Subatomic Particles

Characteristics of Electrons, Protons, and Neutrons

An atom is divisible and consists of charged particles called subatomic particles. The three main subatomic particles are electrons, protons,

Electrons are negatively charged particles discovered by J. J. Thomson. They have a very small mass, approximately 1/2000th the mass of a

Protons are positively charged particles discovered by E. Goldstein. They have a mass of 1 atomic mass unit (amu).

Neutrons are neutral particles discovered by James Chadwick. Their mass is almost equal to that of protons.

Characteristics	Electron	Proton
Symbol	e	p
Relative charge	-1	$+1$
Nature	Negatively charged	Positively charged
Discovered by	J. J. Thomson	E. Goldstein
Mass	1/2000 times mass of hydrogen atom	1 unit

Summary Table

The table compares the key characteristics of electrons, protons, and neutrons including their charge, mass, and discoverers.

Thomson Model

Model Description

Thomson proposed that an atom is a uniform sphere of positive charge with negatively charged electrons embedded within it, similar to see
electrically neutral because the positive and negative charges balance each other.

Limitations

This model could not explain how protons and electrons could be arranged so closely within the atom without collapsing.

Rutherford Experiment

Alpha Particles and Experiment Setup

Alpha particles are helium ions with two positive charges and a mass of four units. Rutherford used alpha particles to probe the structure of

Gold was chosen because it is malleable and can be beaten into very thin sheets.

Observations

- Most alpha particles passed straight through the foil without deflection.
- Some were deflected at small angles.
- One in every 12,000 particles was deflected back.

Conclusions

- Most of the atom is empty space, allowing alpha particles to pass through.
- The positive charge and most of the mass are concentrated in a very small central nucleus.
- The nucleus occupies a very small volume compared to the whole atom.

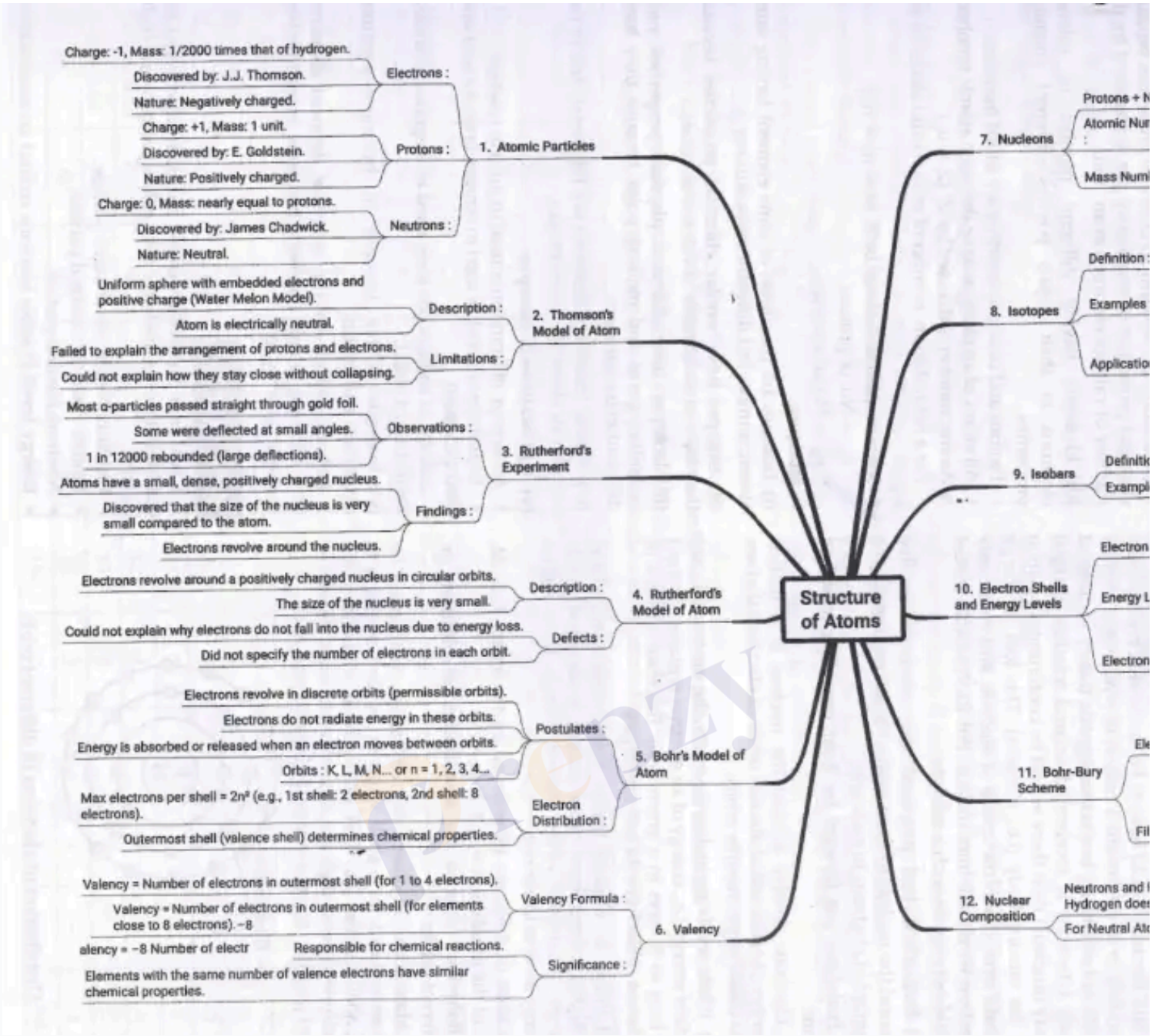
Rutherford Model

Model Description

The atom has a small, dense, positively charged nucleus containing protons and neutrons. Electrons revolve around the nucleus in well-defi
small compared to the atom.

Defects

- According to electromagnetic theory, electrons moving in circular orbits should radiate energy and spiral into the nucleus, but this does
- The model did not specify the number of electrons in each orbit.



Bohr Model

Postulates

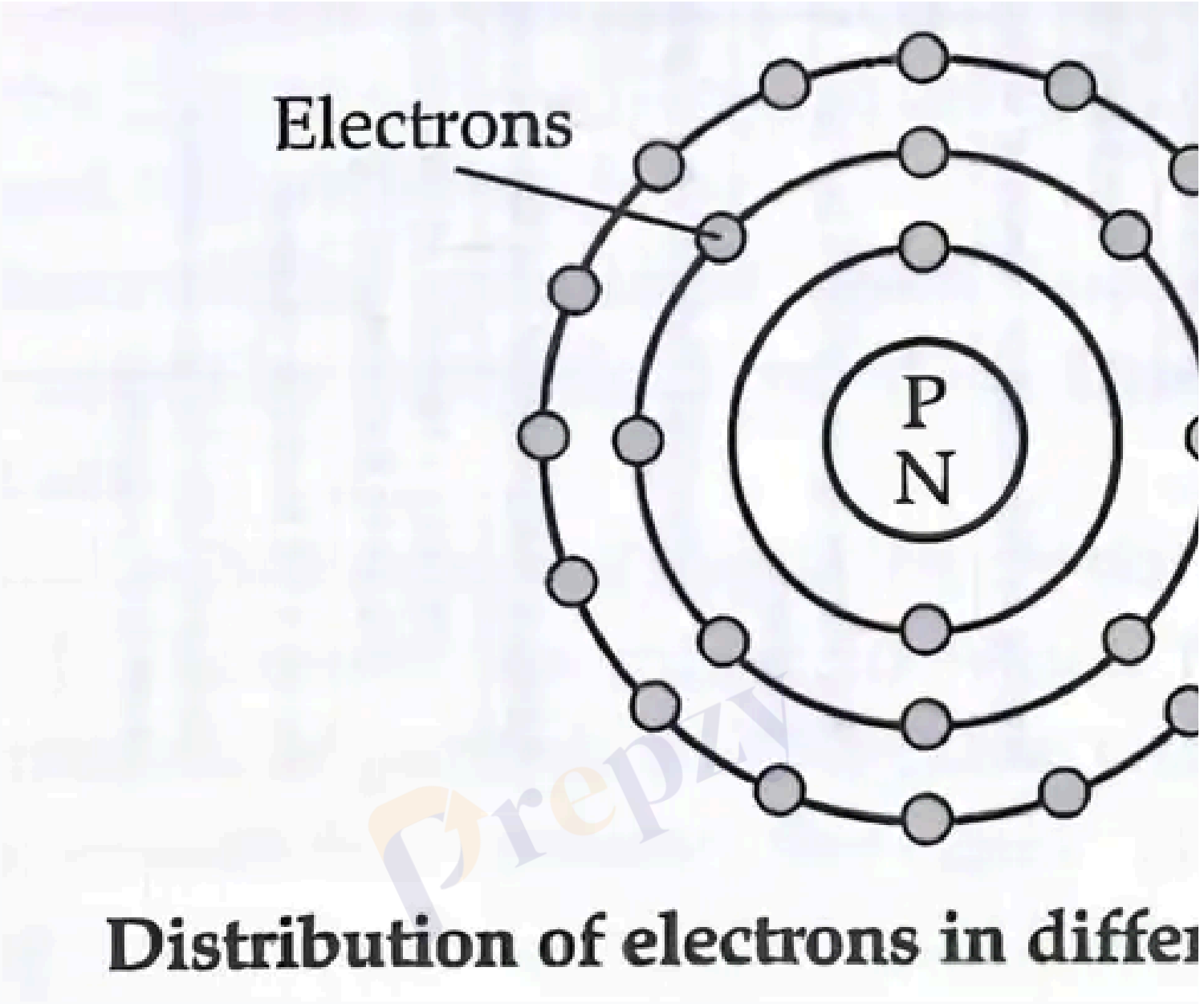
- Electrons revolve around the nucleus in discrete orbits called permissible orbits.
- Electrons do not radiate energy while in these orbits; their energy remains constant.
- Energy is absorbed when electrons jump to higher orbits and released when they fall to lower orbits.

Electron Distribution

Orbits or shells are labeled K, L, M, N or by numbers n = 1, 2, 3, 4, etc.

The maximum number of electrons in a shell is given by $2n^2$, where n is the shell number.

For example, the first shell can hold 2 electrons, the second 8, the third 18, and so on.



Distribution of electrons in diffe

Valence Electrons and Valency

The outermost shell is called the valence shell. Neutrons are located in the nucleus except in hydrogen atoms.

If the valence shell is full, the valency is zero.

For elements with 1 to 4 valence electrons, valency equals the number of valence electrons.

For elements with valence electrons close to 8, valency equals 8 minus the number of valence electrons.

Valence electrons determine chemical properties and reactivity.

Isotopes and Isobars

Isotopes

- Atoms of the same element with the same atomic number but different mass numbers.
- They have similar chemical properties but different physical properties.
- Examples include protium, deuterium, and tritium (isotopes of hydrogen).
- Applications include use in nuclear reactions, medical treatments, and diagnostics.

Isobars

Atoms of different elements with different atomic numbers but the same mass number.

Example: Calcium-40 and Argon-40.

Solved Examples

Practice Set

- **Level 1:** What is the charge and relative mass of an electron?
- **Level 1:** Define valence electrons and explain their significance.
- **Level 2:** Explain why most alpha particles passed through the gold foil in Rutherford's experiment without deflection.

Answer Key

- **Level 1:** Electron has a negative charge (-1) and a very small relative mass approximately 1/2000th of a hydrogen atom.
- **Level 1:** Valence electrons are the electrons present in the outermost shell of an atom. They determine the chemical properties and reac
- **Level 2:** Most alpha particles passed through because most of the atom's volume is empty space, allowing particles to pass without def

Quick Reference Table

Common Mistakes and Misconceptions

Glossary