On the basis of his observations, Rutherford concluded that all of the positive charge in an atom and most of the atom's mass are found in a region that is small compared to the size of the atom. He called this concentration of positive charge and mass the *nucleus* of the atom. Any electrons in the atom were assumed to be in the relatively large volume outside the nucleus. So, according to Rutherford's theory, most alpha particles missed the nuclei of the metal atoms entirely and passed through the foil, while only a few came close enough to the nuclei to be deflected.

extension

Integrating Technology

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Keyword HF6ATMX

Rutherford's model predicts that atoms are unstable

To explain why electrons in this outer region of the atom were not pulled into the nucleus, Rutherford viewed the electrons as moving in orbits about the nucleus, much like the planets orbit the sun, as shown in **Figure 9.**

However, this assumption posed a serious difficulty. If electrons orbited the nucleus, they would undergo a centripetal acceleration. According to Maxwell's theory of electromagnetism, accelerated charges should radiate electromagnetic waves, losing energy. So, the radius of an atom's orbit would steadily decrease. This would lead to an ever-increasing frequency of emitted radiation and a rapid collapse of the atom as the electrons plunged into the nucleus. In fact, calculations show that according to this model, the atom would collapse in about one-billionth of a second. This difficulty with Rutherford's model led scientists to continue searching for a new model of the atom.

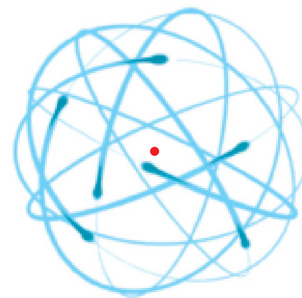

Figure 9
In Rutherford's model of the atom, electrons orbit the nucleus in a manner similar to planets orbiting the sun.

ATOMIC SPECTRA

In addition to solving the problems with Rutherford's planetary model, scientists hoped that a new model of the atom would explain another mysterious fact about gases. When an evacuated glass tube is filled with a pure atomic gas and a sufficiently high potential difference is applied between metal electrodes in the tube, a current is produced in the gas. As a result, the tube gives off light, as shown in **Figure 10.** The light's color is characteristic of the gas in the tube. This is how a neon sign works. The variety of colors seen in neon signs is the result of the light given off by different gases in the tubes.

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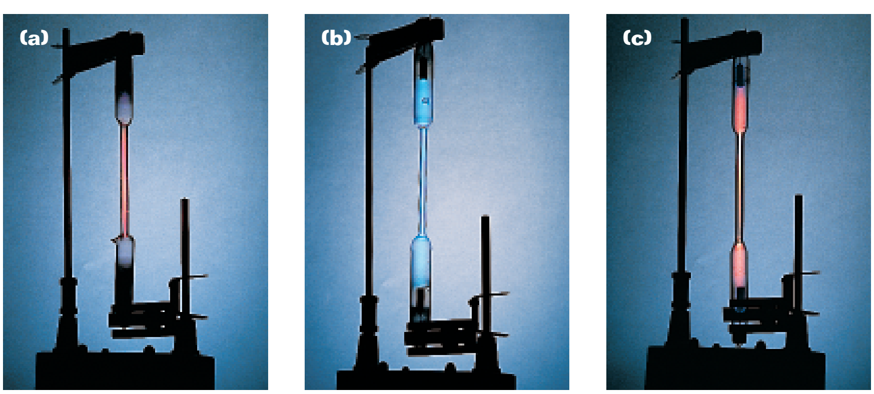

Figure 10
When a potential difference is applied across an atomic gas in a tube—here, hydrogen **(a),** mercury **(b),** and nitrogen **(c)**—the gas glows. The color of the glow depends on the type of gas.