NanoLeap

Nanoscale Materials and Their Properties
Teacher Guide Unit 1: *Nanoscience: What Is It?*
Lesson 1.1 What is Nanoscience?

Objectives for *Nanoscience: What Is It?*
Lesson objectives: What is Nanoscience? **(bold)**
Students will be able to:

1. **Define nanoscience as the study of the fundamental principles of structures having at least one dimension lying roughly between 1 and 100 nanometers.**
    a. **Compare and contrast the size of atoms, ions, and molecules to the size of nanoparticles.**
    b. **Identify structures that are appropriately measured in nanometers.**
    c. Compare and contrast nanoparticle samples to atomic and macro-level samples in terms of the particle size, number of atoms, and operational model.
2. Explain the importance of nanoscience research and technology.
3. Evaluate the ethical considerations associated with nanoscience research and nanotechnology.
4. Recognize the interdisciplinary nature of nanoscience.
5. Identify the requirements of nanoscience and nanotechnology, including:
    a. new production methods,
    b. new measurement instruments, and
    c. a cleanroom environment for nanoscale research and technology.

Suggested Time Frame: 45–60 Minutes

Chemistry Concepts

- Size: SI prefixes—Macro, Micro, Sub Micro (Nano)

At a Glance for the Teacher

- Begin K-W-L introductory activity –“What do you know about nanoscience?”
- ❖ View video *NanoSize Me* (See advanced preparation for Flash requirements)
- Review “Fact Sheet 1– Common SI Prefixes”
- Complete “Problem Sheet 1–Nanoscience: What Is It?”
- Complete “Activity 1–What are Your Ideas about Small Sizes?”
- Answer “Making Connections” questions
- Review “Flow Chart”

❖ **New Concept**
• **Review**

Advanced Preparation

- If you are playing the *NanoSize Me* video from your computer, download and test the video in advance.
- If you are using the *NanoScale Me* interactive in a computer lab or on multiple computers, make sure that Flash Player (5.0 and higher) is loaded on each computer that will be used. The appropriate version can be found at the Web site http://www.adobe.com/shockwave/download/index.cgi?P1_Prod_Version=ShockwaveFlash.
- In the event that you do not have access to a computer lab for the *NanoScale Me* activity, you may print and cut out the cards from the interactive. Students can conduct the sorts as directed. For the "all sort," the cards can be placed in a line by relative size and displayed on a clothesline.

Materials

- PowerPoint – *Nanoscience: What is it? What is Nanoscience?*
- Video – *Nanosize Me* http://www.mcrel.org/nanoleap/multimedia/index.asp
- Interactive – *NanoScale Me* http://www.mcrel.org/nanoleap/multimedia/Nanosize_me.swf
- Computer (one per pair of students)
- Computer with LCD Projector with Speakers
- Student Handbook
- Student Handbook-Teacher Version
- Teacher Handbook

Introduction

To introduce the NanoLeap module, play the *NanoSize Me* video. Before the video, have students complete the first column of the K-W-L chart in their handbook or on a whiteboard for the question, "What is Nanoscience?" The video is a Flash media piece that highlights some current and anticipated applications of nanoscale science and engages students in exploring the counterintuitive properties of some specific nanoparticles. The video can be played from the Web site http://www.mcrel.org/nanoleap/multimedia/index.asp.

<table>
<tr><th><u>Slide #</u>
Student Handbook Page #</th><th><u>Teacher Background Information and Pedagogy</u>
Teacher Script</th></tr>
<tr><td>Slide 1
Student Handbook Teacher Version: page 3

Student Handbook: page 3</td><td>1) Before students watch the video, have them complete the first column of the K-W-L chart or whiteboard for the question, “What is Nanoscience?” This video is intended to provide a background, some history, and current and future applications of nanoscale science and technology. Some students in the field test were frustrated by the fast pace of the video. Feel free to show it more than once. The second time, pause the video and discuss what was being shown in the segment and record student questions on the board and in the second column of the K-W-L chart. Then, following the video:
You have just watched a video on nanoscience and nanotechnology. Let’s explore this new field of science further by searching for answers to some questions about it. We have been considering what you know about nanoscience. On the basis of what you saw in NanoSize Me, how would <u>YOU</u> define nanoscience?
{Click}

2) Have students revise their notes on the first column and complete the second column after they watch the video. Follow instructions found in the Teacher Resource Guide on page 9.

A field test teacher had students pair up and share their K-W, then she chose two responses from each pair to post on the class list on the board in order for the rest of the class to see and hear what others were thinking.

Accept student answers, which may include: it is the <u>relatively new field of science</u> that deals with <u>very small particles</u> or the <u>different properties</u> that common chemicals have at the nanoscale level or <u>possible future uses</u>.

Pilot students said, “small, tiny, really small, too small to see.” They only mentioned examples from the video.</td></tr>
<tr><td>Slide 2
“Fact Sheet 1 – Common SI Prefixes” Student Handbook-TV: page 4

Student Handbook: page: 4</td><td>3) Have students refer to “Fact Sheet 1 – Common SI Prefixes” found in the Student Handbook on page 4.

Nanoscience starts with the same prefix as nanometer.
1. What is a nanometer? How large is a nanometer?
one billionth of a meter or 10^{-9} meter</td></tr>
</table>

Slide 3	4) *Ask students the following questions and record the answers on the board. Explain that in this activity, they will have some new experiences in classifying and ordering very small objects to better understand the size of objects at the nanoscale.* • **Name some objects that are smaller than a penny.** *Student responses will vary.* • **Identify which of those objects would be considered microscopic (unable to be seen with the unaided eye).** *Student responses will vary.*
Slide 4 "Problem Sheet 1–On the Nanoscale" Student Handbook-TV: Page 7 Student Handbook: Page 4, 5	**This size line shows a wide range of some familiar objects on an exponential nanoscale <u>with 1 meter shown at the far right.</u> If a nanometer is 10^{-9} meter then one meter is one billion (10^{9}) nanometers.** 5) *Refer to copies of "Problem Sheet 1–On the Nanoscale" found in the Student Handbook on page 5. Explain that in this activity, students will have some new experiences in classifying and ordering very small objects to better understand the size of objects in the nanoscale. Begin by having students review metric prefixes and define a nanometer by thinking about objects that can be divided into equal parts.* **"You are going on a journey into a new world through the use of imagery and artists' animation. As you begin this journey, it will be important to understand some metric prefixes in order to navigate into this world. On the bottom of Student Handbook page 4, common objects are ranked from largest (one centimeter) to smallest (one nanometer). Compare the size of each object by reading the labels for each image."** 6) *Click on the red "play" button to activate hyperlink to* NanoScale Me *interactive.*
NanoScale Me **Interactive** **"Activity 1** – What are Your Ideas about Small Sizes?" Student Handbook TV: Page 9 Student Handbook:	7) *Refer to "Activity 1–What are Your Ideas about Small Sizes?" In the* NanoScale Me *interactive, students will be conducting five image sorts using an online interactive. The progression of the sort is increasingly smaller.* 8) *Model the use of the* NanoScale Me *interactive by providing a demonstration of the "Sort Meters" activity. Emphasize the importance of determining an operational definition for size. In this case we are consistently measuring the width or diameter of each object. (Access the activity through the navigation bar located at the bottom of the interactive screen.) Do this in conjunction with the Student Handbook page 7 for the meter sort. Ask students to write their prediction in their handbook (left column) before they sort with the interactive. Then, in the right column, they should record the actual order. There should be little disagreement on the objects order because students are familiar with this range.* **"In the interactive, click on "Sort Meters." Move your cursor over the objects in order to determine their names. Note that the objects are not depicted in the same scale. In your handbook, page 7, first record your predicted order largest to smallest based on the width of the object. Then see how well you did by completing the image sort in the interactive and recording the actual size orders.** **At the bottom of each screen is an instrument commonly used to study the objects at each range. Also the**

Pages 6–8	**dominant force that acts on each object is listed. Simply record the instrument in your handbook. We will be studying instrumentation in more detail in future lessons.”** *9) Working in small groups, have the students proceed to “Sort Millimeter.” Have them write their prediction in their handbook (left column) before they sort with the interactive and then record the actual order on the right column.* *Repeat this process for the remaining ranges to sort.* *10) When students have completed each range sort, have them compare the widths of each object at the same scale by using the “Exploring Scale” page. Then, complete the “Sort All.”* **“When you have completed all of the image sorts for each range, select the “Exploring Scale” link and view the images from largest to smallest this time you can compare the relative size of each object.”** *11) Once students have completed “Exploring Scale,” ask them a question similar to the following:* **“How did this interactive change the way you compare objects at different scales?”** (*Students may comment that they did not know there were so many degrees of objects that were so small.)* *12) Use the “Sort All” tool to assess student understanding of the landmark images of the various ranges.* **“After you have viewed ‘Exploring Scale,’ complete the interactive ‘Sort All.’”**
Optional Handbook Page –TV Page: 10	*Optional*: The Power of Ten *Web sites can be used to help students understand the meaning of powers of ten. This optional activity allows students to elaborate on their exploration of nanoscale using Web resources.* *http://www.nanoreisen.de/* *http://micro.magnet.fsu.edu/primer/java/scienceopticsu/powersof10/index.html* *http://microcosm.web.cern.ch/microcosm/p10/english/welcome.html*
Slide 5	*13) The “Making Connections” questions at the conclusion of each lesson can be used at the end of the class period or the beginning of the next day as a warm up. Generally the first few questions are a review of the present lesson, while the last question is a preview of future lessons.* *Answer for question one: nanoparticles are larger than subatomic particles, but smaller than cells.*
Slide 6	*14) The pilot-test teachers highly recommend using this flow chart at the end and/or beginning of each lesson. The end of each lesson contains this flow chart that provides an opportunity to show students the “big picture” and where they are in the lesson sequence.*