

Scale Model Solar System (Grades 2-4)

Teacher's Guide

In this exercise (based on the Colorado Model Solar System), students will create their own scale model solar systems from common materials for the purpose of exploring concepts of size and distance in the solar system. The activity is broken into 2 sections; each can take approximately 45 minutes to complete depending on the amount of guidance provided by the teacher. Time includes short introductions and follow-ups. Children should work in small groups for part one, and the entire. The Scale Model Solar System is in line with and matched to [National Science](#) and [Math Education Standards](#) for grades K-8.

Please note: This scale model solar system has been updated to include a version without Pluto, which as of August 24, 2006 was officially classified as a dwarf planet rather than a planet.

Purpose: To introduce students to each of the nine (or eight) planets, and concepts of relative size and distance in the solar system.

Supplies for Part 1:

- Index cards or pre-made planet cards [with](#) or [without](#) Pluto (1 set of 8 or 9 cards per student)
- Containers for objects (at least one per small group of students)
- Markers or crayons (for index cards)
- Transparent tape
- Metric rulers
- A copy of the size table, [with](#) or [without](#) Pluto, for each student
- A large grapefruit or approx. 5" yellow ball for the Sun
- Objects for the planets. Suggestions:
 - poppy seeds or other tiny dark seeds (Mercury, Mars, *Pluto*)
 - small round candy sprinkles (Venus, Earth)
 - white peppercorns or unpopped popcorn (Uranus, Neptune) note: can be dyed blue
 - Marbles (Jupiter, Saturn), colored marbles from the floral accents section of a craft store work well.
- Models of real objects students are familiar with: doll and toy car on different scales, doll and toy car on the same scale.
- [Large planet cards](#) and [Sun card](#) (optional)

At Least One Day Before: If you choose to dye the popcorn, put the unpopped kernels into a zip-top plastic bag and pour in enough blue liquid water color such as Colorations liquid water color (food coloring does not work as well) to cover the kernels completely. Let the water color sit in the bag for at least one hour. Pour off the extra liquid. Next,

remove the kernels from the bag and place on a thick paper plate (or a few thin plates stacked together to protect your workspace). Pat the kernels dry, and gently shake them around on the plate to prevent sticking. Let the corn kernels dry over night.

Before Class:

If you will be using pre-made planet cards, print out enough planet cards for every student and the teacher to each have a complete set. A color printer using card stock or heavy paper is recommended. Cut and sort the cards into sets. Presort the marbles and candy sprinkles by color, if desired, to match the color of the planets. (Presorted candy sprinkles can be purchased at many stores.) Good color choices would be yellow candy sprinkles for Venus, blue candy sprinkles for the Earth, Jupiter and yellow or orange marbles for Saturn).

Supplies for Part 2:

- One completed set of planet cards
- Masking tape
- Meter stick(s)
- An open area or straight hallway at least 80 meters (87 yards) long. This is a bit less than the length of a football field.
- One copy of the distance table, [with](#) or [without](#) Pluto, for the teacher
- A set of cones, one for each planet included on your walk, on which to attach planet cards. (optional)

Introduce the Concept of a Model and Scale

Ask the children if they know what a model is. If they say yes have them elaborate. Toys used as props help tremendously in making sure the entire class understands the concept of a model. A doll and a small toy car make especially good visuals for a discussion of models.

Introducing Models and Scale



Models with Different Scales



Models with the Same Scale

Discuss how both are models for real things (let the children tell you what they are models of.) Then ask if the doll will fit in the car like a real baby would fit in a real car. Explain that even though both are models, they have different scales. Next show the children another doll and car, this time on the same scale. Explain that because both are models on with the same scale, the doll and toy car fit together the way a real person and car would fit.

Another good way to talk about scale factors with your students is to discuss maps. On a map, a centimeter may equal a kilometer. (Children this age may understand English units more clearly than metric for this analogy. The teacher should use whatever units will make the concept clear to the students.) In this scale model, instead of one centimeter equaling a kilometer, for example, every centimeter in the model equals 10 billion centimeters in the real solar system. Similarly, 1 meter in this scale model equals 10 billion meters. Students in this age group are unlikely to understand what 10 billion really is, and may be unfamiliar with the term "billion". For very young students it may help to ask them if 10 billion is bigger than ten, a hundred, a thousand, or a million.

Scaled Sizes (Part 1):

Key concepts:

- All planets are much smaller than the Sun.
- The Earth is a relatively small planet.

Instructions:

1. Ask the students to name the planets, when they do so write each name on the board. If you aren't using pre-made planet cards, ask the students to write the name of one of the nine planets on each index cards. (The Sun doesn't require an index card.) You may also want to have the students write down facts about each planet on that planet's index card (leaving space for the object that will represent the planet).
2. Provide a selection of objects for each small group students to choose from to represent the planets. If you have fewer than eight or nine types of objects available (plus the object for the model Sun), mention to your students that they can use the same type of object for more than one planet. For younger children providing separate containers for different types of objects is helpful.
3. Using the scaled diameters of the Sun and planets given in the size table, guide each group select objects that are the closest to the same size as the scaled size for each planet and the Sun. For 7 to 9 year olds, do one planet at a time having each group suggest an object for each planet with you as the teacher guiding the class as a whole

to the appropriate object. The Earth (a blue candy sprinkle) is a good one for you to use to guide the class through their first choice. You may also need to introduce the term **diameter**.

4. Have the students attach the object selected for each planet to the appropriate planet card after selecting the object.

Transparent tape placed **over** the object works well to attach an object to the index card.

5. Moving on to Mercury, allow a couple of minutes per planet for groups to work together to pick objects for each of the other planets. Repeat for each of the remaining seven planets.

Note: Make sure that the students understand that the objects need to be close to, but not exactly, the correct size to minimize frustration. If students have difficulty selecting the objects to use, have students line up their planet cards in order from the smallest to the largest to aid in object selection.

6. Compare the objects you and the class have selected for the Sun and the planets to the object selected for the Earth.

This can be used as a follow-up to the scaled sizes portion of the activity.

7. Have students put their planet cards in number order to prepare for part 2 of this activity.

Scaled Distances (Part 2):

Key concepts:

- The solar system is mainly empty space.
- The scale of the solar system is immense.
- The small inner planets (Mercury, Venus, Earth, and Mars) are much closer to the Sun than the outer planets.

Consider in Advance:

Before you begin making scale model solar system, find a location that is at least 80 m long where the students can walk a relatively straight line from their model Sun. (You will need an area about $\frac{1}{4}$ of a mile long if you want to walk as far as Neptune, and more if you want to walk as far as Pluto, both of which will probably require a field trip to a park or other location.) Extra adult supervision may be necessary if you will go past Jupiter.

Instructions:

Rather than use a measuring tape, the model will use steps as the measuring tool. It's fine that the model won't be exact. Although the typical stride length for a young child is closer to a meter, an enthusiastic child's step can be closer to a meter long, similar to that of an adult. You may double the number of steps between each planet given in the distance table if you choose to estimate using $\frac{1}{2}$ meter steps. (If the students have been introduced to the concepts of nonstandard units and/or estimation and approximation, then using steps instead of a more accurate measuring tool can be discussed as you do the activity.)

1. Bring one set of planet cards, the grapefruit, and the distance table to the area where you will make the scale model solar system.
2. Discuss the scale of the model. Just as the grapefruit is 10 billion times smaller than the real Sun, each step taken in the model will be like taking 10 billion steps in the real solar system. (The scale factor is the same for size and distance.)
3. Put down the grapefruit or ball representing the Sun at one end of the area where you are making your scale model. (You can also use the scale sun printout attached to an object. The important point is that the model sun be visible as you make your scale model in distance.)
4. Tell the students that in the model, the first planet from the Sun, Mercury, is 12 steps away from the Sun. Ask the students to count along as the entire class walks the 12 steps.
5. Tape the Mercury card to a cone (or, if necessary, place it on the ground.)
6. Repeat for steps 4 & 5 for the planets Venus, Earth, Mars.
7. Pause at Mars and have the students look back at the "Sun" and planet cards. Tell them that the first four planets are sometimes called the inner planets because they are

close to the Sun. The other planets, including Jupiter, are much farther from the Sun and are sometimes called the outer planets.

8. Repeat steps 4&5 with Jupiter.

9. If you have sufficient space, time and help, and if the students have a sufficient attention span, continue out to Neptune (450 m or about 1/4 mile from the model Sun) or Pluto (591 meters or about 1/3 mile from the model Sun). If not, talk about how far you have walked, and how much farther the class would have to walk to add the other planets the model solar system. Using landmarks rather than numbers may be a better way to talk about relatively large distances with young children. (For example, “If we were to put all of the planets in our model, we would have to go outside the gate and past the park down the street.”)

Collect your planet cards and model Sun so that they may be used in the follow-up. Be sure to ask the children to calmly walk with you back to their classroom!

Things to think about (follow-up):

Discuss some or all of the following with your students.

- Which planet is larger, the Earth or Jupiter? It may help to show the students the relevant the planet cards when asking this question).
- Which planets are smaller than the Earth?
- Which planets are bigger than the Earth?
- Which planet is about the same size as the Earth?
- Are any planets bigger than the Sun?
- If you put the Moon in this model, it would be only about 4 centimeters (38 millimeters) away from the scale model Earth (and 1/4 the diameter of the scale model Earth).

The Moon is about 30 Earth diameters from the Earth.

Light takes about 8 minutes to travel from the Sun to the Earth. Light only takes about 1.2 seconds to travel the distance between the Earth and the Moon.

Stars can be confusing to children at this age, and terms such as falling stars can complicate matters. If your students ask about stars here are some ways to talk

about them. Otherwise, you may want to avoid the topic to prevent introducing confusion.

Falling Stars:

Falling stars can't be real stars, because all stars, like our own star the Sun, are too big to fall to Earth. Real stars only look small because they are very, very far away. If a student asks about stars falling to Earth, show hold the grapefruit up to the class, and remind them that it is a model of the Sun, and the Sun is a star. Next, hold up a candy sprinkle and remind the class that that is our model of the Earth *on the same scale*. Next, hit the candy sprinkle with the star. Ask the class if they think that is what really happens.

So what are falling stars, really? Falling stars are usually tiny bits of dust falling through our atmosphere (or the air, to keep it simple), that we see as light as they burn up. Because they look like tiny points of light, long ago people gave them the name falling stars.

How far away are the other stars?

If you wanted to put the nearest star to the Sun (Alpha Centauri) on your scale model solar system you would need to walk **4,000,000 meters** or **4,000,000 steps!** You would have to walk across the entire United States.

The Apollo spacecraft took about 3 days to get to the Moon. At that speed, it would take them about a **million years** to get to the nearest star from our own star, the Sun.

You may want to ask your students why scientists have sent spacecraft to every planet in our solar system, but not to another star.

Asteroids, and the Asteroid Belt

The Scale Model Solar System activity doesn't include asteroids or the asteroid belt. However, you may wish to discuss them with your students.

The asteroid belt should, of course, be located between Mars and Jupiter. A common misconception is that the asteroid belt is densely packed with rocky debris. In fact, on this scale you would need to grind up a fraction of a poppy seed to represent the material in the asteroid belt, and distribute it in a ring between about 30 and 50 meters from the Sun. Not all asteroids are in the asteroid belt, but a large fraction of them are, and the other asteroids are spread even more thinly. Astronomers have found thousands of objects, but most are very tiny compared to a planet. They can be as large as hundreds of kilometers across, but most are tens of kilometers across or smaller. Even the largest are barely

visible on the scale of this Scale Model Solar System. (In fact, the largest asteroid, Ceres, is 930 km in diameter, and is now considered to be a dwarf planet, along with Pluto.) Added together, the asteroids in the asteroid belt have less material (mass) than any of the planets or the Moon.

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Based on the *Colorado Model Solar System* at the University of Colorado at Boulder