

Teacher's Preparatory Guide

What's in YOUR Neighborhood?

Overview: This activity gives students a sense of size and scale using their classroom and their neighborhood as a frame of reference. The activity focuses on measuring length, for this is the most common feature when presenting nanoscale structures or nanoscale science. Understanding size and scale is fundamental to learning about nanotechnology as size defines the nanoscale (1-100nm in one dimension). Size is often divided into scales – macro, micro, nano and atomic. Helping students understand these “worlds” is an important part of their science knowledge and will help them to understand the relatively small size of the nanoscale. It can be introduced into K–12 curriculum by discussing scientific measurement.

Purpose: This activity is designed to help students understand the size and scale of objects using their classroom as a frame of reference.

Time Required: 15 minutes

Level: Elementary, middle school, and high school; general science, life science, mathematics

Big Idea: Size and Scale

Teacher Background: Students often have trouble understanding size and scale in science, due to the different measurement units taught (metric and English), the different types of units used for length and volume, and the lack of consistent practice through their educational career. These lessons are aimed at presenting size and scale to students from kindergarten to high school.

Common student misconceptions₁ include:

- mixing units such as centimeters and inches
- not realizing the connection between relative and absolute sizes of two objects
- the inability to use measurement tools accurately
- believing that objects that cannot be seen with the naked eye are approximately the same size

This lesson introduces scales larger than 1 meter by factors of ten. This facilitates the introduction and reinforcement of the metric scale and paves the way to the discussion of lengths and distances that are greater than 1 meter and enhances understanding of powers of ten. Using a map of the neighborhood around your school gives the students context in the discussion of measurement. Try to bring actual street names and notable landmarks when discussing or sharing answers in class. This will give the students a concrete example of metric distances.

Source:

1. Stevens, S., Sutherland, L., Krajcik, J., *The Big Ideas of Nanoscale Science and Engineering*. NSTA Press, 2009.

Materials per class:

- a meter stick
- pictures of your school from Google maps, 1 per student (see *Advance Preparation*)
- prepared teacher copy of the picture of your school from Google maps (see *Advance Preparation*)
- class set of compasses

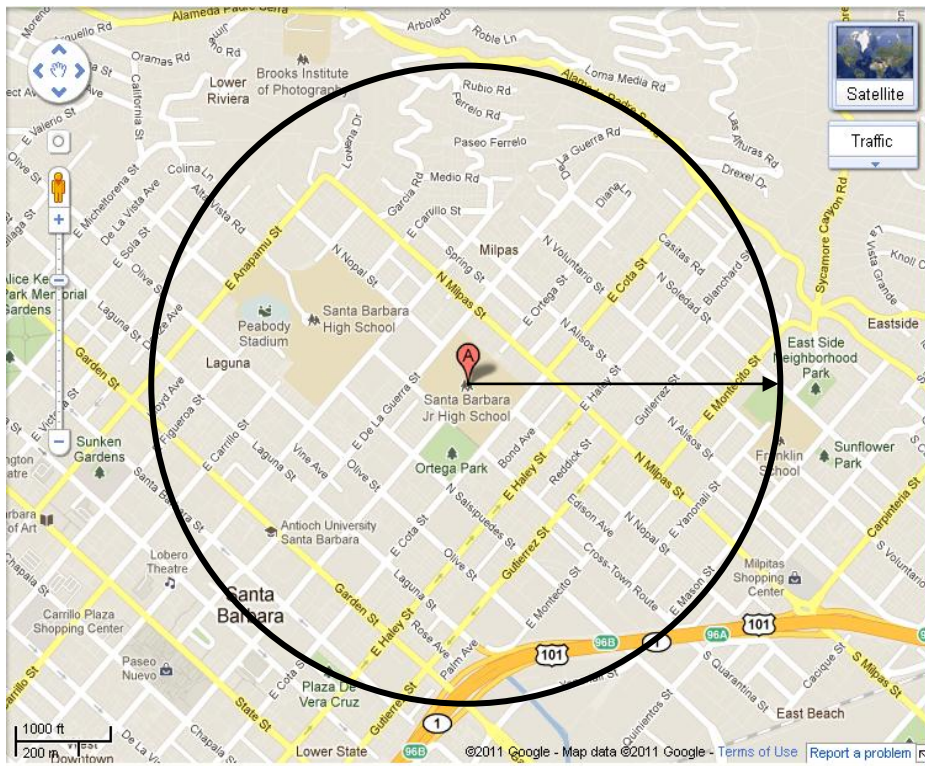
Advance Preparation: Use Google maps to create an image of your school and its surrounding neighborhood that shows at least a 1 km radius around it. Use a drawing program to draw a 1,000 meter radius circle on it to serve as a teacher copy (for K–3 also draw a 100 meter radius circle). Print a class set of circle-less maps without the scale bars for the students.

1. ***Create maps from Google.*****For both Mac & PC:**

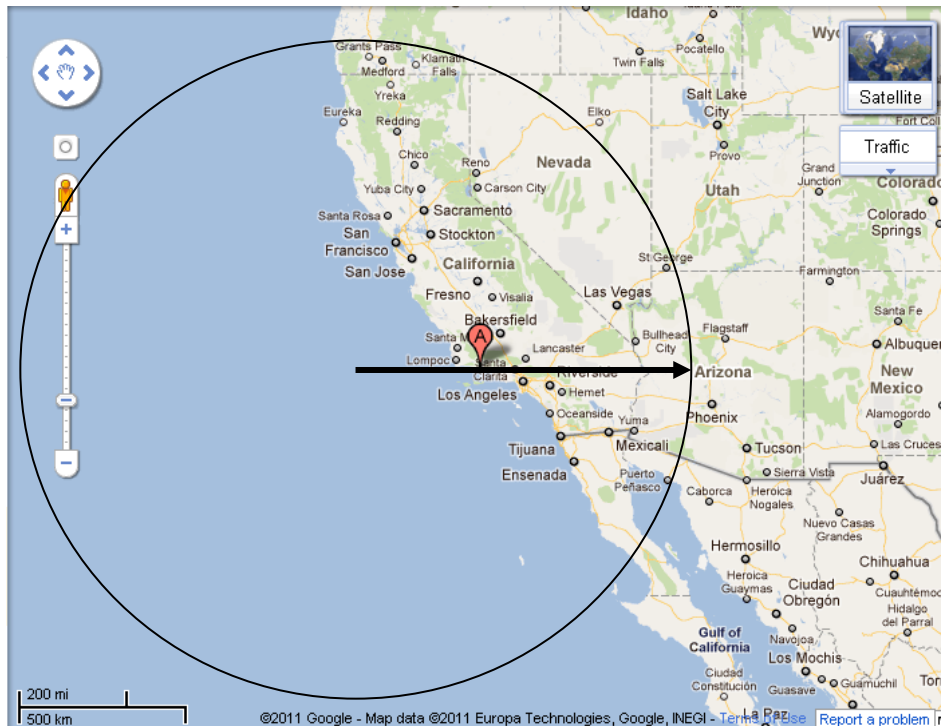
- Go to Google Maps: <http://maps.google.com>
- Search for your school site by name or address.
- Zoom in or out so that the scale bar at the bottom left reads 200 m for a 1,000 m radius circle, or 500 m for a 1,000,000 m radius circle.
- Press Print Screen for PC (for Mac, hold down Apple key ⌘ + Shift + 3 and release all)

Here's where it get's a little different across platforms:

PC	Mac
<ol style="list-style-type: none"> 1. Open <u>P</u>aint Program. 2. Open the print screen map image. 3. On the toolbar, go to <u>E</u>dit, then <u>S</u>elect <u>A</u>ll, then <u>C</u>opy. 4. Put your cursor into the new document. 5. On the toolbar, go to <u>E</u>dit, then <u>P</u>aste. 6. Using the <u>S</u>elect function, select the map only and <u>C</u>ut the map. 7. <u>P</u>aste the map into a word document. 8. Draw an arrow of the appropriate radius length using the scale as a guide. 9. Draw a circle with the radius of the arrow. 	<ol style="list-style-type: none"> 1. Download and Open Paintbrush: http://paintbrush-mac.en.softonic.com/mac 2. Open the print screen map image. 3. On the toolbar, go to <u>E</u>dit, then <u>S</u>elect <u>A</u>ll, then <u>C</u>opy. 4. Put your cursor into the new document. 5. On the toolbar, go to <u>E</u>dit, then <u>P</u>aste. 6. Draw an arrow of the appropriate radius length using the scale as a guide. 7. Draw a circle with the radius of the arrow.



Example of a Google map with a 1,000 m radius drawn around the school.



Example of a Google map with a 1,000,000 meter radius around the school.

Teaching Strategies When having students guess how large a 10 m or 1,000 m circle is, have them first measure how many steps are in 1 m. Then, have students guess how far that many steps is for 10m and 1,000m.

Kindergarten–Grade 2	Grades 3–12
<ol style="list-style-type: none"> 1. Use a meter stick to show a 1-meter radius circle around you. Name names of who falls within your 1 m circle. You may draw the circle on the ground with chalk, to illustrate. 2. Ask students to predict how far a 10-meter radius circle would reach. Together, look beyond the classroom and use specific landmarks around the school in your discussions. Then with the students, walk out a 10-meter radius. 3. Give each student a map of the school neighborhood. Ask them to draw a 100-meter radius from your classroom. 4. Repeat step 3, but this time have them draw a 1,000-meter radius from your classroom. 5. Show the teacher’s version of the map and have the students mark the correct answer on their maps. 	<ol style="list-style-type: none"> 1. Use a meter stick to show a 1-meter radius circle around you. Name names of who falls within your 1 m circle. 2. Give each student a map of the school neighborhood. Have them draw a 1,000-meter radius circle on their maps. 3. Have the students share their results with another student, then share as a class. 4. Show the teacher’s map. Have students share how close or far their predictions were and explain why perhaps their predictions were not very close.

Extension for Grade 3–12:

- Show a Google map of the city showing a 1,000 km radius circle. Then, show a larger map that increases the radius by 1,000 times more. This last circle would have a radius that is 1 billion times larger than the one in the classroom. At this scale, if the billion-meter radius circle were equivalent to a meter then their 1-meter radius circle would be a nanometer (or about the width of a DNA strand).
- **Note:** the circumference of the Earth is about 40,000 km. Thus, we could not even fit a 1 billion-meter radius circle on Earth. If we use the Earth itself as the center of the circle, the billion-meter radius circle would reach 2.6 times farther than the moon! The Moon orbits at 384,400 km away from the earth. Using the Earth now as the center of the circle, have the students predict how far away the Moon is orbiting in meters.

Assessment: For reinforcement, have students identify locations within a km of the school.

Going Further: As an extension to the activity, you could present a map of a different area in the world with a scale bar and ask students to draw a 1,000,000-meter radius around a location to identify cities or landmarks within that area.

Another idea would be to have students find and present their most ideal 1,000,000-meter radius circle in the world in the form of a map with a drawn circle and scale bar and write a paragraph to justify their choice. For instance, a 1,000,000-meter radius circle with the center as Paris, France would encircle many neighboring countries!

National Science Education Standards (Grades K–4, 5–8, 9–12)

Content Standard B: Physical Science

- Properties of objects and materials (Grades K–4)
- Properties and changes of properties in matter (Grades 5–8)
- Structure and properties of matter (Grades 9–12)

Content Standard E: Science and Technology

- Understandings about science and technology

Principles and Standards for School Mathematics

Measurement

- Understand measurable attributes of objects and the units, systems, and processes of measurement
- Apply appropriate techniques, tools, and formulas to determine measurements

Numbers and Operation

- Understand numbers, ways of representing numbers, relationships among numbers, and number systems
- Compute fluently and make reasonable estimates