SECTION 1

The Nucleus

SECTION OBJECTIVES

- Identify the properties of the nucleus of an atom.
- Explain why some nuclei are unstable.
- Calculate the binding energy of various nuclei.

PROPERTIES OF THE NUCLEUS

In the chapter "Electric Forces and Fields," you learned that atoms are composed of electrons, protons, and neutrons. Except for the ordinary hydrogen nucleus, which consists of a single proton, both protons and neutrons are found in the nucleus. Together, protons and neutrons are referred to as *nucleons.*

As seen in the chapter "Atomic Physics," Rutherford's scattering experiment led to the conclusion that all of an atom's positive charge and most of its mass are concentrated in the nucleus. Rutherford's calculations revealed that the nucleus has a radius of no greater than about 10^{-14} m. Because such small lengths are common in nuclear physics, a convenient unit of length is the *femtometer* (fm). Sometimes called the *fermi,* this unit is equal to 10^{-15} m.

A nucleus can be specified by an atomic number and a mass number

There are a few important quantities that are used to describe the charge and mass of the nucleus. **Table 1** lists these quantities and the symbols commonly used to represent them. The mass number (A) represents the total number of protons and neutrons—or nucleons—in the nucleus. The atomic number (Z) represents the number of protons in the nucleus, and the neutron number (N) represents the number of neutrons in the nucleus. Note that A, Z, and N are always integers.

Table 1 **Symbols for Nuclear Quantities**

Symbol	Name	Explanation
A	mass number	the number of nucleons (protons and neutrons) in the nucleus
Z	atomic number	the number of protons in the nucleus
N	neutron number	the number of neutrons in the nucleus

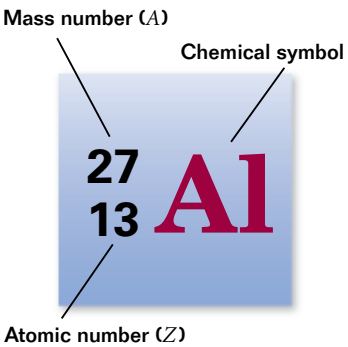

Figure 1
The chemical symbol of an element is often written with its mass number and atomic number, as shown here.

As an example, a typical atom of aluminum has a mass number (A) of 27 and an atomic number (Z) of 13. Therefore, it has 13 protons and 14 neutrons ($27 - 13 = 14$). A periodic table of the elements usually includes the atomic number of each element above or near the element's chemical symbol.

Frequently, the mass number and the atomic number of the nucleus of an atom are written before the atom's chemical symbol, as shown in **Figure 1.**