

Orbitals

Teacher's Guide

1.0 Summary

"Orbitals" is the first activity to be done after the pre-test. This activity should take approximately one class period.

2.0 Learning Goals

Driving Question: Where do we expect to find electrons in an atom?

This activity provides a brief history of the development of the atomic model. The model is then used to reinforce the current understanding of atomic orbitals. Electrons move in random patterns around the nucleus. The electrons are moving so quickly that we map their location as clouds instead of actual points. These clouds are negatively charged and are important because they are responsible for the formation of bonds between atoms in the formation of molecules.

Learning Goals

- Students will review the development of the atomic model.
- Students will understand that electrons are negatively charged.
- Students will understand that electrons exist as clouds around the nucleus.
- Students will understand why Dalton's model does not adequately explain our current understanding of the atomic model.
- Students will understand that electron clouds are negatively charged.

Additional Teacher Background

Electrons behave according to laws of quantum mechanics. These laws are very difficult for most people to understand because they do not map well within the macroscopic world. It is important that students move away from the belief that electrons orbit the nucleus like the Earth orbits the Sun. There are some similarities; electrostatic force pulls the electron to the nucleus such as gravity pulls the Earth toward the sun. Although the forces are different, the role of mathematics is similar.

However, the electrons move so quickly that they behave very differently from planets. These electrons follow apparently random patterns around the nucleus of an atom that are unlike a planet's elliptical orbit. The electrons' position in space can be determined by using probability models that treat the electrons like waves as opposed to particles.

3.0 Standards Alignment

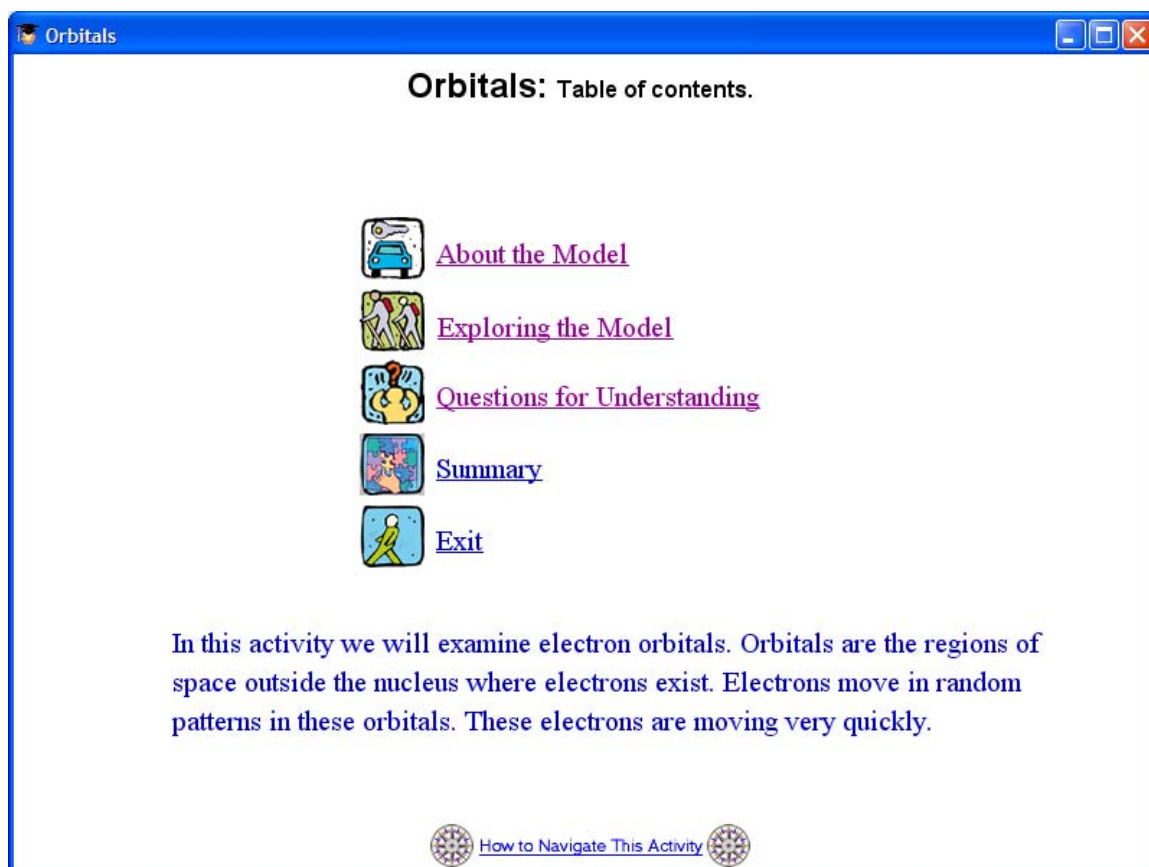
Alignment to National Math and Science Standards (NCTM or NSES)

Objective	Standards
Students will understand the development of the atomic model.	<ul style="list-style-type: none">Varies by state.
Students will understand that electrons exist as negative clouds around the nucleus.	<ul style="list-style-type: none">Varies by state.






4.0 Activity Sections

4.1 Table of Contents

This activity has 4 sections.



The screenshot shows a window titled "Orbitals" with a blue border. The main heading is "Orbitals: Table of contents." Below this, there are five menu items, each with a small icon to its left:

-  [About the Model](#)
-  [Exploring the Model](#)
-  [Questions for Understanding](#)
-  [Summary](#)
-  [Exit](#)

Below the menu items, there is a paragraph of text:

In this activity we will examine electron orbitals. Orbitals are the regions of space outside the nucleus where electrons exist. Electrons move in random patterns in these orbitals. These electrons are moving very quickly.

At the bottom center, there is a small icon of a globe and the text "How to Navigate This Activity" flanked by two more globe icons.

4.2 About the model

The first step provides students with a brief history of the atomic model.

The screenshot shows a software window titled "Orbitals: About the model." with a blue title bar. Inside the window, the title "Orbitals: About the model." is centered at the top. Below it, the text "Bohr Model" is displayed above a diagram of the Bohr Model, which consists of a central nucleus of red and grey spheres and two concentric white circles representing electron shells, with four blue dots representing electrons on the inner shell and two on the outer shell. Below the diagram, there are two paragraphs of text. The first paragraph explains that the Bohr Model reflects the idea of electrons orbiting the nucleus like planets orbit the sun. The second paragraph states that in 1913, Niels Bohr discovered that negatively charged electrons orbit the positively charged nucleus in specific patterns. Below the text is a horizontal timeline with five points: 1803 (John Dalton Atomic Theory), 1897 (J.J. Thompson Positive & Negative Charges), 1910 (Ernest Rutherford Nucleus & Electrons), 1913 (Niels Bohr Bohr Model, highlighted in yellow), and Present (Current Theory Orbital Model). At the bottom of the timeline are blue double-headed arrows and a document icon.

Orbitals: About the model.

Bohr Model

Often, when people learn about atoms, they learn that electrons orbit the nucleus like planets orbit the sun. The Bohr Model above reflects this thinking. This model is named after Niels Bohr, who developed it in the 1900's.

In 1913, Neils Bohr discovered that negatively charged electrons orbit the positively charged nucleus in very specific patterns. In addition, he found that the nucleus contains most of the weight of an atom and all the positively charged protons.

Year	Scientist	Theory/Model
1803	John Dalton	Atomic Theory
1897	J.J. Thompson	Positive & Negative Charges
1910	Ernest Rutherford	Nucleus & Electrons
1913	Niels Bohr	Bohr Model
Present		Current Theory Orbital Model

4.3 Exploring the Model

This section introduces the student to the simulation that promotes an understanding of orbitals.

Orbitals: Determining the pattern of electron movement.

Legend:

- ← Nucleus
- ← + charged proton
- ← neutral neutron
- ← - charged electron

Modern Model of the Atom

Dalton's Model of an Atom

Delay Between Finding Electrons

long short

Trace Electrons

Electrons are constantly moving around the nuclei of atoms. The atom above is set up so that you can "stop time" and find the current location of the electrons. The slider allows you to slow down or speed up this sampling of electron locations. You can't see the electrons actually moving, just find where they are at particular moments in time.

1. Is the pattern of the electrons more like the Orbital Model or more like the Dalton Model.

Orbital Model

Dalton Model

I can't tell

Submit Answer

Notice that the slider on the left can be moved to adjust the frequency at which electrons are seen. The simulation will move faster if students push the slider toward "short." It is also important to make sure that the "trace electrons" button is checked. This insures that the last position of the electron remains on the screen.

As the simulation continues it should begin to look more and more like the modern model (orbital model) of the atom.

Question 2 in this activity asks students how electrons move around the nucleus. You may need to suggest the quick random movements of the electrons.

4.4 Questions for understanding

This section asks the students questions to help assess their understanding of the concepts.

The first question asks how only two electrons can make up a cloud. You may need to remind students that only one electron is needed to make up a cloud. Two electrons would actually make the cloud even faster.

The second question in this section asks about the charge on the cloud. Since the cloud is made up of electrons, it carries a negative charge.

The final question asks why the solid ball or Dalton model is not a good representation of the atom. You may need to remind students that the cloud is not solid matter.

4.5 Summary

This section shows the answers to all the questions. There is an icon on the lower left that will print each student's answers. After the student clicks on the icon, s/he will be asked to type in her/his name. This is only for the printout; the names are not saved in our database. Then, a web page is generated with the answers. This process may take a few moments. The standard print dialog box will open and the student can select the appropriate printer.

5.0 Student Reports

Your students' work with the Orbital activity is logged and viewable on the MAC Project Web Portal at <http://mac.concord.org>. For each student, you can view a report containing questions and answers.

"Finding the Nucleus" is the next activity in the Chemica sequence.