

Finding the Nucleus

Teacher's Guide

1.0 Summary

"Finding the Nucleus" is the second activity to be done after the pre-test. This activity should take approximately 10 minutes.

2.0 Learning Goals

Driving Question: How does the size of an atomic nucleus compare to the atom's size?

This activity is intended to provide perspective on the scale of the atom. It is difficult for students to understand the actual sizes of atoms because they are so small and because the scale is almost always corrupted in images. These images show the critical parts of the atom, but they do not use appropriate distances. This problem of scale is also frequently seen in pictures of the solar system. Students will manipulate a control that will allow them to zoom in and out on an atom. As the nucleus becomes visible, the electron cloud becomes much larger than the screen. This activity should reinforce that the nucleus of an atom is approximately 10,000 times smaller than the electron cloud. If the nucleus were a 9" (23 cm) soccer ball, than the electron cloud could extend up to 1.5 miles (2.3 km) away.

It is also worth noting that there is no absolute atomic size. The probability of finding the electron becomes very small beyond a certain distance, but this does not mean that the atom's outer limit has ended.

Learning Goals

- Students will review atomic size and know that atoms are very small.
- Students will review that atoms are made up from protons, neutrons, and electrons.
- Students will learn atoms are almost never drawn to scale.
- Students will learn that the nucleus of an atom is 10,000 times smaller than the electron cloud.
- Students will, considering the nucleus to be as large as a pea, make an inference about the size of an atom.
- Students will make inferences about why Rutherford's gold foils scatter experiment only deflected very few particles.

Additional Teacher Background

The development of the atomic model was briefly reviewed in the previous section. A good pictorial overview of this process can be seen at the Thinkquest web site at: <http://library.thinkquest.org/C006669/data/Chem/atomic/development.html>. Ernest Rutherford is generally credited with discovering the atom's small positively charged nucleus. He did this by firing alpha particles that are helium nuclei (helium nuclei contain 2 protons, 2 neutrons and no electrons) at a very thin layer of gold foil. Gold was used because it is very malleable and can be hammered into very thin gold sheets. Rutherford used a special screen to track the alpha particles. This screen would glow when struck by an alpha particle.

Rutherford expected all the alpha particles to slice through the gold foil with ease. This expectation was based on the work of J.J. Thompson, who believed atoms were a soft entity. However Rutherford noticed that some of these fast moving alpha particles bounced off the atoms and were deflected. This was quite surprising, and he reasoned that these deflections were caused by a small positive nucleus and that the rest of the atom was mostly empty space.

3.0 Standards Alignment

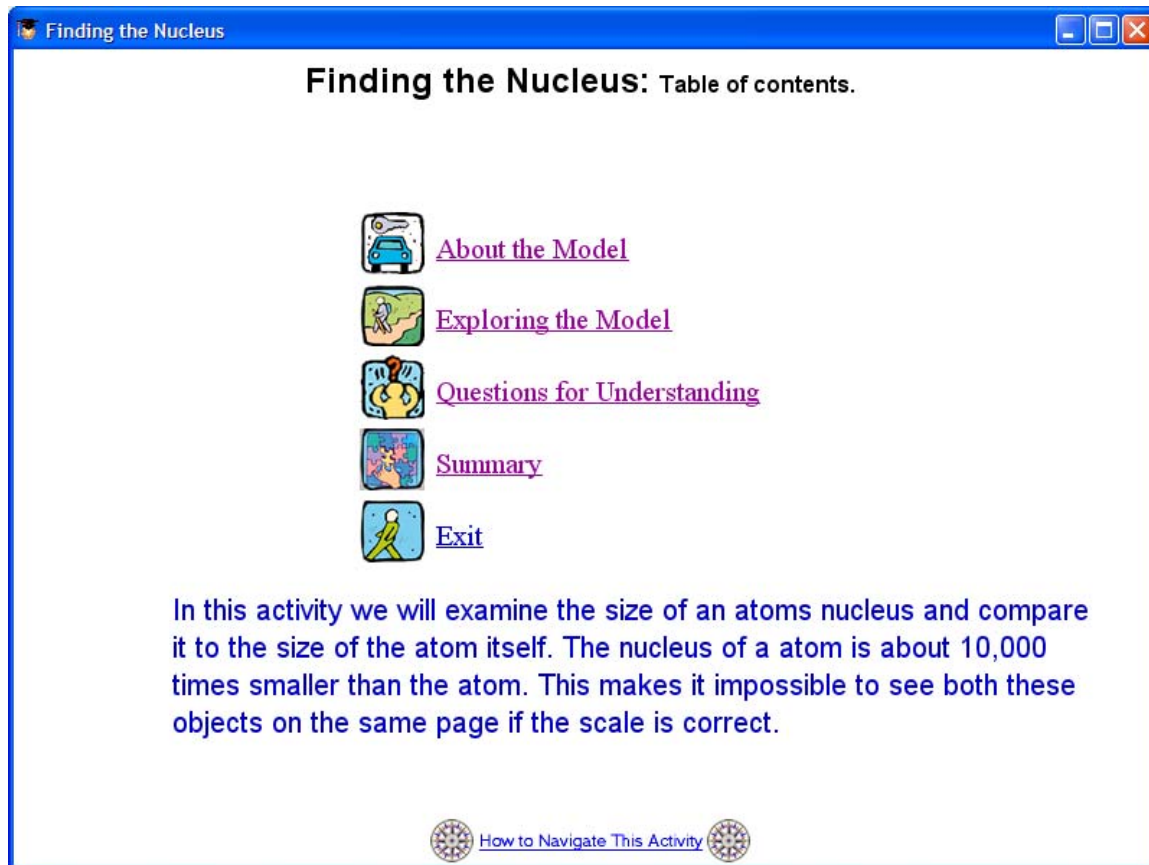
Alignment to National Math and Science Standards (NCTM or NSES)

Objective	Standards
Students will understand the size of an atom.	<ul style="list-style-type: none">• Varies by state.
Students will understand the relationship between the size of the atom and the size of the electron cloud.	<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 "Finding the Nucleus" with a blue border. The main content area is titled "Finding the Nucleus: Table of contents." and contains a vertical list of five items, each with a small icon to its left and a blue underlined text label to its right:

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

Below the list, there is a paragraph of text in blue font:

In this activity we will examine the size of an atoms nucleus and compare it to the size of the atom itself. The nucleus of a atom is about 10,000 times smaller than the atom. This makes it impossible to see both these objects on the same page if the scale is correct.

At the bottom center, there is a small globe icon followed by the text "How to Navigate This Activity" and another globe icon.

4.2 About the model

The first step provides students with an overview of the scale of an atom. It should get the student to begin thinking about the size of the nucleus in comparison to the size of the electron cloud that surrounds it.

4.3 Exploring the Model

This section introduces the model of the atom that enables zooming. The slider on the page will enable the students to zoom in and out. It is worth noting that when the entire atom is visible the nucleus is not and that when you can see the nucleus the electron cloud is larger than the screen.

Finding the Nucleus: Exploring the model.

A Helium Atom

low high

Magnification

Above is a model of a Helium atom enlarged about a billion times. One thing you can't see is the nucleus. Even though the atom is magnified so much, the nucleus is still too small to see. Adjust the slider to magnify the atom even further.

1. In your own words, how would you compare the size of the nucleus to the size of the atom

ox

4.4 Questions for understanding

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

The first question asks the students to estimate the size of the atom if the nucleus were the size of a pea. Since 10,000 times is a big number, students should choose the largest answer (a football field) and attempt to justify their response.

The second question in this section shows students a picture of Rutherford's model and asks them to interpret his results. Students should be able to match up the few deflections with the small size of the nucleus compared to the entire atom.

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 "Finding the nucleus" 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.