Chapter 5
Early Atomic Theory and Structure
Advanced Chemistry

5.1 Dalton's Model of the Atom

Learning Objective	

Describe Dalton's model of the atom and compare it to the earlier concepts of matter.	• Summary of Dalton's model of the atom:
	  ○ Elements are composed of atoms.
	  ○ Atoms of the same element are alike (mass and size).
	  ○ Atoms of different elements are different in mass and size.
	  ○ Compounds form by the union of two or more atoms of different elements.
	  ○ Atoms form compounds in simple numerical ratios.
	  ○ Atoms of two elements may combine in different ratios to form different compounds.
	• Greek model of matter:
	  ○ Four elements—earth, air, water, fire
	  ○ Democritus—atoms (indivisible particles) make up matter
	  ○ Aristotle—opposed atomic ideas

Key Term	
Dalton's atomic model	The first modern atomic theory to state that elements are composed of minute individual particles called atoms.

5.2 Electric Charge

Learning Objective	

Recognize the force between particles and distinguish between a cation and an anion.	• Properties of electric charge:
	  ○ Charges are one of the two types—positive and negative.
	  ○ Unlike charges attract and like charges repel.
	  ○ Charge is transferred from one object to another by contact or by induction.
	  ○ The force of attraction between charges is expressed by
	  $$F = \frac{kq_1q_2}{r^2}$$
	  F = force of attraction, k is constant, q_1 = charge 1, q_2 = charge 2, r = distance between the charges
	• Michael Faraday discovered electrically charged ions.
	• Svante Arrhenius explained that conductivity results from the dissociation of compounds into ions:
	  ○ Cation—positive charge—attracted to negative electrode (cathode)
	  ○ Anion—negative charge—attracted to positive electrode (anode)

5.3 Subatomic Parts of the Atom

Learning Objective	

Describe the three basic subatomic particles and how they changed Dalton's model of the atom.	• Atoms contain smaller subatomic particles:
	  ○ Electron—negative charge, 1/1837 mass of proton
	  ○ Proton—positive charge, 1.673×10^{-24} g
	  ○ Neutron—no charge, 1.675×10^{-24} g
	• Thomson model of the atom: negative electrons are embedded in a positive sphere.

Key Terms	
Subatomic particles	Particles found within the atom, mainly protons, neutrons, and electrons.
Electron	A subatomic particle that exists outside the nucleus and carries a negative electrical charge.
Proton	A subatomic particle found in the nucleus of the atom that carries a positive electrical charge and a mass of about 1 amu. An H^+ ion is a proton.
Thomson model of the atom	Thomson asserted that atoms are not indivisible but are composed of smaller parts; they contain both positively and negatively charged particles—protons as well as electrons.
Neutron	A subatomic particle that is electrically neutral and is found in the nucleus of an atom.

5.4 The Nuclear Atom

Learning Objective	

Explain how the nuclear model of the atom differs from Dalton's and Thomson's models.	• Rutherford gold foil experiment modified the Thomson model to a nuclear model of the atom:
	  ○ Atoms are composed of a nucleus containing protons and/or neutrons surrounded by electrons, which occupy mostly empty space.
	  ○ Neutral atoms contain equal numbers of protons and electrons.

Key Terms	
Nucleus	The central part of an atom that contains all its protons and neutrons. The nucleus is very dense and has a positive electric charge.
Atomic number (Z)	The number of protons in the nucleus of an atom of a given element.

5.5 Isotopes of the Elements

Learning Objective	
Define the terms atomic number, mass number, and isotope.	• The atomic number of an element is the number of protons in the nucleus. • The mass number of an element is the sum of the protons and neutrons in the nucleus. • Isotopes are atoms of an element that have the same atomic number but different atomic masses. $^{A}_{Z}E$ A = mass number (sum of protons and neutrons in nucleus) Z = atomic number (number of protons in the nucleus) E = symbol of element $A - Z$ = neutrons
Key Terms	
Isotope	An atom of an element that has the same atomic number but a different atomic mass. Since their atomic numbers are identical, isotopes vary only in the number of neutrons in the nucleus.
Mass number (A)	The sum of the protons and neutrons in the nucleus of a given isotope of an atom.

5.6 Atomic Mass

Learning Objective	
Explain the relationship between the atomic mass of an element and the masses of its isotopes.	• The average atomic mass is a weighted average of the masses of all the isotopes present in the sample.
Key Terms	
Atomic mass unit (amu)	A unit of mass equal to one-twelfth the mass of a carbon-12 atom.
Atomic mass	The average relative mass of the isotopes of an element referred to the atomic mass of carbon-12.