4-52. The term quantum refers to the discrete packages of energy that are central to quantum theory. In contrast to classical physics where energy is regarded as a continuum, in quantum theory, energy is restricted to discrete values called quanta.

4-54. She could place the sample in a flame and look for a blue flame as shown in Figure 4.27. Measuring the emission lines with a spectrometer and comparing frequencies of the radiation to those listed in a handbook would confirm whether the sample contained cesium ions.

4-55. Experiments such as the photoelectric effect suggest that the electron is particle-like. Experiments such as electron diffraction suggest that the electron is wavelike.

4-58. When \( n = \infty \) and \( E = 0 \), the hydrogen atom has been ionized; that is, the electron has been removed from the atom and the proton and electron are far apart.

4-59. By definition, the energy of a separated proton and electron is zero \( (n = \infty) \). Because the bound states of a hydrogen atom are more stable than the separated electron and proton, these states are lower in energy. Consequently, the bound states must have negative energy values.