❑ Thomson atomic model:

In 1897 Joseph John Thomson (J. J. Thomson) discovered the electron and then went to propose a model for the structure of the atom. This model is also called plum pudding model. He compared the electrons with the raisins in the spherical pudding. The postulates of Thomson's model are

i) An atom consists of a positively charged sphere with electrons embedded in it.
ii) An atom as a whole is electrically neutral because the negative and positive charges are equal in magnitude.

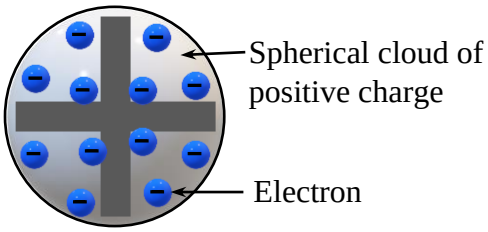

Fig. 1. Thomson's plum pudding model of the atom.

Limitations:

i) It failed to explain the stability of an atom because this model of atom failed to explain how a positive charge holds the negatively charged electrons in an atom. Therefore, this model also failed to account for the position of the nucleus in an atom.
ii) It failed to explain the scattering of alpha particles by thin metal foils.
iii) There is no experimental evidence in its support.

Although Thomson's model was not an accurate model to account for the atomic structure, it proved to be the base for the development of other atomic models.

❑ Rutherford's alpha scattering experiment:

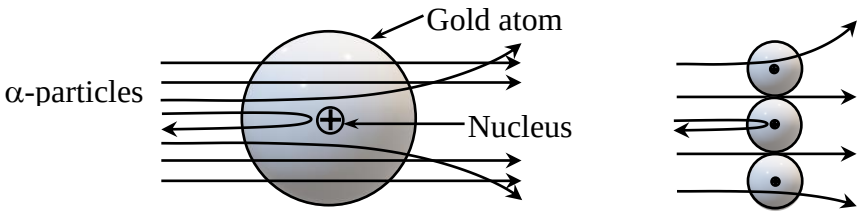

Fig. 2. Rutherford's alpha scattering experiment

Rutherford conducted an experiment by bombarding a thin sheet of gold with alpha (α) particles and then studied the trajectory of these particles after their interaction with the gold foil. He directed high energy streams of α-particles from a radioactive source at a thin sheet (100 nm thickness) of gold. In order to study the deflection caused to the α-particles, he placed a fluorescent zinc sulphide screen around the thin gold foil. He made certain observations that contradicted Thomson's atomic model.

Observations of Rutherford's alpha scattering experiment:

The observations made by Rutherford led him to conclude that-

i) A major fraction of the α-particles bombarded towards the gold sheet passed through it without any deflection, and hence most of the space in an atom is empty.
ii) Some of the α-particles were deflected by the gold sheet by very small angle, and hence the positive charge in an atom is not uniformly distributed. The positive charge in an atom is concentrated in a very small volume.
iii) Very few of the α-particles were deflected back, that is only a few α-particles had nearly 180° angle of deflection. So, the volume occupied by the positively charged particles in an atom is very small as compared to the total volume of an atom.

❑ Rutherford atomic model:

Based on the observations and conclusions of alpha scattering experiment, Rutherford proposed the atomic structure of elements. According to the Rutherford atomic model-

i) The positively charged particles and most of the mass of an atom are concentrated in an extremely small volume. He called this region of the atom as a nucleus.
ii) This model proposed that the negatively charged electrons surround the nucleus of an atom. He also claimed that the electrons surrounding the nucleus revolve around it with very high speed in circular paths. He named these circular paths as orbits.
iii) Electrons being negatively charged and nucleus be a densely concentrated mass of positively charged particles are held together by a strong electrostatic force of attraction.

❑ Limitations of Rutherford atomic model:

Although the Rutherford atomic model was based on experimental observations, it failed to explain certain things-

i) Rutherford proposed that the electrons revolve around the nucleus in fixed paths called orbits. According to Maxwell, accelerated charged particles emit electromagnetic radiations and hence an electron revolving around the nucleus should emit electromagnetic radiation. This radiation would carry energy from the motion of the electron which would come at the cost of shrinking of orbits. Ultimately electrons would collapse in the nucleus. According to calculations, if Maxwell's explanation is followed, Rutherford's model will collapse within 10^{-8} sec.
So, Rutherford's model was not in accordance with Maxwell's theory and could not explain the stability of an atom.
ii) One of the major drawbacks of the Rutherford model was that he did not say anything about the arrangement of electrons in an atom which made his theory incomplete.

Although the early atomic models were inaccurate and failed to explain the structure of atom and certain experimental results, these were the base for future developments in the world of quantum mechanics.

❑ Postulates of Bohr's atom model:

Rutherford's experiment on the scattering of α-particles led Bohr to the conclusion that the atom consists of a positively charged nucleus at its center. Moreover, Bohr applied the quantum theory of radiation as developed by Planck and Einstein to the Rutherford's model. His theory mainly based on the following postulates-

i) An atom consists of a positively charged nucleus at the center.
ii) The negatively charged particles known as electrons move round the nucleus in various orbits known as stationary energy levels. The electrons can not emit radiations when moving in their stationary levels.
iii) The Coulombian and Newtonian forces are applicable in the domain of the atom.
iv) The electrons revolve round the nucleus in various circular orbits and the angular momentum

$$mvr = \frac{nh}{2\pi}$$

where, n (= 1, 2, 3, ……. etc.) is called the quantum number, and h is the Planck's constant.

v) When an electron jumps from a higher energy level to a lower energy level, it gives out electromagnetic radiations of a particular frequency.

Bohr's postulates are the combination of some of the ideas of classical physics and quantum physics. While, in some way they agree with classical physics but in some aspects, they are contradictory to it. Here the energy levels are quantized. It means that the electrons can move only in some particular orbits of definite radii as suggested by Rutherford's model.