

Chapter 3 Structure of Matter

Atomic Structure

3. a. *Students know* the structure of the atom and know it is composed of protons, neutrons, and electrons.

Parts of an Atom

The smallest particle of an element is an atom. Each atom is made up of even smaller particles, called protons, neutrons, and electrons.

Nearly all the mass of an atom is concentrated in a tiny region in its center, called the **nucleus**. The nucleus contains two kinds of particles: **protons**, which are positively charged, and **neutrons**, which have no charge. A proton and a neutron are about equal in mass.

Surrounding the nucleus of an atom are negatively charged particles called **electrons**. Each electron has about $1/2000$ the mass of a proton or neutron.

In a neutral atom, the number of protons and electrons are equal. For example, a helium (He) atom is composed of 2 protons, 2 neutrons, and 2 electrons. The positive charge from the protons equals the negative charge from the electrons, making the atom neutral. The number of neutrons does not always equal the number of protons. Neutrons do not affect the charge of an atom because they have no overall charge.

Every atom of a given element has the same number of protons. For example, every atom of helium has 2 protons, and every atom of iron has 26 protons. The number of protons in the nucleus of an atom is the **atomic number** of that atom's element. Helium has an atomic number of 2. Iron has an atomic number of 26.

Development of Atomic Models

Scientists revised the model of the atom as they collected more experimental evidence. In 1897, J.J. Thomson discovered that atoms contain negatively charged particles (electrons). Thomson proposed an atomic model in which negative charges are scattered throughout a ball of positive charge. Figure 3–1 shows Thomson's model and the models that followed as scientists gained a better understanding of the atom.

In 1911, physicist Ernest Rutherford inferred the existence of the nucleus in an atom and proposed a new atomic model. In Rutherford's model, the atom is mostly empty space with electrons moving around a nucleus that contains protons. In 1913, Danish physicist Niels Bohr showed that the electrons in an atom can have only specific amounts of energy as they move around the nucleus.

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The discovery of the neutron in 1932 led to further changes in the model. According to the modern atomic model, the atom is mostly empty space, with a dense nucleus containing positively charged protons and neutral neutrons. This nucleus is surrounded by a cloudlike region of moving, negatively charged electrons. The energy of each electron in an atom keeps it in motion around the positive nucleus to which it is attracted. Electrons of different **energy levels** are likely to be found in different places.

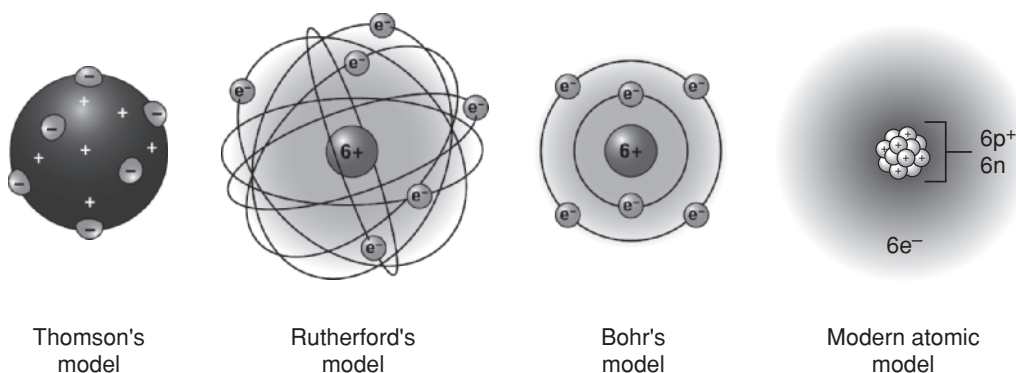


Figure 3–1 Models of an atom The model of the atom was revised over time as scientists gained a better understanding of the atom through experiments and investigations.

Standard 3. a. Check

- 1** The three particles that make up an atom are
- A protons, neutrons, and nuclei.
 - B protons, neutrons, and electrons.
 - C electrons, energy levels, and molecules.
 - D electrons, elements, and compounds.

- 2** Which statement *best* describes an atom?
- A An atom is a solid sphere that cannot be divided into smaller parts.
 - B An atom is mostly empty space, with a tiny, dense nucleus.
 - C An atom has a negatively charged nucleus surrounded by a cloud of positive charge.
 - D An atom is composed of only neutral particles.

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3 Which particles in an atom account for nearly all the atom's mass?

- A electrons only
- B protons only
- C neutrons only
- D protons and neutrons

4 Which particles of an atom move around the nucleus, forming a cloudlike region of negative charge?

- A protons
- B neutrons
- C electrons
- D molecules