

Essential Question: What is nanotechnology and at what size is the technology applicable?

Standards

NGSS Science Standards Gr. 5

5-PS1-1. Develop a model to describe that matter is made of particles too small to be seen.

Mathematics

Geometric Measurement: understand concepts of volume and relate volume to multiplication and to addition.

3. Recognize volume as an attribute of solid figures and understand concepts of volume measurement.

Materials

- Powers of 10 card game set: Cards with recognizable objects of varying size will include the size as a power of 10 (in meters).

Overview

The purpose of this lesson is to introduce nanotechnology and tie it to the concept of scaling, or the size relationship between different things. The main topic of the lesson will be how small nanoparticles are compared to everything else we see and experience. This is the first lesson in a series of introductory nanotechnology lessons that puts things into perspective in terms of scaling.

Major Concepts

- A nanometer is one billionth of a meter.
- Objects can be described as being some quantity multiplied by the size of another object. This is scale, or how objects relate to each other in length, width, height, or volume.
- The logarithmic scale
- Things function differently at such small sizes.
- Atoms are on the scale of nanometers and are in everything we see around us.

Objectives

Students will:

- Demonstrate understanding of a nanometer
- Demonstrate an understanding of just how small things on the nanoscale are and that they cannot be seen using the naked eye
- Make the connection between atoms, cells, and nanometers

Lesson Preparation

Preparation

- **Print Nano cards for teams of 4**
- **Student Sheet**

Activity 1: Preparation for the Class

Explanation of what a nanometer is.

A nanometer is 1×10^{-9} meters, or .000000001 meters.

Some comparisons:

A sheet of paper is about 100,000 nanometers thick, or .0001 meters.

A strand of human DNA is 2.5 nanometers in diameter (40,000 times smaller than the thickness of a piece of paper)

There are 25,400,000 nanometers in one inch

A human hair is approximately 80,000- 100,000 nanometers wide

A single gold atom is about 0.33 nanometers in diameter (about 5 times larger than a carbon atom)

On a comparative scale, if the diameter of a marble was one nanometer, then diameter of the Earth would be about one meter

One nanometer is about as long as your fingernail grows in one second

Define “nanotechnology” and introduce the concept of scale:

Nanotechnology is use of particles on the scale of 1 to 100 nanometers to create a desired function. It uses particles on this scale to create larger structures with the desired functionality.

Define Standards:

Things on the nanoscale are too small to be seen.

Nanoparticles are 3D things that have volume. Nanoparticles can also be combined into essentially 2D planes.

Activity 2: Powers of 10 Game

Teams of students (about 4 per team) should be given the set of cards.

They will put them in order from smallest to largest based on their own knowledge of scaling.

They will then use the worksheet to write down what they think the value (either in length, diameter, or height as specified) is of the object.

The cards will range from a nanoparticles (or atom) to something seemingly infinitely large like the universe.

Students will then turn the cards over and observe the actual size of the object in terms of meters as a power of ten.

This will demonstrate to them the size relationship between objects and that things can be unimaginably large or small.

The teacher should then create a log scale line that encompasses all of the objects.

The line should start at -11 and go to +26 with evenly spaced intervals at every integer.

These numbers signify 10^x and the size value of each object will fit somewhere in between each of these intervals.

Have the students come up to the board and write down where each object would be placed on the log scale.

This will show them that things that are vastly different in size can be expressed using a scale that is more practical to comprehend and display.

Activity 3: Wrap Up

Students will be given a post-lesson worksheet with the following questions:

- What is a “nanometer”?
- How we can observe nanotechnology?
- How big is an atom?
- What is nanotechnology?
- Put a list of things in order from smallest to largest (objects from the powers of 10 card game)

Resources:

1. United States Nanotechnology Initiative. “What’s So Special about the Nanoscale?” Nano.gov. 3/9/2015. <http://www.nano.gov/nanotech-101/special>
2. Nanoscale Science Education. “Scale and Scaling.” North Carolina State University. 3/9/2015. <http://www.ncsu.edu/project/scienceEd/scale.html>
3. Scaleofuniverse.com