

What is a Nanometer?

Background:

Classical mechanics describes the motion and energy of objects large enough for us to see, even if we see them with magnifying lenses. Quantum mechanics describes the properties of objects at the atomic and molecular level. Substances often exhibit different physical properties at the atomic/molecular level than they do when in groups element composed of billions of atoms bonded together. Nanotechnology bridges the transition between the classical and quantum worlds of matter. Objects that can be classified as having something to do with nanotechnology are larger than atoms but much smaller than can be perceived directly with our senses. (Kulinowski). To best understand the various fields involving nanotechnology, a solid “feel” for the relative size and scale of nano-sized objects is helpful.

Purpose:

The purpose of this activity is to familiarize students with the actual and relative sizes of nanoscale objects with respect to objects they commonly see. Students will make analogies of relative sizes of common objects on the nano and micro scale level.

Materials:

*A computer with internet access (helpful but optional)
Reference books in microbiology, biology, zoology, and chemistry
Reference chart with the ten common metric prefixes for powers of ten

Procedure:

- *1. Visit the website <http://www.vendian.org/envelope> and click on the “Scaling the Universe to Your Desktop” option.
2. Complete each of the charts on the data page that make analogies to the relative sizes of common objects. For example, if bacteria (actual size $\approx 1 \times 10^{-6}$ m) were the size of a beach ball (about 1m), an analogy to a DNA molecule (actual size $\approx 1 \times 10^{-9}$ m) might be a brass BB (about 1ml). Include the actual sizes of the objects named.
- *3. On the website, scroll down below the horizontal “ 10^x meters” scale and click on “Nanometers in your hands.” Complete the chart on the data page. Express your answers in terms of common objects.
- *4. Return to “Scaling the universe to your desktop” page and click on “micrometers in your hands.” Complete the chart on the data page. Express your answers in terms of common objects.
- *5. Return to “Scaling the universe to your desktop” page and click on “millimeters in your hands.” Complete the chart on the data page. Express your answers in terms of common objects.

*These steps can be used if internet access is available

Name _____

Section _____

Date _____

Data Page

Table I
Nanometers in Your Hands

1. If bacteria were the size of a beach ball 1 m across, what would represent the size of each of these?

Actual size of a beach ball _____

	actual size in m	analogous object	actual size in m
DNA	$1 \times 10^{-9} \text{m}$	brass BB	$1 \times 10^{-3} \text{m}$
Virus			
Atom			
Cell Membrane			
Width of a human hair			

Table II
Micrometers in Your Hands

2. If your hair were as thick as a softball, what analogous object would be the size of each of these?

Actual size of a softball _____

	actual size in m	analogous object	actual size in m
Red Blood Cell			
Tip of a Hypodermic			
Atom			
A Honey Bee's Knees			
Ribosome			

Table III

Millimeters in Your Hands

3. If your hand is its true size, give an example of two common things that are approximately the size of the quantity given:

	object	actual height (m)	object	actual height (m)
1 micrometer				
1 millimeter				
1 centimeter				
1 decimeter				
1 meter				

Questions:

1. Approximately how many sugar grains would fit in a box that measures 10 mm^3 ?

2. Approximately how many sugar grains would fit in a box that measures $10 \text{ }\mu\text{m}^3$?

3. Approximately how many average-sized bacteria can fit in line across one of your fingertips ($1 \times 10^{-2} \text{ m}$)?

4. Approximately how many atoms can you line up across the widest part of a pin head that measures 1mm in diameter?

Insight: _____

