Grades 7-8

Science- The Universe, Using Models
Math- Scientific Notation, Scales
The Battle for the Ultimate Power

NTTI 2002 Master Teacher
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Overview
Using video and/or Internet components, students will gain an understanding of how the powers of 10 and scientific notation can be used to represent the scale of things in the universe.

Time Allottment
Four to six 45 minute class periods: 1day for the Introductory Activity, 2-3 days for the Learning Activities, and 1-2 days for the Culminating Activity

Learning Objectives
Students will be able to:

- Write large and small numbers using scientific notation.
- Relate the number of stars in the universe to the number of grains of sand on Earth's beaches.
- Create a model to demonstrate the relative sizes of well-known objects.
- Create a scale model of the solar system and universe.

Standards
National Mathematics Standards:
(Source**:** Principals and Standards for School Mathematics, **http://www.standards.nctm.org/document/index.htm**)

Instructional programs from pre-kindergarten through grade 12 should enable all students to

- Understand numbers**,** ways of representing numbers, relationships among numbers, and number systems
- Develop an understanding of large numbers and recognize and appropriately use exponential, scientific, and calculator notation

State Standards*:*
Mathematics
(Source: Massachusetts Math Frameworks, http://www.doe.mass.edu/frameworks/math00/num7.html)

Number Sense and Operations for Grades 7-8:
8.N.4 Represent numbers in scientific notation, and use them in calculations and problem situations

Science
(Source: Massachusetts Science, Technology/Engineering Curriculum Framework, May 2001, http://www.doe.mass.edu/frameworks/scitech01/0501final.doc)

Earth Science Grades 6-8: The Earth in the Solar System
12. Recognize that the universe contains many billions of galaxies, and that each galaxy contains many billions of stars.

Media Components
Video: IMAX *Cosmic Voyage* (alternate: *Powers of Ten*)- both videos are available at https://www.mailordercentral.com/aspsky/ by using the "Search" button and typing in "Powers of Ten"

Video: *The Best of Cosmos*

Web site: Molecular Expressions: Science, Optics and You- Powers of 10:Interactive Java Tutorial
URL= http://micro.magnet.fsu.edu/primer/java/scienceopticsu/powersof10/index.html
Description= This site allows the viewer to view an online version of the video "Powers of Ten"

This site uses Java Applets. Your browser must have Java enabled.

Materials:
Per student:
1 copy of the worksheet "Powers of Ten"
1 copy of the worksheet "Sand Vs Stars"
1 pair of tweezers
1 piece (9" X 12" of black construction paper)
1 magnifying glass (optional)

Per group of 3-4 students:
1 10 ml graduated cylinder
A beaker of sand (about ½ full)
1 sheet of poster board or large sheet of newsprint
Markers, crayons or colored pencils

Per class:
1 large clear glass of plastic container (such as a 5 gallon fish tank)
Enough fine grain sand to fill the large container
1 copy of the sheet "More Power to You"

Prep For Teachers
Make copies (1 per student) of the worksheets "Powers of Ten" and "Sand Vs Stars."

Make copies (1 per class) of the sheet entitled "More Power to You." Cut each sheet into sections for each class.

Cue the video *Cosmic Voyage* to the scene when the ferry is pulling into the harbor and the narrator is saying, "Our own voyage begins here in the center of Galileo's Venice, St. Mark's Square."

Cue the video *The Best of Cosmos* to the scene when Carl Sagan is just about to prick his finger with a pin.

Bookmark the following Web site:
Web site: Molecular Expressions: Science, Optics and You-Powers of 10:Interactive Java Tutorial
URL=
http://micro.magnet.fsu.edu/primer/java/scienceopticsu/powersof10/index.html

Enable Java on your browser on a PC by clicking on the "Tools" menu at the top of your browser window and selecting "Internet Options (or Preferences, depending on your browser)." Make sure that the box for enabling Java is selected. For assistance, you can also check with your building's technical support person.

Determine the volume of the large clear container and then fill it with the fine grain sand. Place it in a location that is visible to all of the students in the class.

Introductory Activity: Setting the Stage
This lesson is designed to follow a lesson on the powers of 10 and scientific notation. If necessary, review the following concepts: Powers of ten, scientific notation, and multiplication using scientific notation. It might also be helpful to review metric prefixes and converting form one prefix to another (i.e. kilometers to meters, meters to centimeters).

Give each student a copy of the worksheet "The Powers of Ten." The **Focus for Media Interaction** is to have students listen for and record on their worksheets the examples of the powers of ten as they are mentioned in the video. **Play** the video from the cue (the scene where the ferry is pulling into the harbor) and **pause** the video after each specific example of the power of 10 (the acrobats' ring, the crowd, St. Mark's Square, the city center, the islands of Venice, the Adriatic Sea and the mainland of Northern Italy, Europe, the Earth, the Moon, the entire solar system, the sun as a star, edge of the Milky Way, entire Milky Way). On their worksheets, students should record the image that is represented, the power of 10, and the value of the power. It may be helpful if students count out the powers of 10 (represented by the rings) as they appear on the screen, while someone keeps track of them on the board. **Resume play** of the video after students have written down the information for each example.
Stop the video when the outer edge of the universe is reached and the narrator says, "At 23 powers of ten, each shining light we see is not a star, but an entire galaxy, composed of countless stars." If necessary **rewind** the video to the start of the segment to allow students the opportunity to fill in any missing information. **Fast forward** the video to the scene when the child is looking at the drop of water with a magnifying glass.
Remind the students that the **Focus for Media Interaction** is to listen for and record on their worksheets the examples of the powers of ten as they are mentioned in the video.
Play the video and **pause** after each example of a power of 10. Allow students the opportunity to fill in the information on their sheets. Again, it may be helpful if students count out the powers of 10 (represented by the rings) as they appear on the screen, while someone keeps track of them on the board.
Resume play after students have recorded their information and **Stop** the video when the image of quarks appears on the screen. If necessary **rewind the video** to the start of the segment to allow students the opportunity to fill in any missing information.

Note: As an option in place of the video, you can use the Web site "Molecular Expressions: Science, Optics and You-Powers of 10:Interactive Java Tutorial" URL=
http://micro.magnet.fsu.edu/primer/java/scienceopticsu/powersof10/index.html
Once the java applet loads, students should **click** on the button labeled "Manual," which is located just below the image. They can then **click** on the arrows to increase or decrease the magnitude of the image. For the Web site, the **Focus for Media Interaction** is to record on their worksheets the examples of the powers of ten as they are shown on the screen in the animation.

Learning Activities

1. Write the following statement on the board "The number of stars in the universe is greater than the number of grains of sand on all of the beaches on Earth". Survey the students to find out how may of them agree or disagree with the statement and record the number on the board.

2. Give each student a copy of the worksheet "Sand Vs. Stars." Point out the large container of sand and ask each student to predict/estimate how many grains of sand are in the container. Have the students record their predictions on their worksheets in the space labeled "Predicted Grains of Sand."

3. Form the students into groups of 3 or 4. Give each student a pair of tweezers, a black piece of construction paper, and a magnifier (optional). Give each group a beaker of sand and a 10 ml graduated cylinder.

4. Each group should measure out exactly 1 ml of sand. Students should then divide the sand up and, on the black construction paper, use the tweezers to count the individual grains. On the worksheet, in the space labeled "Grains of Sand in 1 ml," students should record the total number of grains of sand in their group.

5. Tell the class the volume of the large container and ask them to calculate the total number of grains of sand in the container.

6. Have the students complete the calculations, using scientific notation (and no more than 2 significant figures) to determine the number of grains of sand on the Earth's beaches and the number of stars in the universe. Students may work in groups to complete the calculations, but each student should show their own work on their own worksheet.

7. Allow time for the discussion of the students' results.

Culminating Activity

1. **Play the video** *The Best of Cosmos* from the cue (the scene when Carl Sagan is just about to prick his finger with a pin).

2. **Pause the video** when Carl Sagan says, "There are as many atoms in a single strand of DNA as there are stars in a single galaxy." Write the statement on the board and allow time for discussion. If time allows, and depending on the ability of your students, determine how many atoms there are in a single human cell or how many "galaxies worth" there are.

3. **Resume** the video and **pause** the video when Carl Sagan says, "…within us is a little universe." Allow time for the discussion of this statement.

4. **Resume** the video and **stop** the video when Carl Sagan licks the blood from his finger.

5. Form students into groups of 3 or 4. Give each group one section of the sheet "More Power to You," a piece of poster board (or a sheet of newsprint), and markers, crayons or colored pencils.

6. Students should make a poster that shows the relative numbers or sizes of each of the items on the list. The poster should show the values of each item written in scientific notation. For each successive item, they should illustrate all of the preceding items (level one: the size of a pollen grain, level two: the size of a pollen grain compared to the size of a flower petal, level three: the size of a pollen grain compared to the size of a petal compared to the size of a flower, level four: the size of a pollen grain compared to the size of a petal compared to the size of a flower, compared to the size of a field of flowers).

Cross-Curricular Connections

Math: Have students re-calculate the number of grains of sand on the Earth, including the sands of deserts and the ocean floor.

Science: Have students calculate the number of body cells for all of the students in the class.

Social Studies: Students can create a timeline of the history of the world, writing time in scientific notation.

Language Arts and Art: Students can write and illustrate a book that explains the powers of 10.

Community Connections

Students can make a scale model for the size of the universe (or atoms) relative to the size of their town or the schoolyard. If possible, they can post signs along a roadway (similar to the Burma Shave ads) to indicate the scale.

Student Materials

Worksheet: "Powers of Ten"
Worksheet: "Sand Vs. Stars"

Additional Resources:

*Powers of Ten: A Flipbook***,** based on the film by Charles and Ray Eames, W.H. Freeman Company, September 1998, ISBN: 0716734419 (available from https://www.mailordercentral.com/aspsky/ by using the "Search" button and typing in "Powers of Ten")

Powers of Ten: About the Relative Size of Things in the Universe, by Philip and Phylis Morrison, W.H. Freeman Company, September 1994, ISBN: 0716760088

Imagining the Universe: A Visual Journey, by Edward Packard, Berkley Publishing Group, November 1994, ISBN: 0399521240

Little Numbers: And Pictures That Show Just How Little They Are, by Edward Packard and Salvatore Murdocca (illustrator), Millbrook Press, September 2001, ISBN: 0761313974

Big Numbers: And Pictures That Show Just How Big They Are, by Edward Packard and Salvatore Murdocca (illustrator), Millbrook Press, March 2000, ISBN: 0761315705

The Sizesaurus: From Hectares to Decibels to Calories, a Witty Compendium of Measurements, Stephen Strauss, Kodansha America, Inc., September 1995, ISBN: 1568361106