Chemical Wonders, L1, Activity 1:The Nano-Scale

Subject Area(s) Physical Science, Science and Technology

Associated Unit Introduction to Engineering

Associated Lesson Chemical Wonders

Activity Title The Nano-Scale

Header Insert image 1 here, right justified to wrap

Image 1
ADA Description: Students working independently on Google Earth
Caption: none
Imagefilename: Students_GoogleEarth_Image1.jpg

Grade Level 4 (3-5)

Time Required 20 minutes

Summary

Working individually in this activity the students will investigate objects at the nanometer level. First the students will conceptualize scaling, drawing analogies from monetary and distance platforms. Next, the students will be introduced to the prefix "nano" and how it relates to distance. They will then use a multimedia interface to reinforce the concept of scaling and visual objects on a nanometer scale. Finally, as homework the students will be asked to investigate currently developed nano-scale machines; discuss potential applications for these devices, limitations and potential design problems which may occur at this scale.

Engineering Connection

It could be argued that the next great bastion of engineering will be in nanotechnology. This type of technology will require a true multidisciplinary approach; requiring expertise in a variety disciplines from physics, chemistry, biology and engineering. It will be of fundamental importance for future engineers in this field to be able to scale their ideas from a macroscopic level to a microscopic level and finally to the submicroscopic scale of nanometers.

Engineering Category

(1) Relates science concept to engineering

Keywords

Nanotechnology, scale, measuring, distance

Educational Standards

- New York science (1996): 2.1, 4.3, 6.1, 6.3, 7.1

Learning Objectives

After this activity, students should be able to:

- Understand the concept of nanoscale
- Convert between different SI units
- Develop the ability to imagine nanoscale devices
- Utilize Google Earth software

Materials List

Each group needs:

- Nanometer ruler
- Centimeter ruler
- Lengths of string
- Computer work station
- Google Earth (Free Download)
- Internet access

Introduction / Motivation

Developing materials and devices on a nanoscale will be an important field of engineering in the coming years. Currently, there are many universities which have developed (or are developing) new curricula and majors whose sole focus is on this new technology. The term 'nano' is misused in a social context to describe a variety of current technologies, leading to a popular culture which has an incorrect notion of this technology. The goal of this activity is to engage the students in conceptual thinking which will help familiarize them with the concept of a nanoscale.

In January of 2000, the National Nanotechnology Initiative (NNI) was announced, marking the emergence of nanoscale science and engineering as federally important technology. Nanotechnology can be defined as the ability to study, manipulate or create devices at the atomic and molecular levels (on a scale of ~1-100 nm). One of the major goals of this technology is describe how individual molecules assemble into objects along several hierarchical scales and disassemble into their individual molecules. The molecular interactions on this scale are considered weak interactions, such as van der Waal forces, hydrogen bonds, electrostatic interactions, fluidics and various surface forces. Before tackling these larger concepts, it is fundamental for the students to be able understand the principles of scaling.

Nanotechnology is often described as a 'new' technology but there is evidence that this technology has been used as early as the 4th Century A.D. In the 1950's Archeologists discovered the Lycurgus cup, a goblet which dates to Ancient Rome. This goblet shifts colors when it is

illuminated from either the inside or the outside, it has been found that the different shifts in colors in a result of nano-particles of gold and silver suspended in the glass.

Header: Insert image 2 here, left justified to wrap

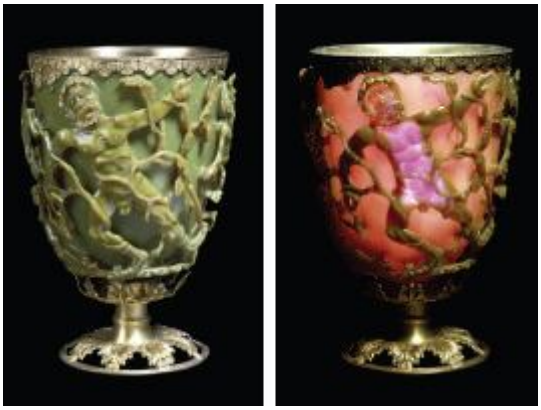


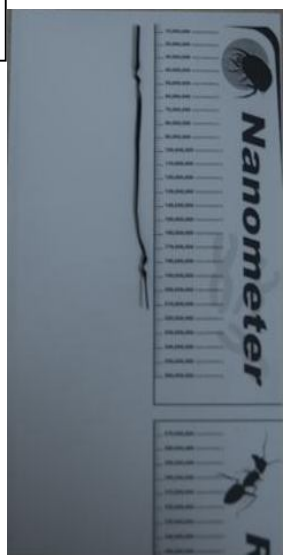
Image 2
ADA Description: Lycurgus cup, dates back to 4th Century A.D.
Caption: Lycurgus cup; illuminated from the inside the cup present a green color (left) and when the light source is presented form the outside the cup presents a red color (right)
Image file name: Lycurgus_Cup_Image_2.jpg
Source/Rights: Copyrights, Trustee of the British Museum

It is unlikely that the Ancient Romans intentionally 'doped' their glass matrices with gold and silver nano-particles but it is interesting to note that the influence of this technology existed long before it was defined as a technology.

Vocabulary / Definitions

Word	Definition
Centimeter	One hundredth of a meter
Kilometer	1000 meters
Meter	The basic unit of length International System of Units (SI)
Nanometer	One billionth of a meter

Image 3
ADA Description: Measuring a small wire with a nanometer ruler
Caption: Measuring a small wire with a nanometer ruler
Image file name: Nanometer ruler_Image3.jpg
Source/Rights: Copyright 2009 Peter James Baker. Used with permission.



Procedure

Before the Activity

- Ask the students leading questions related to scaling and familiar monetary units. For instance, ask the students if they were going to purchase a computer would they use change or dollar bills.
- Engage the students with questions relating to measuring distances using S.I units of meters. For instance, ask them what scale units would they measure the height of the school or the length of their thumb.
- **With the Students**

1. Ask the student why scientists use the SI system of measurement?
2. Identify what a nanometer is and what it is used to measure.

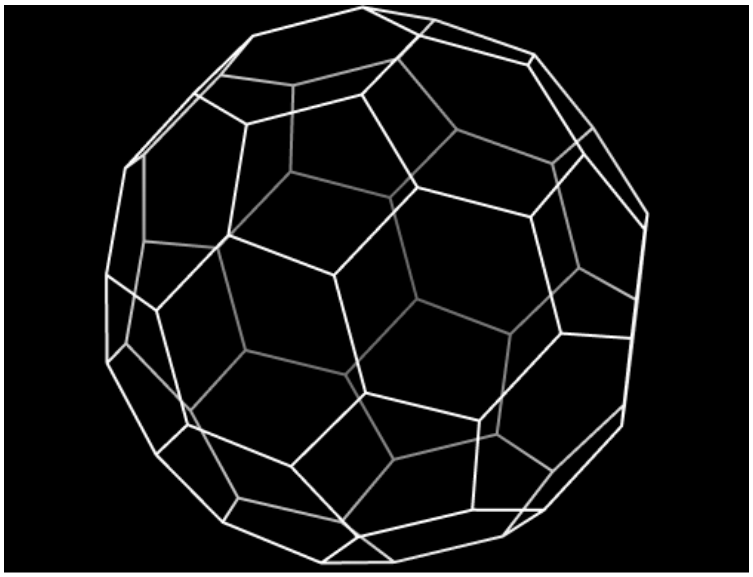


Image 4
ADA Description: 3-D structure of a nanoscale buckyball
Caption: 3-D structure of a nanoscale buckyball
Image file name: Buckyball_Image4.jpg
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3. Distribute centimeter ruler, nanometer ruler, and length of string.
4. Have the students measure the length of string using both rulers.
5. Have the students write their results in tabulated form on the blackboard.
6. Identify the relationship between the familiar scale of centimeters and that of nanometers using scientific notation.
7. Have the students open Google Earth software.
8. Using the zoom function on the tool bar have the students zoom in and out of Earth. Make sure the particular attention to the scale bar in the right hand corner. This will assist the students in understanding that as you zoom in objects become closer and as you zoom out objects become farther away.
9. In the search box enter "Empire State Building", have the students zoom in and out of the building. Engage the students in a conversation, that this zooming allows scientists to use microscopy to see nano-sized objects.
10. Have the students navigate to the following website: http://www.wired.com/science/discoveries/multimedia/2008/02/nano_gallery_jmm?slide=9&slideView=10.
11. The students will peruse the different nano-images and the teacher will describe the significance of each image and how it relates to potential nanotechnology applications.

Attachments

Nanoruler.pdf

Troubleshooting Tips

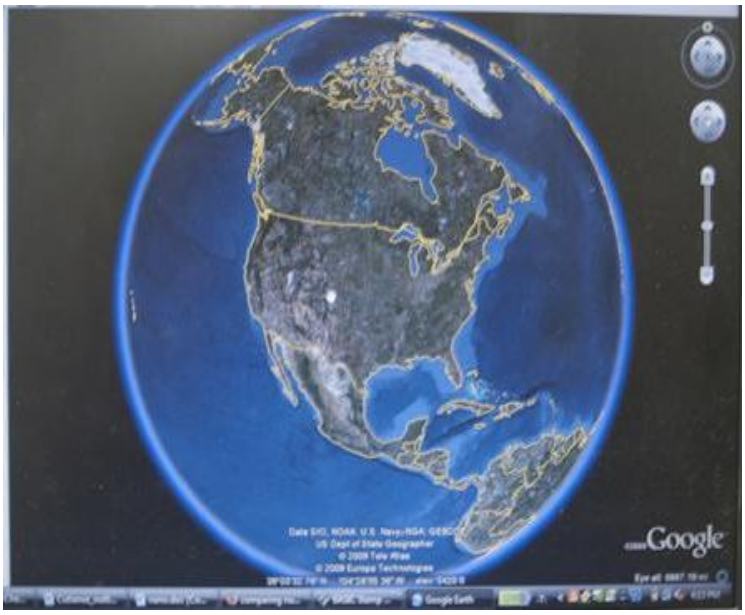
Make sure that Google Earth is installed on all computers beforehand. It is also helpful to have the websites bookmarked to save time.

For the first time teaching this lesson, it is useful to do a dry-run as manipulating the controls on Google Earth will be unfamiliar to first-time users.

Assessment

Post-Activity Assessment
Title: The Nano Future:

Ask the students to spend the week to imagine a nanotechnology device. They will need to draw a picture of what the device will look like, write a few sentence of what kind of tasks the device will perform and how it will be constructed. It is important to reinforce that the only limitation in developing this device is their imagination.



Redirect URL
http://gk12.poly.edu/amps/

Owner
Peter James Baker

Contributors
Peter James Baker

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 The development of this activity was supported by Project AMPS under a GK-12 Fellows grant 0741714 from the National Science Foundation.

Image 5
ADA Description: Google Earth
Caption: Google Earth
Image file name: GoogleEarth_Image5.jpg
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