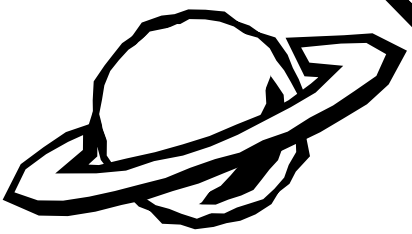
CLASSROOM ACTIVITY



The Solar System in Your Neighbourhood

General Information

- ★ Level: All cycles of elementary; secondary 1 to 5.
- ★ Students per group: Three to four.
- ★ Duration: Two 50-minute periods.
- ★ Where: In class and around the school neighbourhood.
- ★ When: After visiting the Planetarium.
- ★ Type of activity: Excursion led by the teacher.
- ★ Key words: Solar system — Sun — planets — model — scale factor.
- ★ Skills developed: Making models, working in scale, measuring, classifying.

Starting Point

What would a scale model showing the diameters of the nine planets and the distances between them look like if the Sun were the size of a basketball?

Preconceptions

Most people believe the planets are about the same size and fairly close together. Students will think their classroom is big enough to build a model of the solar system in which the diameter of the planets and the distances separating them are shown to scale.

Basic Concepts

Can you imagine how big the solar system really is? Many people think they can, but their conception of the solar system is usually far off the mark. Photomontages and illustrations showing the planets close together give us a distorted view of reality.

In truth, the solar system is so vast that it's hard to imagine. The planets are infinitesimally small, whereas the distances separating them are almost absurdly large. To accurately depict the scale of planets and the distances separating them, we need to create a very large model. That's why we must leave the classroom behind and head outside.

By using everyday objects (pinheads, dried peas, peppercorns and a basketball), students create a model illustrating to scale the diameters of the planets and the distances between them. This tour of the solar system is based on the approximate length of a journey between the planets.

Note: The real distances used here aren't very precise since the length of a teacher's or a student's footstep can vary. What's most important in this exercise is the overall impression participants are left with.

Goals

Students learn to:

- Make a scale model that emphasizes the diameters of the planets in the solar system as well as their distances from the Sun.
- Measure diameters and distances to scale.

This activity is both a hands-on exercise and a guided excursion. It gives students a strong mental image of the dimensions of the solar system and its contents. What stands out is the sheer size of the space that the solar system takes up. This vast space enables you to depict both the size of the planets and their distances from the Sun. You can adapt this excursion to all grades by modifying the information you present.

Steps in the Activity

Preparation

Gather (or have students gather) the objects listed in Table 1. It might seem simpler to use stones of different sizes, but the advantage of using objects like nuts, dried peas and pinheads is that students will recall their sizes more easily. Don't worry if the pea isn't fully round or doesn't measure exactly 0.8 cm in diameter.

A basketball is about 23 cm in diameter, the perfect size for illustrating our massive Sun. It's a good idea to stick the pins through pieces of cardboard so their heads are more visible. If you wish, you can also affix the other "planets" to labelled cards.

Before starting, pick out an area where you can safely walk for 1 km. It doesn't matter if the path isn't completely straight or if you can't see the end from your starting point. You might even choose a path that loops back on itself. The important thing is simply to teach students the relative dimensions of our solar system.

Supplies

Table 1 lists the objects needed for the activity. Tell each team to bring one of the objects listed. Have them bring several different sizes of their object so they can choose the right size based on the other objects in the model.

TABLE 1
Supplies Needed

	Diameter to scale	Suggestions
Sun	23 cm	Basketball
Mercury	0.08 cm	Pinhead
Venus	0.2 cm	Peppercorn
Earth	0.2 cm	Peppercorn
Mars	0.1 cm	Pinhead
Jupiter	2.3 cm	Chestnut or walnut
Saturn	1.8 cm	Hazelnut or acorn
Uranus	0.8 cm	Dried pea or coffee bean
Neptune	0.8 cm	Dried pea or coffee bean
Pluto	0.03 cm	Pinhead*

** Smaller than Mercury since Pluto is the smallest planet.*

You should also collect a few examples of scale models to show students (toy car, doll, globe). If some students are model makers, have them bring a few models to class to help you discuss the concept of scale factor.

Assignment

First Period (in Class)

❶ Begin by asking students whether they know what a scale model is. Show a few examples: toy car, globe, roadmap, map of the world, glue-together model. Point out that these scale models are faithful reproductions of a real object whose dimensions have all been reduced by the same factor (called scale factor). Tell them you'll be doing the same thing: you'll reduce the diameters and relative distances of the planets by the same scale factor.

❷ Spread the objects out in a row on a classroom table. Have students name the nine planets in order (starting with the planet nearest the Sun). If need be, teach them the mnemonic My Very Excellent Mother Just Served Us Nine Pizzas. The first letter of each word is also the first letter of each planet. You might even have students invent their own mnemonic beforehand in a written exercise.

❸ The first discovery is the contrast between the huge Sun and the tiny planets. (This contrast becomes much clearer when students see the objects rather than simply read the diameter measurements.) Compare the second peppercorn (our supposedly enormous Earth) with the basketball (our truly gigantic Sun).

❹ After presenting the objects to be used in the model, ask, "How much space will we need to make our model?"

Children might believe the tabletop or a section of it will suffice. They might even suggest simply spacing the objects out a bit. Adults might suggest placing the objects around the room or perhaps down a hallway.

To obtain the answer, you must introduce the notion of scale. The peppercorn represents our planet, Earth. The Earth has a diameter of 12,756 km. The peppercorn representing Earth is about 0.2 cm in diameter. The Sun has a diameter of 1,392,000 km. The ball representing it is 23 cm in diameter. Thus, 1 cm in the model really represents about 60,000 km. This is the scale factor, which we can write as 60,000 km/cm or 6,000,000 km/m or as 1:6,000,000,000.

This means that 1 m represents 6 billion m or 6 million km. Hence, a stride of 1 m across the floor represents a huge journey through space of 6 million km!

What's the distance between the Earth and Sun? 150,000,000 km. In our model, this distance is 25 m. This figure might not mean much till you ask a student to place her back against the classroom wall and to stride forward 25 giant steps. She'll probably reach the opposite wall within 12 to 15 steps. That's why you and your class must head outdoors.

While you explain the notion of model making, it might be useful (depending on your students' ages) to write the data below on the blackboard.

TABLE 2
Scale Factor

	Real	Model
Diameter of the Earth	12,756 km	0.21 cm
Diameter of the Sun	1,390,000 km	23 cm
Distance Sun-Earth	150,000,000 km	25 m

❺ Give the Sun and planets to students, ensuring they all know the names of the objects represented so that they'll place these objects in the right spot when you ask. Next, take your students outside to where you've chosen to begin your journey through the solar system.

Second Period (Outside)

❶ Place the ball representing the Sun in the chosen spot and continue your trek as described below (Table 3 lists the number of steps required between each planet).

- **10 steps:** Have the student carrying Mercury place his pin and cardboard on the ground. Weigh down the cardboard with a stone if needed.
- **8 steps farther:** The Venus peppercorn is placed on the ground.
- **7 steps farther:** The Earth.

After the first few planets, ask a volunteer to become your "human measuring tape" by counting the steps.

- **Another 13 steps:** Mars.

Now the distances start getting larger.

- **Another 92 steps to Jupiter:** This "giant planet" is only walnut size and over a block away from its closest neighbour in space.

Now, the distances start to grow incredibly.

- **Another 108 steps:** Saturn.
- **Another 241 steps:** Uranus
- **Another 271 steps:** Neptune.
- **Another 235 steps:** Pluto.

You've walked just under 1 km.
(The total distance in the model is 985 steps.)

TABLE 3

Number of Steps

Planet	Distance to the next planet	Distance from sun
Mercury	10 steps *(from the Sun)*	10 steps
Venus	8 steps	18 steps
Earth	7 steps	25 steps
Mars	13 steps	38 steps
Jupiter	92 steps	130 steps
Saturn	108 steps	238 steps
Uranus	241 steps	479 steps
Neptune	271 steps	750 steps
Pluto	235 steps	985 steps

❷ If you've walked a straight line, look back now at the basketball representing the Sun (can you still see it?) and then look down at the pinhead representing Pluto. You can now grasp the awe-inspiring distances in our solar system.

Wrap-up

On the way back, retrace your steps and review the distances you've travelled. By counting their steps back, students have another chance to appreciate distances in solar system. As they see the objects left along the trail, they can better grasp just how tiny the planets are in space.

This strategy works well. Students pay careful attention, particularly when they count the final steps toward a planet and wonder whether they'll find it again. But this strategy won't work if you can't locate the objects. That's why affixing the objects to cardboard or placing large rocks or pennants near them might be helpful.

You might find that some of the "edible" planets have disappeared for some reason. And someone, or even the wind, may move the ball representing the Sun. Consider these risks the equivalent of cosmic threats like supernovae or black holes!

The child who finds each card can write a short message on it indicating where it was found ("on the corner of X and Y streets" or "in front of the Z convenience store"). Once you're back in class, line up the objects on a shelf as a souvenir of your excursion. You might also use string to hang them from the ceiling.