

# 3 Anatomy of the Atom

## 3.0 CHAPTER PREVIEW

In this chapter, we will:

- Review the history of atomic theory.
- Learn of the contributions to atomic theory by John Dalton, Ernest Rutherford, J.J. Thomson and Niels Bohr.
- Explore properties of the subatomic particles called protons, neutrons and electrons.
- Describe the features of the nucleus and the electron shells.
- Discuss the Bohr and electron cloud models in detail.

## 3.1 ANATOMY OF THE ATOM: THE HISTORY OF ATOMIC THEORY

- Atomic theory is the concept that all matter is composed of the “smallest whole units” of matter called atoms, and atoms themselves are built from even smaller units called protons, neutrons and electrons.

### Topic question:

What three subatomic particles are atoms built from? **Protons, neutrons and electrons.**

## 3.2 ANATOMY OF THE ATOM: EARLY MODELS

- Today we know that atoms are built from positively-charged protons, neutral neutrons and negatively-charged electrons, but the first atomic model—developed by J.J. Thomson in the last decade of the 19th century after he discovered electrons—had atoms as positively charged “space” inside of which electrons were contained.
- Ernest Rutherford believed that J.J. Thomson’s model was not quite correct, so he performed experiments that showed that atoms in fact have a “solid” center, which he called the nucleus.

### Topic question:

J.J. Thomson’s atomic model was one where the atom was composed of a positively charged space within which the negatively charged electrons were contained. What was this model called? **The plum pudding model.**

## 3.3 ANATOMY OF THE ATOM: PROTONS, NEUTRONS AND ELECTRONS

- Following the work of J.J. Thomson and Ernest Rutherford, by the mid-1920’s, scientists had determined the basic design of the atom, with the protons and neutrons in the center of each atom—in an area called the nucleus—and the electrons orbiting outside the nucleus in the electron shells (also called the electron cloud).

### Topic question:

True or False? A proton is more than 1,800 times larger than an electron, yet the strength of the proton’s positive charge is the same as the electron’s negative charge. **True**

## 3.4 ANATOMY OF THE ATOM: WHAT KEEPS THE NUCLEUS TOGETHER?

- The strong nuclear force (or just strong force) is a non-charge-based interaction between neutrons and protons that prevents the protons from repelling each other out of the nucleus, keeping the nucleus together.

### Topic question:

What is the strong force and why is it necessary? **It’s an interaction between protons and neutrons that prevents the positively charged protons from repelling each other out of the nucleus.**

### 3.5 ANATOMY OF THE ATOM: ELECTRONS AND THEIR SHELLS...OR ORBITALS... OR CLOUDS

- Electrons orbit the nucleus in an area that has multiple names (depending upon the point one is trying to get across)—electrons shells/orbitals or the electron cloud.
- Electrons fill shells/orbitals in a specific way because each orbital can only hold so many electrons before it's filled and then the electrons start to fill the next shell/orbital. The maximum number of electrons that a shell can hold is determined by the formula  $2n^2$ .

#### Topic question:

What are the "areas" or "layers" around an atom that hold electrons called? **Electron shells or orbitals.**

### 3.6 ATOMIC MODELS

- There are different ways to diagrammatically draw an atom. None of them are "wrong" or "right"; they are simply different and the one that's used is the one that best makes whatever point you're trying to make.

#### Topic question:

What is the name of the atomic model/diagram named for a famous physicist that shows the nucleus in the middle and the electrons in concentric circles outside of the nucleus? **Bohr model.**

### 3.8 KEY CHAPTER POINTS

- Concepts consistent with modern atomic theory date back as far as 400BC.
- There are three atomic building blocks—protons (charged positively) and neutrons (no charge) make up the nucleus, and electrons (charged negatively) orbit the nucleus.
- Atomic theory, in a nutshell, is that all matter is composed of indivisible particles called atoms.
- Key figures in atomic theory are John Dalton (who proposed modern atomic theory), J.J. Thomson (who discovered the electron) and Ernest Rutherford (who discovered that the atom is composed of the nucleus and further discovered the proton and the neutron).
- The plum pudding model was an early atomic model that gave way to the model that is still in use today, the Bohr model.
- Despite being significantly different masses, protons and electrons have the same relative charge - +1 for protons and -1 for electrons. Neutrons have no charge.
- The attractive forces between the protons in the nucleus and the electrons orbiting the nucleus keep the electrons from flying away from the atom.
- Protons and neutrons each have 1,867 times more mass than electrons.
- Protons are held tightly into the nucleus by the strong nuclear force, which is provided by neutrons.
- There is a total of 8 electron shells, which can each maximally hold different numbers of electrons.