

Chapter 5 – Atomic Structure and the Periodic Table

Chapter 5: 1 – 16, 20, 21, 23, 24, 27 - 32, 35, 42, 44, 49, 50, 55 (32 total)

Section Review 5.1

1. In your own words, state the main ideas of Dalton's atomic theory.

Elements are composed of a single atom; atoms of different elements differ; chemical changes involve a rearrangement of atoms. Compounds are comprised of particles that are chemical combinations of different kinds of atoms.

2. Characterize the size of an atom.

Atoms are tiny; a pure copper penny-sized coin would have about 2.4×10^{24} atoms.

3. Democritus and Dalton both proposed that matter consists of atoms. How did their approaches to reaching that conclusion differ?

Dalton used reasoning based upon the results of scientific experiments (the scientific method), whereas Democritus used mental reasoning and logic only.

Section Review 5.2

4. What are the charges and relative masses of the three main subatomic particles?

- protons are positively charged particles with a relative mass of 1.
- electrons are negatively charged particles with a relative mass of $1/1840$.
- neutrons have no charge, with a relative mass of 1.

5. Describe the basic structure of an atom. Draw a diagram if that would help.

An atom has a central, dense and massive core, composed of protons and neutrons, called the nucleus. Electrons, although they are $1/1840$ the mass of protons or neutrons, surround the nucleus, spaced very far apart from one another, and account for nearly all the volume of an atom.

6. Describe Thomson's, Milikan's, and Rutherford's contributions to atomic theory. Include their experiments, if appropriate.

In 1897, Thomson passed electric current through sealed glass tubes filled with gases. The resulting glowing beam was described as a stream of tiny negatively charged particles moving at high speed, because these rays were attracted to a positively charged cathode. These were later called electrons.

In 1916, Robert Millikan was able to determine the charge of an electron.

In 1911, Ernest Rutherford performed the gold-foil experiment which suggested the atom was comprised of a heavy, positively charged nucleus, with a huge volume of empty space.

Practice Problems

7. How many protons and electrons are in each atom?

- a. fluorine 9 protons; 9 electrons
- b. aluminum 13 protons; 13 electrons
- c. calcium 20 protons; 20 electrons

8. Complete the table.

Element	Atomic number	Protons	Electrons
K	19	<u> 19 </u>	19
<u> B </u>	<u> 5 </u>	<u> 5 </u>	5
<u> S </u>	16	<u> 16 </u>	<u> 16 </u>
<u> V </u>	<u> 23 </u>	23	<u> 23 </u>

Practice Problems

9. How many neutrons are in each atom?

- a. $^{16}_8\text{O}$ 8
- b. $^{32}_{16}\text{S}$ 16
- c. $^{108}_{47}\text{Ag}$ 61
- d. $^{80}_{35}\text{Br}$ 45
- e. $^{207}_{82}\text{Pb}$ 125

10. Use Table 5.2 and Figure 5.8 in your textbook to express the composition of each atom in shorthand form.

- a. carbon-12 $^{12}_6\text{C}$
- b. fluorine-19 $^{19}_9\text{F}$
- c. beryllium-9 ^9_4Be

11. For each atom in Problem 9, identify the number of electrons.

Carbon has 6 electrons; fluorine has 9; beryllium has 4.

Practice Problems

12. Three isotopes of oxygen are oxygen-16, oxygen-17, and oxygen-18. Write the complete symbol for each, including the atomic number and mass number.

- $^{16}_8\text{O}$
- $^{17}_8\text{O}$
- $^{18}_8\text{O}$

13. The three isotopes of chromium are chromium-50, chromium-52, and chromium-53. How many neutrons are in each isotope, given that chromium always has an atomic number of 24?

Chromium-50 has 26 neutrons; chromium-52 has 28; chromium-53 has 29.

Practice Problems

14. Boron has two isotopes: boron-10 and boron-11. Which is more abundant, given that the atomic mass of boron is 10.81? Explain.

Boron's atomic mass of 10.81 would suggest that the isotope of boron-11 is in greater abundance.

15. There are three isotopes of silicon; they have mass numbers of 28, 29, and 30. The atomic mass of silicon is 28.086 amu. Comment on the relative abundance of these three isotopes.

More than likely silicon-28 is the most abundant since the weighted average of all three isotopes is 28.086.

16. The element copper has naturally occurring isotopes with mass numbers of 63 and 65. The relative abundance and atomic masses are 69.2% for mass = 62.93 amu; and 30.8% for mass = 64.93 amu. Calculate the average atomic mass of copper.

To solve this, multiply each isotopes mass by its relative abundance, then add the values together:

$$62.93 \text{ amu} \times 0.692 = 43.5476 \text{ amu}$$

$$64.93 \text{ amu} \times 0.308 = \underline{19.9984 \text{ amu}}$$

$$\text{Average atomic mass of copper:} = 63.5460 \text{ amu}$$

Section 5.3 Review

20. An atom is identified as platinum-195.

a. what does the number represent?

The value of 195 represents the mass number of the isotope for platinum.

b. Symbolize this atom using superscripts and subscripts.



21. How are isotopes of the same element alike? How are they different?

Isotopes of the same element are alike in that they all have the same number of protons and electrons. Where they differ from one another is in the number of neutrons. Since they have the same number of protons and electrons, they are chemically identical - they react exactly the same.

23. List the number of protons, neutrons, and electrons in each pair of isotopes.

- a. ${}^6_3\text{Li}$; 3 p, 3 n, 3 e ${}^7_3\text{Li}$ 3 p, 4 n, 3 e
- b. ${}^{42}_{20}\text{Ca}$; 20 p, 22 n, 20 e ${}^{44}_{20}\text{Ca}$ 20 p, 24 n, 20 e
- c. ${}^{78}_{34}\text{Se}$; 34 p, 44 p, 34 e ${}^{80}_{34}\text{Se}$ 34 p, 46 n, 34 e

24. The atomic masses of elements are generally not whole numbers. Explain why.

The atomic mass represents the weighted average of the masses of that elements isotopes.

Section 5.4 Review

27. Describe how the periodic table was developed.

Mendeleev observed trends in properties and grouped similar elements together. Then he arranged the groups so the elements were in order of increasing mass. There were blank spaces in the arrangements that were filled in as the elements were discovered. Moseley modified this model only by rearranging the elements according to atomic number, not mass.

28. What criteria did Mendeleev use to construct his periodic table of elements?

Mendeleev used increasing atomic mass and similarities in chemical properties to construct his periodic table.

29. Relate group, period and transition metals to the periodic table.

A group is a vertical column; whereas a period is a horizontal row; transition metals are all group B elements.

30. Identify each element as a metal, metalloid, or nonmetal.

- a. gold metal b. silicon metalloid c. manganese metal
- d. sulfur nonmetal e. barium metal

Metalloids have properties that are intermediate between metals and nonmetals.

31. Which of the elements listed in the preceding question are representative elements?

Group A elements are called representative elements, and these are sulfur, silicon, and barium.

32. Name two elements that have properties similar to those of the element calcium.

Many other alkaline earth metals, from Group 2A, such as beryllium and magnesium.

Chapter 5 Review

35. Would you expect two electrons to attract or repel each other? Why? 5.2

Two electrons would repel one another because they are negatively charged.

42. Complete this table. 5.3

Atomic number	Mass number	Number of protons	Number of neutrons	Number of electrons	Symbol of element
9	19	9	10	9	F
14	29	14	15	14	Si
22	47	22	25	22	Ti
25	55	25	30	25	Mn

44. How can there be more than 1000 different atoms when there are only about 100 different elements? 5.3

Although there are only about 100 different elements, the existence of isotopes for many of the elements makes it possible for 1000 different atoms to exist.

49. Provide the symbol of each element. 5.4

a. the nonmetal in Group 4A C

b. the inner transition metal with the lowest atomic number La

c. all of the nonmetals for which the atomic number is a multiple of five B, Ne, P, Br

d. the two elements that are liquid at room temperature Hg, Br

e. the metal in Group 5A Bi

50. Compare the relative size and relative density of an atom with its nucleus.

The nucleus is very massive compared to the electron, being 1,840 times its size; but it occupies very little space; electron clouds are responsible for the huge volume of the atom (by comparison to the nucleus).

55. Why are atoms considered the building blocks of matter even though small particles, such as protons and electrons, exist?

An atom is the smallest building block of matter that retains the properties of its respective element. Once an atom is broken down, it no longer retains those unique properties.