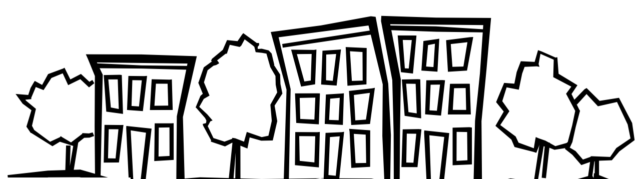
CLASSROOM ACTIVITY

The Solar System in Your Neighbourhood

General Information

- ★ Level: All cycles
- ★ Students per group: Three to four
- ★ When: Before the Planetarium visits your school
- ★ Duration: One or two 50-minute periods
- ★ Where: In class and around the school neighbourhood
- ★ Type of activity: Excursion led by the teacher
- ★ Subjects covered: **Preschool, Elementary and Secondary**: Science and technology — Mathematics — Visual Arts — Physical Education and Health
- ★ Essential knowledges:
  - > **Preschool**: Motor and physchomotor strategies; cognitive and metacognitive strategies; learnings related to sensory and motor development (gross motor movements), to social development (cooperative actions) and to cognitive development (mathematics, science and technology, concepts related to space)
  - > **Elementary**: **Science and technology**: solar system; terminology related to an understanding of the material world, of living things, of the Earth and the universe; conventions and types of representations specific to the concepts studied (symbols, tables, norms and standardization) — **Mathematics**: arithmetics: meaning of operations involving numbers (natural numbers, decimals and integers); geometry: geometric figures and spatial sense (space); measurement (lengths: estimating and measuring); statistics; cultural references; symbols; vocabulary — **Visual Arts**: transforming gestures and their extension; the tools; language of visual arts; visual arts production — **Physical Education and Health**: principles of communication; roles; regular physical activity; fitness; motor skills (locomotor skills)



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- ★ Compulsory Concepts
  - > **Secondary cycle one**: Science and technology: Scale of the Universe (location of the Earth in the Universe); characteristics of the solar system; properties of matter; using scales; exploration, instrumentation, analytical and communication strategies — **Mathematics**: Arithmetic: understanding real numbers, understanding operations involving real numbers, operations involving real numbers; statistics: one-variable distributions; geometry: length; analytic geometry: locating; introduction to matrices — **Visual Arts**: Transforming gestures, materials and tools; visual arts productions; visual arts and multimedia language (elements and space); uses of transforming gestures and elements of visual arts language — **Physical Education and Health**: Technical aspects of movement related to activities; locomotor skills; principles of communication; roles; action rules in cooperative activities; safe participation in physical activity; fair play; help and mutual assistance; acceptance of differences; sense of responsibility
  - > **Secondary cycle two**: **Science and technology**: Scale of the Universe (location of the Earth in the Universe); characteristics of the solar system; properties of matter; using scales; scales; standards and representations; exploration, instrumentation, analytical and communication strategies — **Mathematics**: Arithmetic: understanding real numbers, understanding operations involving real numbers, operations involving real numbers; statistics: one-variable distributions; geometry (analyzing situations involving measurements of length); analytic geometry: locating; introduction to matrices — **Visual Arts**: Transforming gestures, materials and tools; visual arts productions; visual arts and multimedia language (elements and space); uses of transforming gestures and elements of visual arts language — **Physical Education and Health**: Technical aspects of movement related to activities; locomotor skills; principles of communication; roles; action rules in cooperative activities; safe participation in physical activity; fair play; help and mutual assistance; acceptance of differences; sense of responsibility
- ★ Subject-specific competencies:
  - > **Preschool**: Perform sensorimotor actions effectively in different contexts; interact harmoniously with others; communicate using the resources of language; construct his/her understanding of the world; complete an activity or project
  - > **Elementary**: **Science and technolog**y: Explore the world of science and technology; propose explanations for or solutions to scientific or technological problems; make the most of scientific and technological tools, objects and procedures; communicate in the languages used in science and technology — **Mathematics**: solve a situational problem related to mathematics; reason using mathematical concepts and processes; communicate by using mathematical language — Visual Arts: produce individual works in the visual arts — **Physical Education and Health**: perform movement skills in different physical activity settings; to interact with others in different physical activity settings; adopt a healthy, active lifestyle

> **Secondary**: **Science and technology**: Seek answers or solutions to scientific or technological problems; make the most of his/her knowledge of science and technology; communicate in the languages used in science and technology — **Mathematics**: Solve a situational problem; use mathematical reasoning; communicate by using mathematical language — **Visual Arts**: create personal images — **Physical Education and Health**: Perform movement skills in different physical activity settings; interact with others in different physical activity settings; adopt a healthy, active lifestyle

★ Cross-curricular competencies:

> **Preschool and elementary**: cooperate with others; use information; exercise critical judgement; use creativity; solve problems; communicate appropriately; adopt effective work methods

> **Secondary**: use information; solve problems; exercise critical judgment; use creativity; adopt effective work methods; use informations and communication technologies; achieve his/her potential; cooperate with others; communicate appropriately

Starting Point

What would a scale model showing the diameters of the planets of the Solar System 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 the 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.

Assignments

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 3/4 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

Planet	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

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.

Steps in the activity

Part one (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 eight planets in order. (Remember that since 2006, Pluto is no longer considered a planet, but rather a dwarf planet.) If need be, teach them the mnemonic : **M**y **V**ery **E**xcellent **M**other **J**ust **S**erved **U**s **N**achos. 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 tomake 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 for The Solar System in Your Neighbourhood

	Real	Model
Diameter of the Earth	12 756 km	0.20 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.

Part two (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). Have the student carrying Mercury **take 10 strides** and place their pin and cardboard on the ground. Weigh down the cardboard with a stone if needed.

- **8 strides farther...** Venus (a peppercorn) is placed on the ground
- **7 strides farther...** the Earth (another peppercorn)
  (After the first few planets, ask a volunteer to become your "human measuring tape" by counting the steps.)
- **Another 13 strides...** Mars (a pinhead)
  (Now the distances start getting larger.)
- **Another 92 strides...** Jupiter (a chestnut or walnut): 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 strides...** Saturn (a hazelnut or acorn)
- **Another 241 strides....** Uranus (a dried Pea or coffee bean)
- **Another 271 strides....** Neptune (another dried Pea or coffee bean)
  (You've walked 3/4 km. The total distance in the model is 750 steps.)

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

TABLE 3
Number of Strides

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

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.