

- (a) What is the significance of the fact that the droplets carried different charges? (b) What conclusion can the student draw from these data regarding the charge of the electron? (c) What value (and to how many significant figures) should she report for the electronic charge?

The Modern View of Atomic Structure; Atomic Weights (Sections 2.3 and 2.4)

- 2.19** The radius of an atom of gold (Au) is about 1.35 \AA . (a) Express this distance in nanometers (nm) and in picometers (pm). (b) How many gold atoms would have to be lined up to span 1.0 mm ? (c) If the atom is assumed to be a sphere, what is the volume in cm^3 of a single Au atom?
- 2.20** An atom of rhodium (Rh) has a diameter of about $2.7 \times 10^{-8} \text{ cm}$. (a) What is the radius of a rhodium atom in angstroms (Å) and in meters (m)? (b) How many Rh atoms would have to be placed side by side to span a distance of $6.0 \text{ }\mu\text{m}$? (c) If you assume that the Rh atom is a sphere, what is the volume in m^3 of a single atom?
- 2.21** Answer the following questions without referring to Table 2.1: (a) What are the main subatomic particles that make up the atom? (b) What is the relative charge (in multiples of the electronic charge) of each of the particles? (c) Which of the particles is the most massive? (d) Which is the least massive?
- 2.22** Determine whether each of the following statements is true or false. If false, correct the statement to make it true: (a) The nucleus has most of the mass and comprises most of the volume of an atom. (b) Every atom of a given element has the same number of protons. (c) The number of electrons in an atom equals the number of neutrons in the atom. (d) The protons in the nucleus of the helium atom are held together by a force called the strong nuclear force.
- 2.23** Which of the following pairs of atoms are isotopes of one another? (a) ^{11}B , ^{11}C ; (b) ^{55}Mn , ^{54}Mn ; (c) ^{118}Sn , ^{120}Sn
- 2.24** What are the differences in the compositions of the following pairs of atomic nuclei? (a) ^{210}Bi , ^{210}Pb ; (b) ^{14}N , ^{15}N ; (c) ^{20}Ne , ^{40}Ar
- 2.25** (a) Define atomic number and mass number. (b) Which of these can vary without changing the identity of the element?
- 2.26** (a) Which two of the following are isotopes of the same element: $^{31}_{16}\text{X}$, $^{31}_{15}\text{X}$, $^{32}_{16}\text{X}$? (b) What is the identity of the element whose isotopes you have selected?
- 2.27** How many protons, neutrons, and electrons are in the following atoms? (a) ^{40}Ar , (b) ^{65}Zn , (c) ^{70}Ga , (d) ^{80}Br , (e) ^{184}W , (f) ^{243}Am .
- 2.28** Each of the following isotopes is used in medicine. Indicate the number of protons and neutrons in each isotope: (a) phosphorus-32, (b) chromium-51, (c) cobalt-60, (d) technetium-99, (e) iodine-131, (f) thallium-201.
- 2.29** Fill in the gaps in the following table, assuming each column represents a neutral atom.

| Symbol | ^{79}Br | | | |
|-----------|------------------|----|-----|-----|
| Protons | 25 | | | 82 |
| Neutrons | 30 | 64 | | |
| Electrons | | 48 | 86 | |
| Mass no. | | | 222 | 207 |

- 2.30** Fill in the gaps in the following table, assuming each column represents a neutral atom.

| Symbol | ^{112}Cd | | | |
|-----------|-------------------|----|----|-----|
| Protons | | 38 | | 92 |
| Neutrons | | 58 | 49 | |
| Electrons | | | 38 | 36 |
| Mass no. | | | | 81 |
| | | | | 235 |

- 2.31** Write the correct symbol, with both superscript and subscript, for each of the following. Use the list of elements in the front inside cover as needed: (a) the isotope of platinum that contains 118 neutrons, (b) the isotope of krypton with mass number 84, (c) the isotope of arsenic with mass number 75, (d) the isotope of magnesium that has an equal number of protons and neutrons.
- 2.32** One way in which Earth's evolution as a planet can be understood is by measuring the amounts of certain isotopes in rocks. One quantity recently measured is the ratio of ^{129}Xe to ^{130}Xe in some minerals. In what way do these two isotopes differ from one another? In what respects are they the same?
- 2.33** (a) What isotope is used as the standard in establishing the atomic mass scale? (b) The atomic weight of boron is reported as 10.81, yet no atom of boron has the mass of 10.81 amu. Explain.
- 2.34** (a) What is the mass in amu of a carbon-12 atom? (b) Why is the atomic weight of carbon reported as 12.011 in the table of elements and the periodic table in the front inside cover of this text?
- 2.35** Only two isotopes of copper occur naturally, ^{63}Cu (atomic mass = 62.9296 amu; abundance 69.17%) and ^{65}Cu (atomic mass = 64.9278 amu; abundance 30.83%). Calculate the atomic weight (average atomic mass) of copper.
- 2.36** Rubidium has two naturally occurring isotopes, rubidium-85 (atomic mass = 84.9118 amu; abundance = 72.15%) and rubidium-87 (atomic mass = 86.9092 amu; abundance = 27.85%). Calculate the atomic weight of rubidium.
- 2.37** (a) Thomson's cathode-ray tube (Figure 2.4) and the mass spectrometer (Figure 2.11) both involve the use of electric or magnetic fields to deflect charged particles. What are the charged particles involved in each of these experiments? (b) What are the labels on the axes of a mass spectrum? (c) To measure the mass spectrum of an atom, the atom must first lose one or more electrons. Which would you expect to be deflected more by the same setting of the electric and magnetic fields, a Cl^+ or a Cl^{2+} ion?
- 2.38** (a) The mass spectrometer in Figure 2.11 has a magnet as one of its components. What is the purpose of the magnet? (b) The atomic weight of Cl is 35.5 amu. However, the mass spectrum of Cl (Figure 2.12) does not show a peak at this mass. Explain. (c) A mass spectrum of phosphorus (P) atoms shows only a single peak at a mass of 31. What can you conclude from this observation?
- 2.39** Naturally occurring magnesium has the following isotopic abundances:

| Isotope | Abundance (%) | Atomic mass (amu) |
|------------------|---------------|-------------------|
| ^{24}Mg | 78.99 | 23.98504 |
| ^{25}Mg | 10.00 | 24.98584 |
| ^{26}Mg | 11.01 | 25.98259 |

- (a) What is the average atomic mass of Mg? (b) Sketch the mass spectrum of Mg.