SECTION 2

Models of the Atom

SECTION OBJECTIVES

- **Explain the strengths and weaknesses of Rutherford's model of the atom.**
- **Recognize that each element has a unique emission and absorption spectrum.**
- **Explain atomic spectra using Bohr's model of the atom.**
- **Interpret energy-level diagrams.**

EARLY MODELS OF THE ATOM

The model of the atom in the days of Newton was that of a tiny, hard, indestructible sphere. This model was a good basis for the kinetic theory of gases. However, new models had to be devised when experiments revealed the electrical nature of atoms. The discovery of the electron in 1897 prompted J. J. Thomson (1856–1940) to suggest a new model of the atom. In Thomson's model, electrons are embedded in a spherical volume of positive charge like seeds in a watermelon, as shown in **Figure 7.**

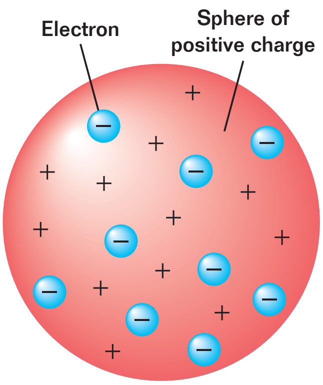

Figure 7
In Thomson's model of the atom, electrons are embedded inside a larger region of positive charge like seeds in a watermelon.

Rutherford proposed a planetary model of the atom

In 1911, Hans Geiger and Ernest Marsden, under the supervision of Ernest Rutherford (1871–1937), performed an important experiment showing that Thomson's model could not be correct. In this experiment, a beam of positively charged *alpha particles*—which consist of two protons and two neutrons—was projected against a thin metal foil, as shown in **Figure 8.** Most of the alpha particles passed through the foil as if it were empty space. Some of the alpha particles were deflected from their original direction through very large angles. Some particles were even deflected backward. Such deflections were completely unexpected on the basis of the Thomson model. Rutherford wrote, "It was quite the most incredible event that has ever happened to me in my life. It was almost as incredible as if you fired a 15-inch shell at a piece of tissue paper and it came back and hit you."

Such large deflections could not occur on the basis of Thomson's model, in which positive charge is evenly distributed throughout the atom, because the positively charged alpha particles would never come close to a positive charge concentrated enough to cause such large-angle deflections.

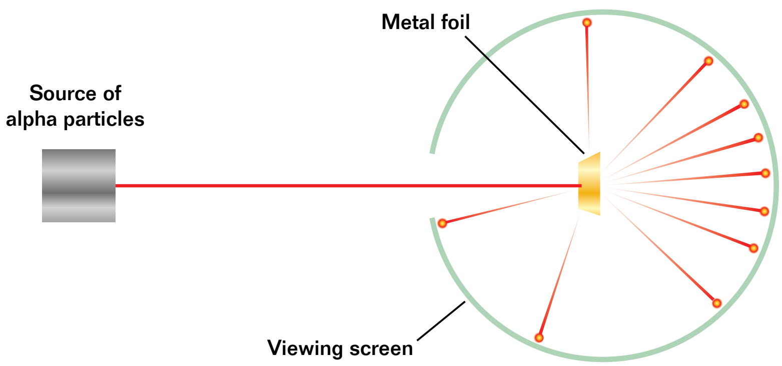

Figure 8
In this experiment, positively charged alpha particles are directed at a thin metal foil. Because many particles pass through the foil and only a few are deflected, Rutherford concluded that the atom's positive charge is concentrated at the center of the atom.