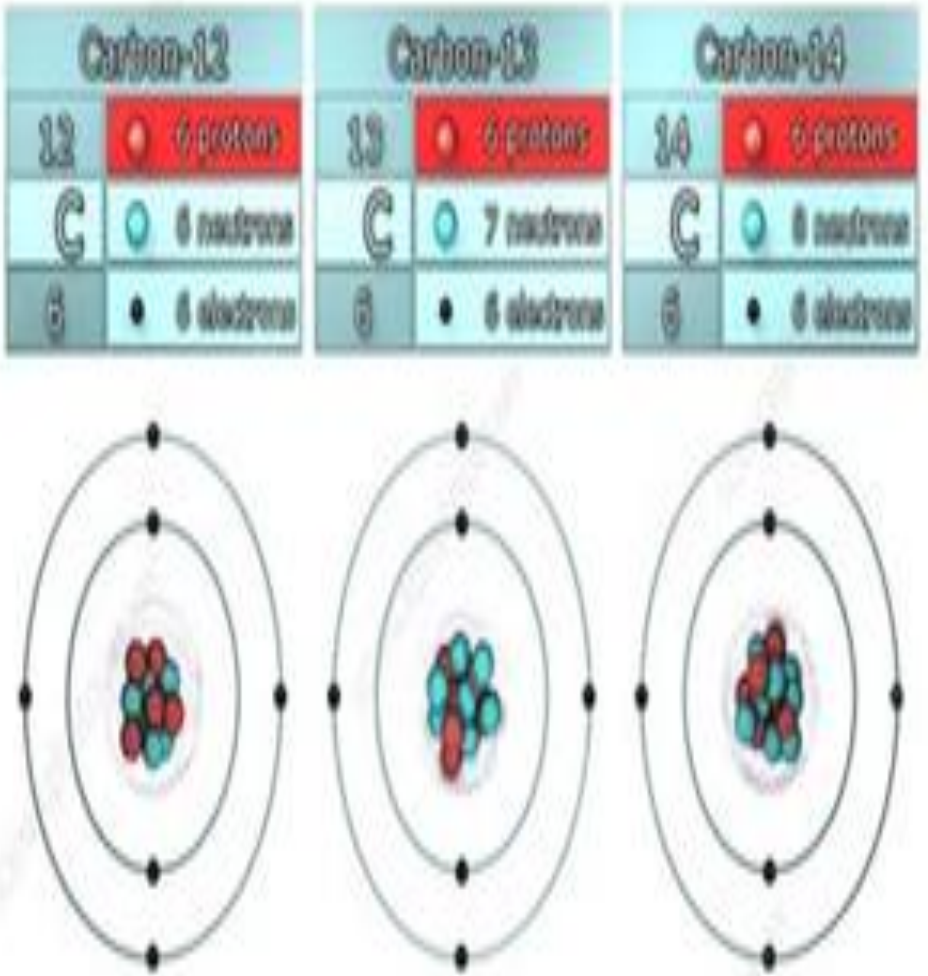
Carbon has three isotopes: C-12, C-13, C-14.

Almost all carbon is carbon-12,

its symbol is ${}_{6}C^{12}$.

Its %age in nature is 98.9%, C-13 and

C-14 are 1.1% in nature. C-14 is radioactive.



APPLICATIONS:

- **: What are applications (uses) of isotopes?**
- **Ans**: **Cadmium-109:** Used to analyze metal alloys for checking stock, scrap sorting
- **Calcium -47**: Important aid to biomedical researchers studying the cellular functions and bone formation in mammals.
- **Carbon-14**: Major research tool. Helps in research to ensure that potential new drugs are metabolized without forming harmful byproducts. Used in biological research, agriculture, pollution control, and archeology.
- **Iodine-123:** Widely used to diagnose thyroid disorders and other metabolic disorders including brain function.
- **Iodine-125:** Major diagnostic tool used in clinical tests and to diagnose thyroid disorders. Also used in biomedical research.
- **Iodine-131**: Used to treat thyroid disorders.
- **Phosphorus-32**: Used in molecular biology and genetics research.
- **Uranium-235:** Fuel for nuclear power plants and naval nuclear propulsion systems…and used to produce fluorescent glassware

HOME-WORK:

Assessment

Worksheet 1

Q: Describe the contribution that Rutherford made to the development of the atomic theory.

Q: Explain how Bohr's atomic theory differed from Rutherford's atomic theory.

Worksheet 2

Q: Draw Bohr's Model for the following atoms indicating the location for electrons , protons and electrons.

a) Carbon (Atomic No. 6, Mass No.12)
b) Chlorine (Atomic No.17 , Mass No.35)
c) Silicon (Atomic No. 14 , Mass No. 28)

Worksheet 3

Q1: Two isotopes of Chlorine are $_{17}Cl^{35}$ and $_{17}Cl^{37}$. How does these isotopes differ? How are they alike?

Q2: How many number of electron, proton and neutron in Uranium $_{92}U^{234}$, $_{92}U^{235}$ and $_{92}U^{238}$ isotopes?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7
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O
Oxygen
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2 6
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Uranium
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Thank
You


TAKE CARE