Scale Activity: Zoom In / Zoom Out
Instructor Guide

Notes to Instructor

This activity allows the participants to demonstrate what they have learned about the various scales while studying the *Comparison of Scale Learning Module*. This activity is supported by a primary knowledge unit, additional activities and an assessment.

The *Comparison of Scale Learning Module* consists of the following.
- A Comparison of Scale: Knowledge Probe (KP) Pre-test
- A Comparison of Scale: Macro, Micro, Nano (PK)
- Scale Inquiry Activity: Cut to Size
- The Scale of Biomolecules Activity
- **Scale Activity: Zoom in / Zoom Out**
- A Comparison of Scale Assessment

The companion Instructor Guide (IG) contains all of the information in the PG as well as answers to the Post-Activity questions.

Description and Estimated Time to Complete

As you learned in the Scale unit and other activities, macro objects consist of micro and nano-sized objects. In this activity you will illustrate what you've learned about the various scales by creating an illustration of an object and the various sized objects that it contains. For example, you could start with a macro-sized object (such as a human) and slowly zoom in to its nano-sized components (like DNA). You may also choose to go the other way and zoom out from the nano-sized object to the macro-sized object.

To get you started, we'll take you through the universe to our galaxy, to earth, to man, and end up somewhere inside of the human body to parts yet unknown.

<u>Estimated Time to Complete</u>
You should set aside approximately 2 – 3 hours to complete this activity.

Introduction

Exploring the universe involves the study of the objects within it as well as its composition. Measurements and comparisons are constantly being made in an effort to discover something new and to move closer to how big the universe could be. While astronomers have been trying to figure out how big the universe really is, scientists and engineers have been exploring how small things are and how small something has to be before it cannot be manipulated or measured.
So what have these scientist found?

In this activity, you will illustrate what these scientists have found.

Activity Objectives and Outcomes

Activity Objective

- Illustrate the relationship of scale by breaking an object into its various sized components: macro (> 100 microns), micro, nano.
- Calculate how much bigger (in powers of 10) one object is over another object in a different scale.

Activity Outcomes

The outcome of this activity should illustrate your understanding of how objects are constructed from smaller objects all the way down to the nano-scale and beyond. At the end of this activity you should be able to answer the following questions:

- When constructing micro-sized objects, would it be more logical to construct the object from the bottom up or from the top down? Be prepared to justify your answer.
- When constructing nano-sized objects, would it be more logical to construct the object from the bottom up or from the top down? Be prepared to justify your answer.

Team

You can do this activity by yourself or with one other participant.

Supplies

The supplies that you need for this activity is dependent upon how you choose to illustrate the assignment.

Resources (You may need to cut and paste the URL)

- Exploring the World of Optics and Microscopy. Molecular Expressions. http://micro.magnet.fsu.edu/index.html
- Virtual Scanning Electron Microscopy. Molecular Expressions. Interactive Java Tutorial. http://micro.magnet.fsu.edu/primer/java/electronmicroscopy/magnify1/index.html
- Introduction to Optical Microscopy, Digital Imaging, and Photomicrography. Molecular Expressions. http://micro.magnet.fsu.edu/primer/index.html
- Secret Worlds: The Universe Within. Molecular Expressions. Interactive Tutorial. http://micro.magnet.fsu.edu/primer/java/scienceopticsu/powersof10/

Documentation

Your documentation will include (but not limited to) the following items:

- A discussion of each on-line tutorial and answers to questions about the tutorials.
- A short description of your project – what you are going to illustrate.
- A visual presentation of your illustration. It could be animated PowerPoint, flash animation, physical model, manual flip animation, or expanded drawing.
- Answers to Post-Activity Questions

Activity: Zoom In / Zoom Out

Description

In this activity you should demonstrate what you have learned about the various scales by creating an illustration of an object and the various sized objects that it contains.

1. Complete an on-line tutorial.

Description

a. Read the following instructions BEFORE going to the tutorial.
b. Go to http://micro.magnet.fsu.edu/primer/java/scienceopticsu/powersof10/ and put the tutorial in the Manual Mode. (Click on the "manual" button) (If the link doesn't work, cut and paste the URL into your browser.)
c. Familiarize yourself with the screen. Find where the name and the size of the objects are illustrated.
d. Zoom In – Read what the object is and its size.
e. Answer the following questions:
   - What is the first object in the micro-scale? How big is this object?
   - What is the first object in the nano-scale? How big is this object?
   - How much bigger is the "oak tree leaf" to the "cells on the leaf's surface"?
   - How big is an individual leaf cell?
   - How big is the nucleus of a carbon atom? (Use a metric prefix.)
   - How much bigger is the nucleus of a leaf cell than the nucleus of a carbon atom?
   - Now Zoom Out.

2. Complete another on-line tutorial.

Description

a. Go to http://micro.magnet.fsu.edu/primer/java/electronmicroscopy/magnify1/index.html (If the link doesn't work, cut and paste the URL into your browser.)
b. Zoom in and out on several objects in this tutorial.
c. "Play" with the four slider controls and figure out what they do.
   - What type of analytical tool was used to capture these images?
   - When viewing these images, what effect did the amount of light (brightness) have on the object's details?

3. Layout your illustration.

Description
a. Pick an object that you would like to create your own zoom in or zoom out.
b. Ideas: Pencil, piece of fruit, any animal (chicken, cat, etc.), MP3 player
c. Outline how you will present this object from the macro to nano-scale or vice versa.

4. Create your illustration.

Description
Create an illustration with at least 15 steps covering three scales that carry the viewer from a nano-sized object to a macro-sized object (zoom out) or vice versa (zoom in).
Here are some ideas on how to create your illustration. You are welcome to use other methods.
a. Animated PowerPoint presentation
b. Flash animation
c. Physical model
d. Manual flip animation
e. Expanded drawing
For each step in your illustration indicate what the object is and its size.

5. Present your illustration.

Description
Present your illustration to your instructor and other participants of this activity.
Solicit feedback.
- What were the strengths and weaknesses?
- What could have made it better?
- What is accurate? If not, where were the inaccuracies?
- Was this a good illustration for what you were trying to represent? If not, why not?

6. Answer the Post-Activity Questions.

Description
Answer the Post-Activity Questions at the end of this procedure.

7. Complete your documentation.

Description	Complete your documentation as outlined in the previous Documentation Section.

8. Submit your illustration and documentation.

Instructor Note: Answers to Activity Questions

- What is the first object in the micro-scale? ***(Answer: Cells on the leaf's surface)***
- How big is this object? ***(Answer: 1 x 10^{-4} m = 100 microns)***
- What is the first object in the nano-scale? ***(Answer: Chromatin in the leaf cell nucleus)***
- How big is this object? ***(Answer: 1 x 10^{-7} m = 100 nanometers)***
- How much bigger is the "oak tree leaf" to the "cells on the leaf's surface"? ***(Answer: 1000 times bigger : 10^{-1} / 10^{-4})***
- How big is the nucleus of a carbon atom (use a metric prefix)? ***(Answer: 10 x10^{-15} = 10 femtometers)***
- What type of tool was used to capture these images? ***(Answer: SEM or Scanning Electron Microscope)***
- When viewing these images, what effect did the amount of light (brightness) have on the object's details? ***(Answers will vary. Students should see that the light affected the details on the objects as well as making the object appear more or less 3 dimensional)***

Post-Activity Questions

1. When constructing micro-sized objects, would it be more logical to construct the object from the bottom up or from the top down? Explain the reasoning behind your answer.

2. When constructing nano-sized objects, would it be more logical to construct the object from the bottom up or from the top down? Explain the reasoning behind your answer.

3. What type of analytical tools enable scientist to see objects in the micro and the nano-scales? *(List at least three. Briefly discuss each. In your discussion identify the distinct differences between the tools in relation to "what" they can see.)*

Post-Activity Questions / Answers

1. When constructing micro-sized objects, would it be more logical to construct the object from the bottom up or from the top down? Explain the reasoning behind your answer.
Answer: From the top down. With larger objects, consisting of millions and billions of molecules, it would be easier to remove a "bulk" of material all at once rather than building the object one molecule at a time.

2. When constructing nano-sized objects, would it be more logical to construct the object from the bottom up or from the top down? Explain the reasoning behind your answer.
Answers will vary but here's a couple acceptable answers:
From the bottom up. Nano-sized objects are only a few nanometers or nm^3 in size; therefore, it would be easier to build them up one molecule or atom at a time rather than removing thousands of select molecules to make a shape. (Remember, a molecule is about 1 nm in diameter)
It really depends on the technology that works best for the given application.
Note: In the case of transistors, some structures are now as small as 40nm. These are made using a top down approach. However, many other nanostructures are use a bottom up fabrication: functional supramolecular structures, molecular self-assembly objects, organized films. (good site to review: http://www.aspbs.com/bu.htm)

3. What type of analytical tools enable scientist to see objects in the micro and the nano-scales? *(List at least three. Briefly discuss each. In your discussion identify the distinct differences between the tools in relation to "what" they can see.)*
(Answers will vary) This link (http://micro.magnet.fsu.edu/primer/index.html) provides general information on Optical Microscopy, Digital Imaging, and Photomicrography. Specific tools include Scanning Electron Microscopes., Tunneling Electron Microscopes, Atomic Force Microscopes, laser scanning confocal microscope, Transmission Electron Microscopes and, X-ray Photoelectron Spectroscopes.

References

- A Comparison of Scale: Macro, Micro, and Nano PK
- Scale Inquiry Activity: Cut to Size

Support for this work was provided by the National Science Foundation's Advanced Technological Education (ATE) Program through Grants. For more learning modules related to microtechnology, visit the SCME website (http://scme-nm.org).