

**SCIENCE KEY CONCEPTS SERIES:**

**PERIODIC TABLE: STRUCTURES OF ATOMS**

*18 minutes, Video*

<i>Chapters:</i>	<i>1. Discoveries of Atomic Structures</i>	<i>6 min.</i>
	<i>2. Atomic Numbers &amp; Mass Numbers</i>	<i>5 min.</i>
	<i>3. Electron Shell Configurations</i>	<i>7 min.</i>

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**FOR USE IN:** Chemistry, Physics

**LEVEL:** Grades 9-12

**EDUCATIONAL ADVISOR:** Dr. O. Roger Anderson, Columbia University, Professor Natural Sciences, Teachers College; and Senior Research Scientist, Lamont-Doherty Earth Observatory

**EDUCATIONAL OBJECTIVES:**

To help the student understand these key concepts:

- the structures of and electrical charges within atoms, which consist of a nucleus made up of protons and neutrons, and electrons surrounding the nucleus.
- the meaning of the terms atomic number and mass number.
- how atomic number determines an element's position in the periodic table, reading left to right.
- how the configuration of electrons in their shells, positions elements in the periodic table, both vertically and horizontally

**BACKGROUND:**

The main value of the periodic table is the ability to predict the chemical properties of an element based on its location on the table. It should be noted that the chemical properties of the elements are similar when moving vertically down a column in the table, but differ when moving horizontally along the rows. The periodic table is now ubiquitous within the academic

discipline of chemistry providing an extremely useful framework to classify, systematize and compare all the many different forms of chemistry behavior. The table has also found wide application in physics, biology, engineering, and industry. The current standard table contains 117 confirmed elements as of October 16, 2006.

## CONTENT

### Chapter 1. Discoveries of Atomic Structures 6 min

#### *Discovery of the Electron*

J.J. Thomson in 1897 was investigating the then mysterious cathode rays using an apparatus which is replicated in the video. By measuring the deflection of the cathode ray by a positive and a negatively charged plate above and below the ray, Thompson brilliantly calculated that the ray was composed of tiny negatively charged particles, parts of atoms. He had discovered the electron and for that won the Nobel Prize.

#### *Discovery of the Nucleus*

In 1911, Ernest Rutherford's experiment is replicated in which he passes high energy alpha particles through gold foil, and particle detectors record that most pass straight through, but unexpectedly, a few are deflected backwards. Rutherford reasons that the few deflected particles must have hit a very small dense center in the gold atom, a center he chose to call a nucleus, which was surrounded by vast empty space which was why most of the alpha particles passed straight through.

Since Thomson and Rutherford, scientists have discovered many more atomic particles, three of which you should know more about, protons, neutrons, and electrons.

### Chapter 2. Atomic Numbers and Mass Numbers 5 min.

The atomic number is simply the number of protons in the nucleus. There is always one negatively charged electron for each positively charged proton in the nucleus. Hydrogen has one proton so its atomic number is 1. Helium with two protons has the atomic number 2, and Lithium with three protons, has atomic number 3. Each element in the periodic table reading left to right in each row (called a Period), has one more proton, and so has an atomic number which increases by one.

The mass number is the number of protons plus neutrons in the nucleus. Hydrogen has one proton, no neutrons, so its mass number is 1. Helium has two protons plus two neutrons, so its mass number is 4. Lithium has 3 protons and 4 neutrons, so its mass number is 7.

### Chapter 3. Electron Shell Configurations 7 min.

Electrons moving around the outside of an atom occupy a series of shells at different distances from the nucleus. This orbital picture is visualized using a group of roller blade skaters, each representing one electron moving around a set of rings drawn on the floor representing electron shells. The players illustrate how the first three shells can hold a fixed number of electrons (2.8.8) and how they fill up starting with the shell closest to the nucleus.

The skaters visualize how the electrons fill up shells in Hydrogen (1 electron), Helium (2), Lithium (3), Fluorine (9), Neon (10), and Sodium (11).

Elements in the same column, called a group, of the periodic table have the same number of electrons in their outer shell, which gives them similar chemical properties such as boiling & freezing temperatures, and electrical conductivity. Group 18 on the far right, the noble gases, has no free electrons on their outer shell, and their common chemical property is virtually no reaction with other elements.

In the far left group, group 1, starting with Lithium top left, and reading down the group, each element in this and every other group has one additional shell, which holds a of varying maximum number of electrons. But the outer shell of each element in this group 1, holds just one electron.

Reading left to right along a row, called a period, each element will have one additional electron in its outer shell.

These are some suggested questions to help stimulate student discussion:

- Why did Rutherford carry out his gold foil experiment in a vacuum?
- What is the atomic number of an atom equal to?
- What is an atom's mass number equal to?

- What is the maximum number of electrons that can fit into the first, second, and third shell?
- Why might chemists be interested in the number of electrons in the outer shell of an atom.
- Why are the noble gases relatively non-reactive?
- Describe how the elements are so arranged in the periodic table that their chemical properties can be described by their location in the table.

**LINKS:**

<http://www.brainpop.com/science/matter/atoms/index.weml> This site contains an **animation showing the structure of atoms.**

<http://www.ewart.org.uk/> This site is called the **Interactive Learning Pages** and contains a number of interactive pages for students on atoms and atomic structure.

<http://www.watertown.k12.wi.us/HS/Staff/Buescher/atomtime.asp> This is a **timeline covering important dates in the history of atomic structure.**

<http://www.schoolscience.co.uk/content/4/physics/atoms/partch1pg3.html> This is an excellent **KS4 site on atoms and their structure. It is designed for self-study by students and contains quizzes and short animation.**

<http://scienceworld.wolfram.com/biography/> This site is called the **Eric Weisstein's World of Scientific Biography** and contains useful information about all the key players in the story of atomic theory from Democritus to Rutherford.

<http://www.touchspin.com/chem/DisplayTable.html>

To view an interactive periodic table, and select any element to view all of its important properties.

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