Interactive Classroom

Glencoe Science

CHEMISTRY

MATTER AND CHANGE

Chapter 4

The Structure of the Atom

Click the mouse button or press the Space Bar to continue.

The Structure of the Atom

Click a hyperlink or folder tab to view the corresponding slides.

Section 4.1 Early Ideas About Matter

Objectives

- **Compare and contrast** the atomic models of Democritus, Aristotle, and Dalton.
- **Understand** how Dalton's theory explains the conservation of mass.

Review Vocabulary

theory: an explanation supported by many experiments; is still subject to new experimental data, can be modified, and is considered successful if it can be used to make predictions that are true

Section 4.1 Early Ideas About Matter (cont.)

New Vocabulary

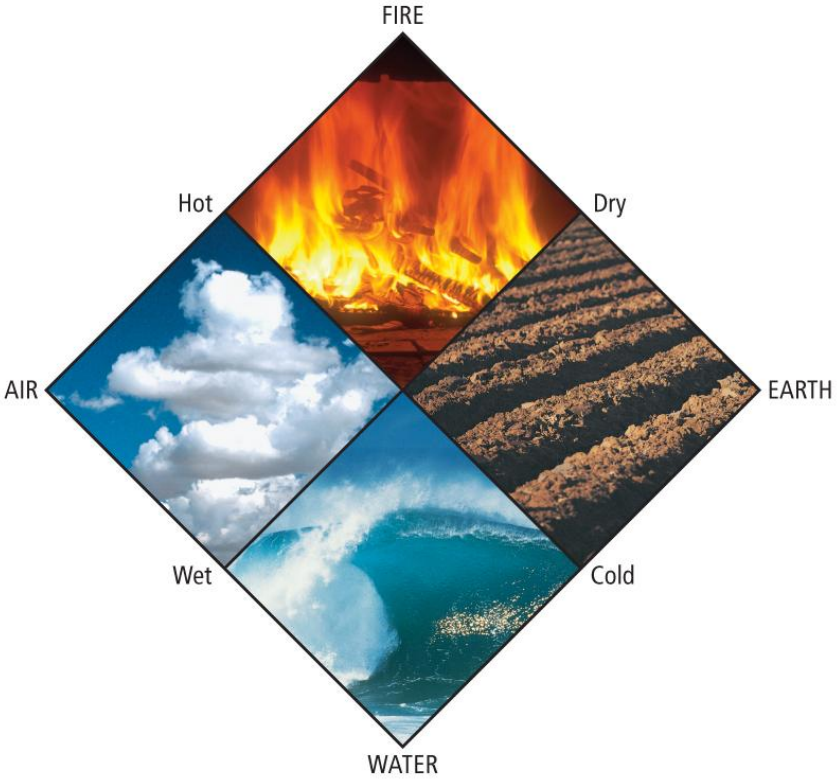
Dalton's atomic theory

MAIN Idea

The ancient Greeks tried to explain matter, but the scientific study of the atom began with John Dalton in the early 1800's.

Greek Philosophers (cont.)

- Many ancient scholars believed matter was composed of such things as earth, water, air, and fire.



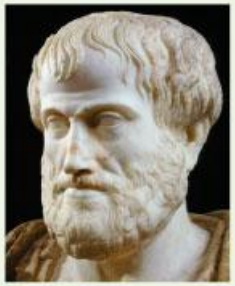
- Many believed matter could be endlessly divided into smaller and smaller pieces.

Greek Philosophers (cont.)

- Democritus (460–370 B.C.) was the first person to propose the idea that matter was not infinitely divisible, but made up of individual particles called atomos.
- Aristotle (484–322 B.C.) disagreed with Democritus because he did not believe empty space could exist.
- Aristotle's views went unchallenged for 2,000 years until science developed methods to test the validity of his ideas.

Greek Philosophers (cont.)

Table 4.1 Ancient Greek Ideas About Matter

Philosopher	Ideas
Democritus (460–370 B.C.) 	• Matter is composed of atoms, which move through empty space. • Atoms are solid, homogeneous, indestructible, and indivisible. • Different kinds of atoms have different sizes and shapes. • Size, shape, and movement of atoms determine the properties of matter.
Aristotle (384–322 B.C.) 	• Empty space cannot exist. • Matter is made of earth, fire, air, and water.

Greek Philosophers (cont.)

- John Dalton revived the idea of the atom in the early 1800s based on numerous chemical reactions.
- **Dalton's atomic theory** easily explained conservation of mass in a reaction as the result of the combination, separation, or rearrangement of atoms.

Table 4.2 Dalton's Atomic Theory

Scientist	Ideas
Dalton (1766–1844) 	• Matter is composed of extremely small particles called atoms. • Atoms are indivisible and indestructible. • Atoms of a given element are identical in size, mass, and chemical properties. • Atoms of a specific element are different from those of another element. • Different atoms combine in simple whole-number ratios to form compounds. • In a chemical reaction, atoms are separated, combined or rearranged.

Section 4.1 Assessment

CheckPoint

Who was the first person to propose the idea that matter was not infinitely divisible?

A. Aristotle

B. Plato

C. Dalton

D. Democritus

Section 4.1 Assessment

CheckPoint

Dalton's theory also conveniently explained what?

A. the electron

B. the nucleus

C. law of conservation of mass

D. law of Democritus

Section 4.2 Defining the Atom

Objectives

- **Define** atom.
- **Distinguish** between the subatomic particles in terms of relative charge and mass.
- **Describe** the structure of the atom, including the locations of the subatomic particles.

Review Vocabulary

model: a visual, verbal, and/or mathematical explanation of data collected from many experiments

Section 4.2 Defining the Atom (cont.)

New Vocabulary

atom

cathode ray

electron

nucleus

proton

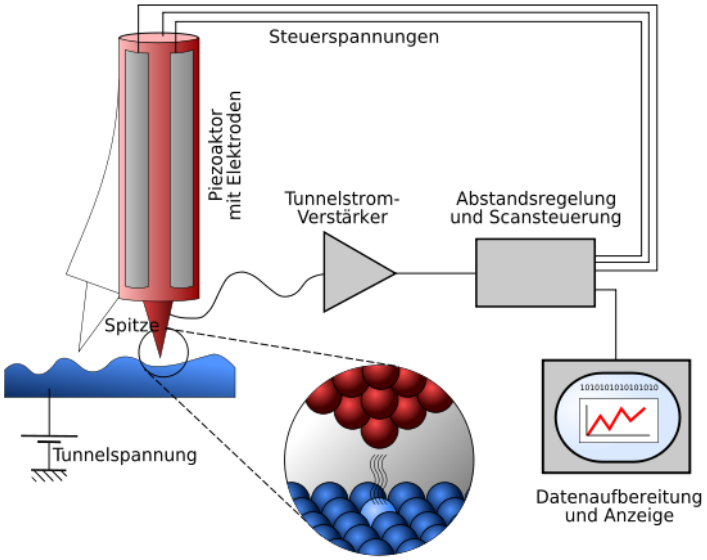
neutron

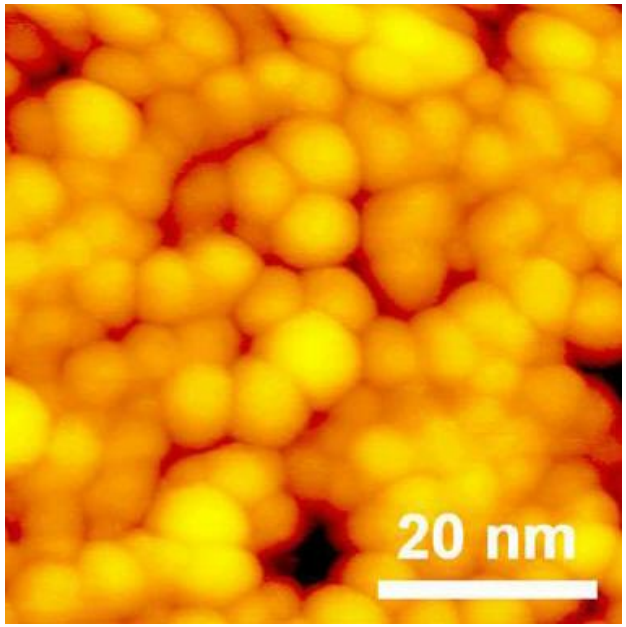
MAIN Idea

An atom is made of a nucleus containing protons and neutrons; electrons move around the nucleus.

The Atom

- The smallest particle of an element that retains the properties of the element is called an **atom**.
- An instrument called the scanning tunneling microscope (STM) allows individual atoms to be seen.



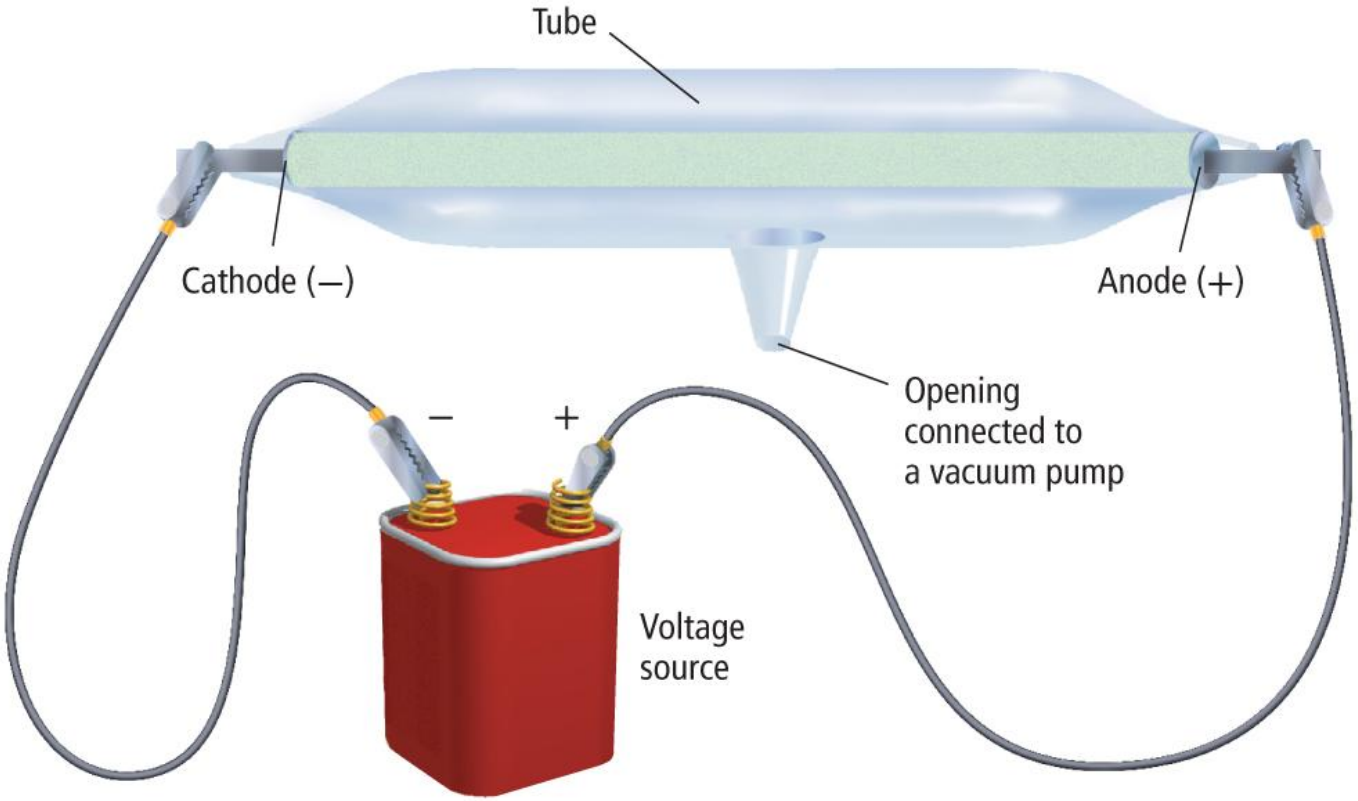


The Electron

- When an electric charge is applied, a ray of radiation travels from the cathode to the anode, called a **cathode ray**.
- Cathode rays are a stream of particles carrying a negative charge.
- The particles carrying a negative charge are known as **electrons**.

The Electron (cont.)

- This figure shows a typical cathode ray tube.

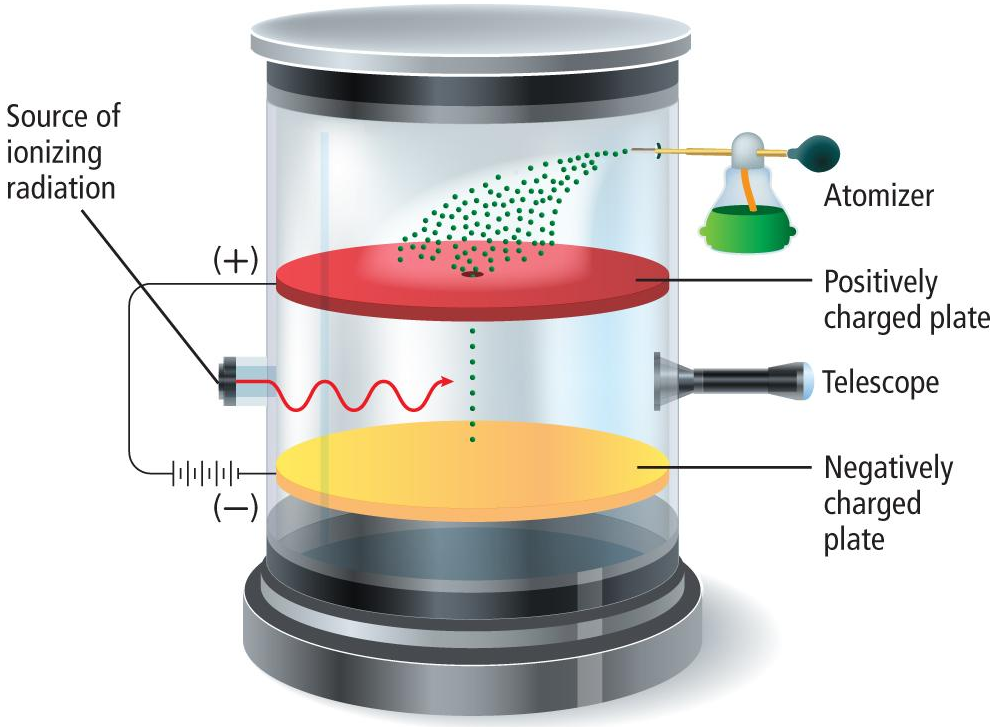


The Electron (cont.)

- J.J. Thomson measured the effects of both magnetic and electric fields on the cathode ray to determine the charge-to-mass ratio of a charged particle, then compared it to known values.
- The mass of the charged particle was much less than a hydrogen atom, then the lightest known atom.
- Thomson received the Nobel Prize in 1906 for identifying the first subatomic particle—the electron

The Electron (cont.)

- In the early 1910s, Robert Millikan used the oil-drop apparatus shown below to determine the charge of an electron.



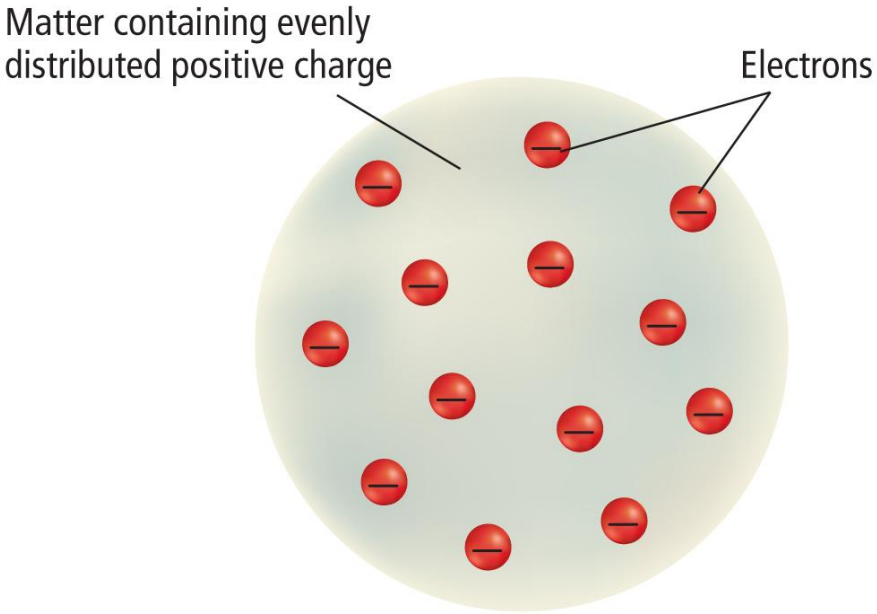
The Electron (cont.)

- Charges change in discrete amounts—1.602×10^{-19} coulombs, the charge of one electron (now equated to a single unit, 1–).
- With the electron's charge and charge-to-mass ratio known, Millikan calculated the mass of a single electron.

$$\text{Mass of an electron} = 9.1 \times 10^{-28}\,\text{g} = \frac{1}{1840}$$ the mass of a hydrogen atom

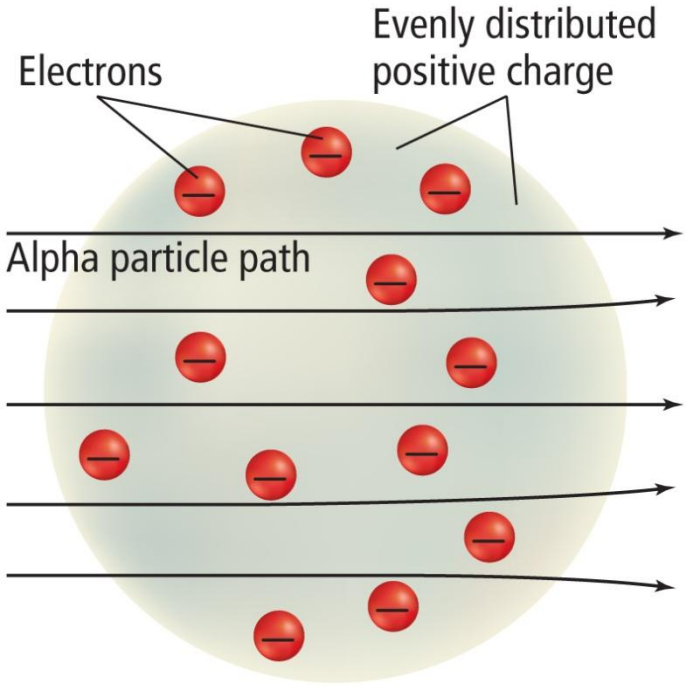
The Electron (cont.)

- Matter is neutral.
- J.J. Thomson's plum pudding model of the atom states that the atom is a uniform, positively changed sphere containing electrons.



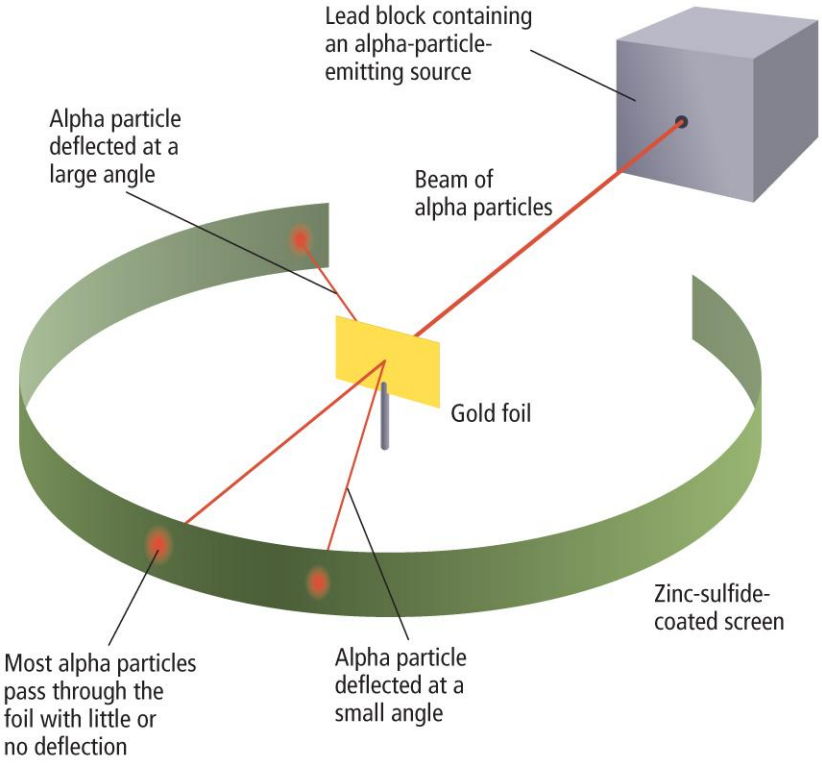
The Nucleus

- In 1911, Ernest Rutherford studied how positively charged alpha particles interacted with solid matter
- By aiming the particles at a thin sheet of gold foil, Rutherford expected the paths of the alpha particles to be only slightly altered by a collision with an electron.



The Nucleus (cont.)

- Although most of the alpha particles went through the gold foil, a few of them bounced back, some at large angles.



Concepts In Motion
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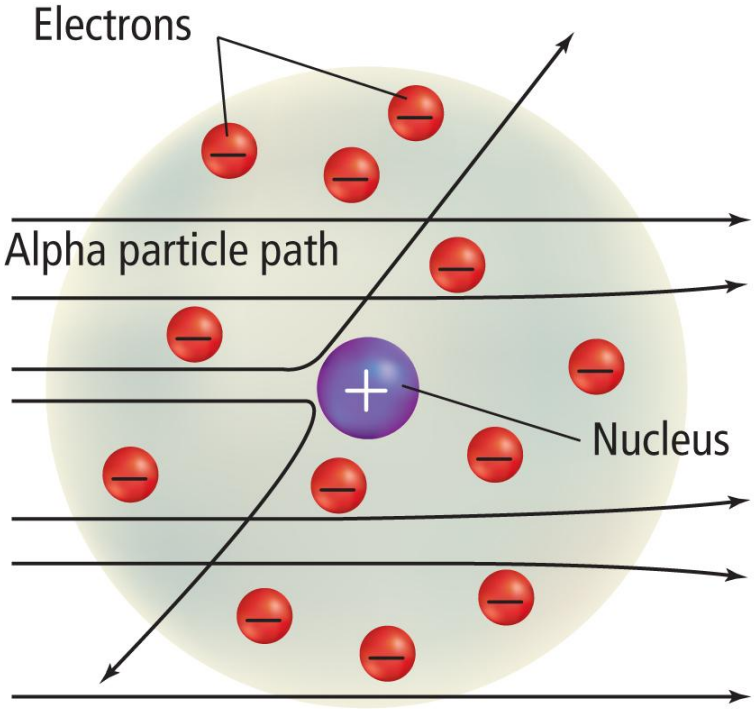
The Nucleus (cont.)

- Rutherford concluded that atoms are mostly empty space.
- Almost all of the atom's positive charge and almost all of its mass is contained in a dense region in the center of the atom called the **nucleus**.
- Electrons are held within the atom by their attraction to the positively charged nucleus.

The Nucleus (cont.)

- The repulsive force between the positively charged nucleus and positive alpha particles caused the deflections.

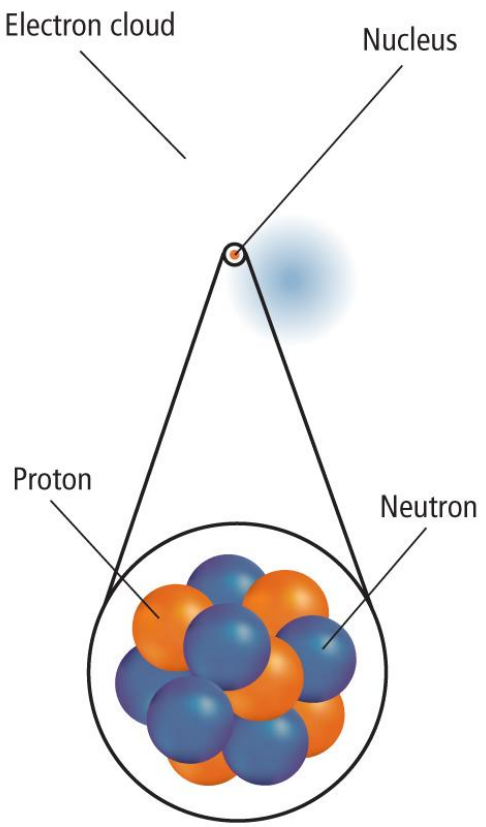


The Nucleus (cont.)

- Rutherford refined the model to include positively charged particles in the nucleus called **protons**.
- James Chadwick received the Nobel Prize in 1935 for discovering the existence of **neutrons**, neutral particles in the nucleus which accounts for the remainder of an atom's mass.

The Nucleus (cont.)

- All atoms are made of three fundamental subatomic particles: the electron, the proton, and the neutron.
- Atoms are spherically shaped.
- Atoms are mostly empty space, and electrons travel around the nucleus held by an attraction to the positively charged nucleus.



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The Nucleus (cont.)

- Scientists have determined that protons and neutrons are composed of subatomic particles called quarks.

Table 4.3 Properties of Subatomic Particles

Particle	Symbol	Location	Relative Electric Charge	Relative Mass	Actual Mass (g)
Electron	e^-	In the space surrounding the nucleus	1−	$\frac{1}{1840}$	9.11×10^{-28}
Proton	p	In the nucleus	1+	1	1.673×10^{-24}
Neutron	n	In the nucleus	0	1	1.675×10^{-24}

Concepts In Motion
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The Nucleus (cont.)

- Chemical behavior can be explained by considering only an atom's electrons.

Section 4.2 Assessment

CheckPoint

Atoms are mostly _____.

A. positive

B. negative

C. solid spheres

D. empty space

Section 4.2 Assessment

CheckPoint

What are the two fundamental subatomic particles found in the nucleus?

A. proton and electron

B. proton and neutron

C. neutron and electron

D. neutron and positron