List

Lesson 1: Dalton Atomic Theory and The modern Atomic Theory

Lesson Objective :

At the end of this lesson You will be :

- discuss the historical development of atomic structure
- explain the experimental observations and inferences made by some famous scientists to characterize the atom
- list the subatomic particles
- identify atomic mass and isotope terms

Brainstorming Question

Which Of Dalton's Postulates Inconsistent With Later Observations?

key terms and concepts

- Atomic mass
- Isotope
- Nucleus
- Neurons

1.1 Introduction

- The Greek philosopher ,Democritus expressed the belief that all matter consists of very small, indivisible particles, which he named atomos (meaning uncuttable or indivisible)
- His idea was not accepted by other Greece philosophers (notably Plato and Aristotle)

1.2 Dalton and The modern Atomic Theory

1.2.1 Dalton's Atomic Theory

Postulates of Dalton's atomic theory

- Elements are made of small particles called atoms.

- Atomsareindivisible
- Atoms can neither be created nor destroyed.
- All atoms of the same element are identical and have the same mass and size.
- Atoms of different elements have different masses and size.
- Atoms combine in small whole numbers to form compounds

Drawbacks Of Dalton’s Atomic Theory

- The indivisibility of an atom was proved wrong: an atom can be further subdivided into protons, neutrons, and electrons
- Atoms of the same element are similar in all respects. However, atoms of some elements vary in their mass
- These atoms of different masses are called isotopes. For example, carbon has three isotopes with mass numbers 12,13 & 14
- Atoms of different elements differ in mass. This has been proven wrong. Eg. argon and calcium atoms each have an atomic mass of 40 amu. They are called isobar.
- According to Dalton, atoms of different elements combine in simple whole-number ratios to form compounds. This is not observed in complex organic compounds like sugar ($C_{12}H_{22}O_{11}$) and protein molecule

1.2.2 The Modern Atomic Theory

Brainstorming Question

Write modern atomic theory?

Postulates Of The Modern Atomic Theory

- All Matter Is Made-up Of Tiny,indivisible particles called atoms
- Atoms can not be created or destroyed during ordinary chemical reactions.
- Allatomsofthesameelementhavethesameatomicnumberbutmayvary in mass number
- Atoms of different elements are different.
- Atoms combine in small whole numbers to form compounds

1.3 Early experiments characterized The Atom

(Discovery of Sub-atomic particle)

sub atomic particle's

This Research Led To The Discovery Of Three Subatomic Particles
electrons
protons,and
neutrons

1.3.1 Discovery of Electron

- William Crookes was the first scientistwho designed the discharge tubewhichwascalledtheCrooke's Discharge Tube Or Cathode Ray Tube.
- The discharge tube consists of a glass tube from which most of the air has been evacuated having two metal plates sealed at both ends. These metal plates are called electrodes.
- These electrodes are connected to positive and negative terminals of a battery.
- The electrode connected the posetive and negative terminal of the battery.

- When both electrodes are connected to high voltage, current starts flowing a green is glow was observed at anode.
- The rays are emitted from the direction of the cathode,and are called Cathode rays
- J. J. Thomson conducted some experiments with a discharge tube for studying the properties of cathoderays.

He investigate the following properties

- cathode rays travel in straight lines.
- cathode rays has particle nature
- cathode rays made up of a negative charge called electrons
- electrons are found in all atoms

IIn1909,RobertA.Millikan,an American physicist,measured the charge of the electron by measuring the effect of anele ctr ical field on the rate at which charged oil drops fell under the influence of gravity.

- Based on careful experiments, Millikan established the charge on an electron as $e = -1.602 \times 10^{-19}$C.
- He used this value and Thomson's mass/charge ratio to calculate an electron's mass to be 9.109×10^{-31}kg

1.3.2 Radio activity and Discovery of Nucleus

Radioactivey

Does Radioactivity Support Dalton's idea of atoms?

- Radioactivity or radioactive decay is the spontaneous emission of particles and/or radiation from the unstable nuclei of certain atoms such as uranium, radium, cromium, nitrogen….
- after the discovery of radioactivity, three types of rays were identified in the emissions from radioactive substance

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Alpha(α)rays

- Alpha(α)raysconsistofpositivelychargedparticles

- They have a mass of about four times that of a hydrogen atom and a charge twice the magnitude of an electron; they are identical to helium nuclei

Beta(β)rays

- Beta (β) rays, orβ particles, are electrons coming from inside the nucleus and are deflected by the negatively charged plate

gamma(γ)rays.

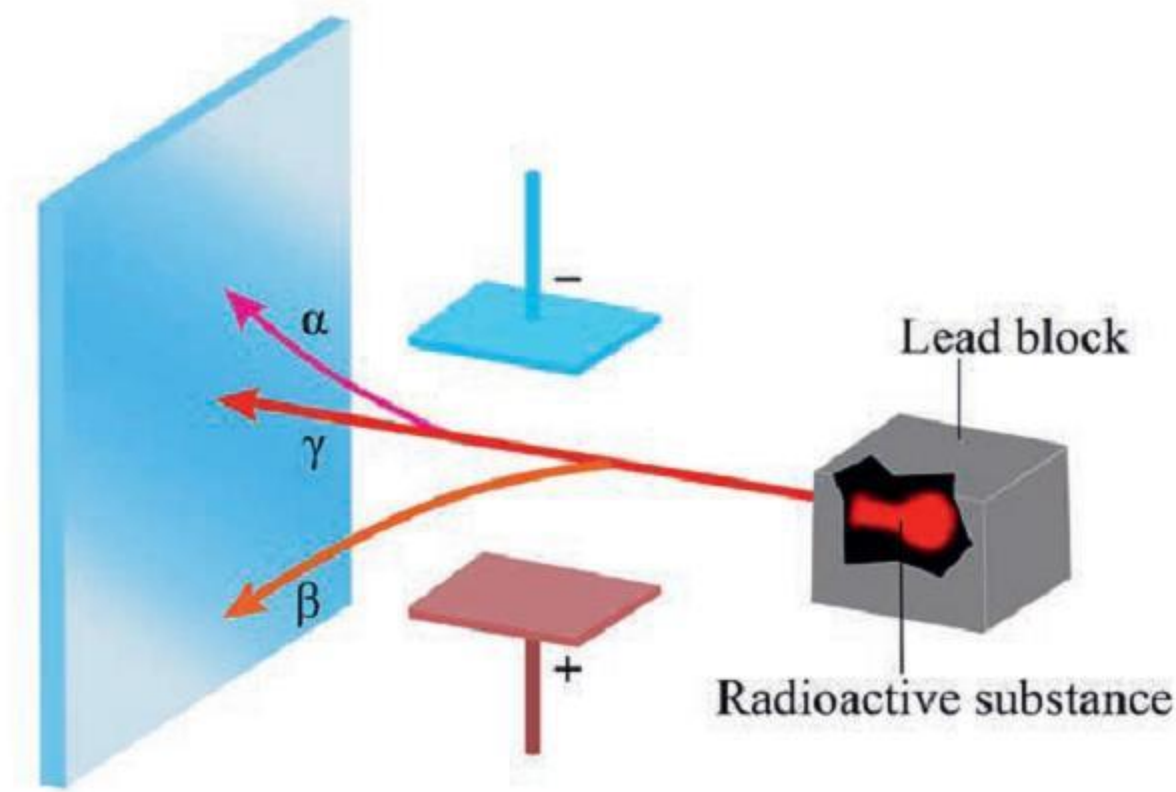


Figure 1.3: Three types of ray emitted by radioactive el

1.2.3 The Discovery Of The Nucles

In 1910, Rutherford carried out a series of experiments using very thin foils of gold and other metals as targets for particles from a radioactive source
They observed that the majority of particles penetrated the foil either un deflected or with only a slight deflection.

From Results Of The α-scattering experiment, Rutherford devised anew model of atomic structure

Theatom’spositive charges,are all concentrated in the nucleus, a dense central core with in the atom

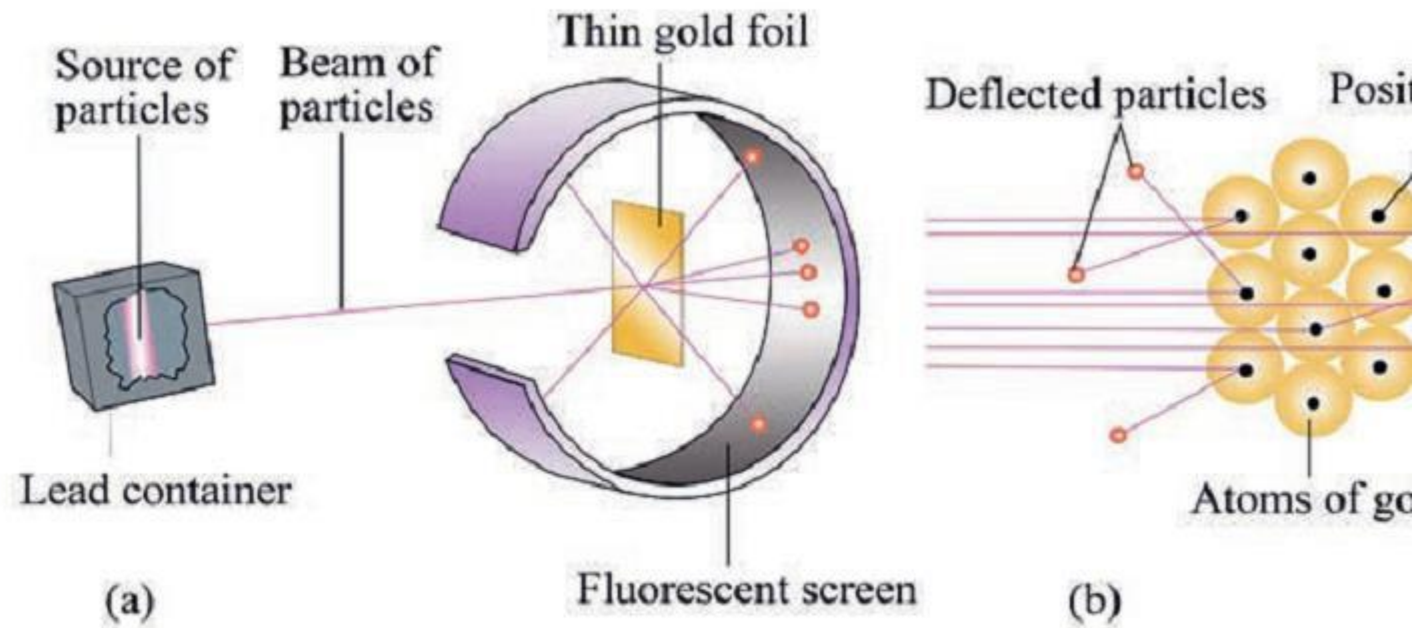


Figure 1.5: (a) α-particles aimed at a piece of gold foil, (b) α-particles passing through and being deflected by nuclei

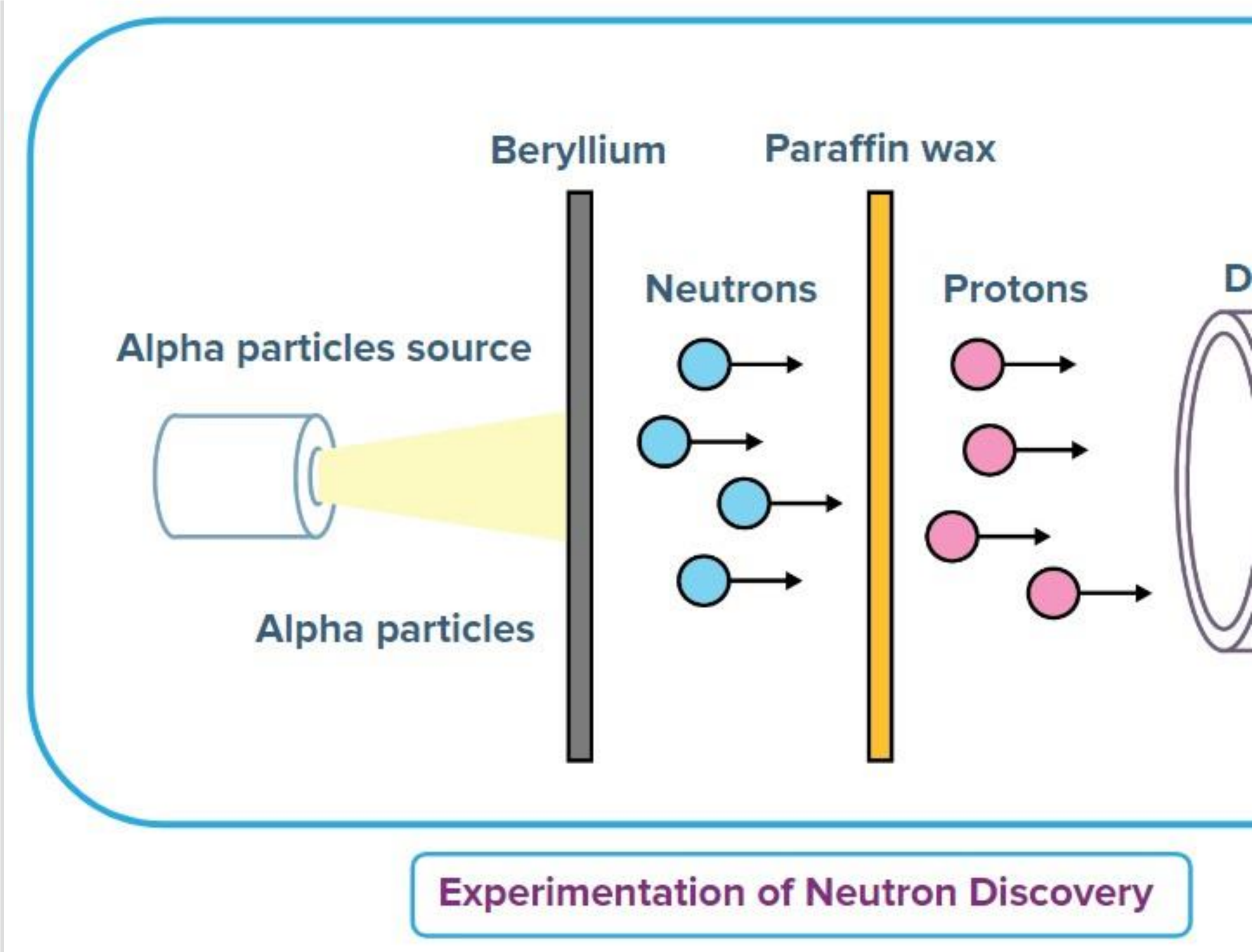
Figure Rutherford’sα-scatteringexperiment

Rutherford’sexperimentsdiscoveredthefollowing aspects of the nucleus:

The nucleus of an atom is positively charged.

Most of the mass of an atom is concentrated in the nucleus. The posetive center is very smal

1.2 .4 The discovery of Neutron



- In 1932, James Chadwick, in 1932. When Chadwick bombarded a thin sheet of beryllium with particles,a very high energy radiation similar to rays was emitted by the metal.
- Theexp’t revealed that electrically neutral particles having amass slightly greater thanthatofprotonsobtained.Chadwick named these particles neutrons

1.4 Make up of The Nucleus

1919, Rutherford discovered that hydrogen nuclei, or what we now call protons, form when alpha particles strike some of the lighter elements, such as nitrogen. A proton is a nuclear particle having a positive charge equal in magnitude to that of the electron. A proton has a mass of mp
= 1.67262 × 10–27 kg, which is about 1840 times
the mass of electrons. The protons in a nucleus give the nucleus its positive charge. Table 1.1 compares the relative masses and charges of the three subatomic particles (note that "amu" stands for "atomic mass unit", which is equal to 1

Table 1.1: Properties of subatomic particles

Particle	Actual mass (kg)	Relative mass (amu)	Actual char (C)
Proton (p)	1.672622×10^{-27}	1.007276	1.602×10
Neutron (n)	1.674927×10^{-27}	1.008665	0
Electron (e^-)	9.109383×10^{-31}	5.485799×10^{-4}	-1.602×0

Table 1.1 properties of

1.4.2 Atomic Mass And Isotope

- All atoms of an element are identical in atomic number but not mass number are called isotope .
- Isotopes of an element are atoms that have different numbers of neutrons and different mass number For example, all carbon atoms have six protons in the nucleus (Z =6) but only 98.89 % of naturally occurring carbon atoms have neutrons in the nucleus(A=12)A smal percentage (1.1%) haves even neutrons in the nucleus (A= 13),an even fewer (less than0.0%) have eight (A=14). Hence,carbon has three naturally occurring isotopes:
- Most Elements found in nature are mixtures of isotopes.
- The average mass for the atoms in an element is called the atomic mass of the element
- and can be obtained as averages over the relative masses of the isotopes of each element, weighted by their observed fractional abundances.
- If an element consists of n isotopes, of relative masses A1, A2…An and fractional abundances of f1 ,f2, …….then the average relative atomic mass (A) is

$$A = A_1 f_1 + A_2 f_2 + \ldots$$

iExample there are two naturally occurring Isotope's of Siliver Isotopes 107 Ag (106.9 amu) account for 51.84% of the total abundance and Isotope 109 Ag (108.9% amu) accounts for the remaining 48.16% . Calculate the atomic mass of silvery ?

Solution

- The portion of the atomic mass from each isotope: Portion of atomic mass from 107Ag: = isotopic mass × fractional abundance= 106.90509 amu × 0.5184 = 55.42 amu Portion of atomic mass from 109Ag: = 108.90476 amu × 0.4816 = 52.45 amu
- Then Atomic mass of Ag = 55.42 amu + 52.45 amu = 107.87 am

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