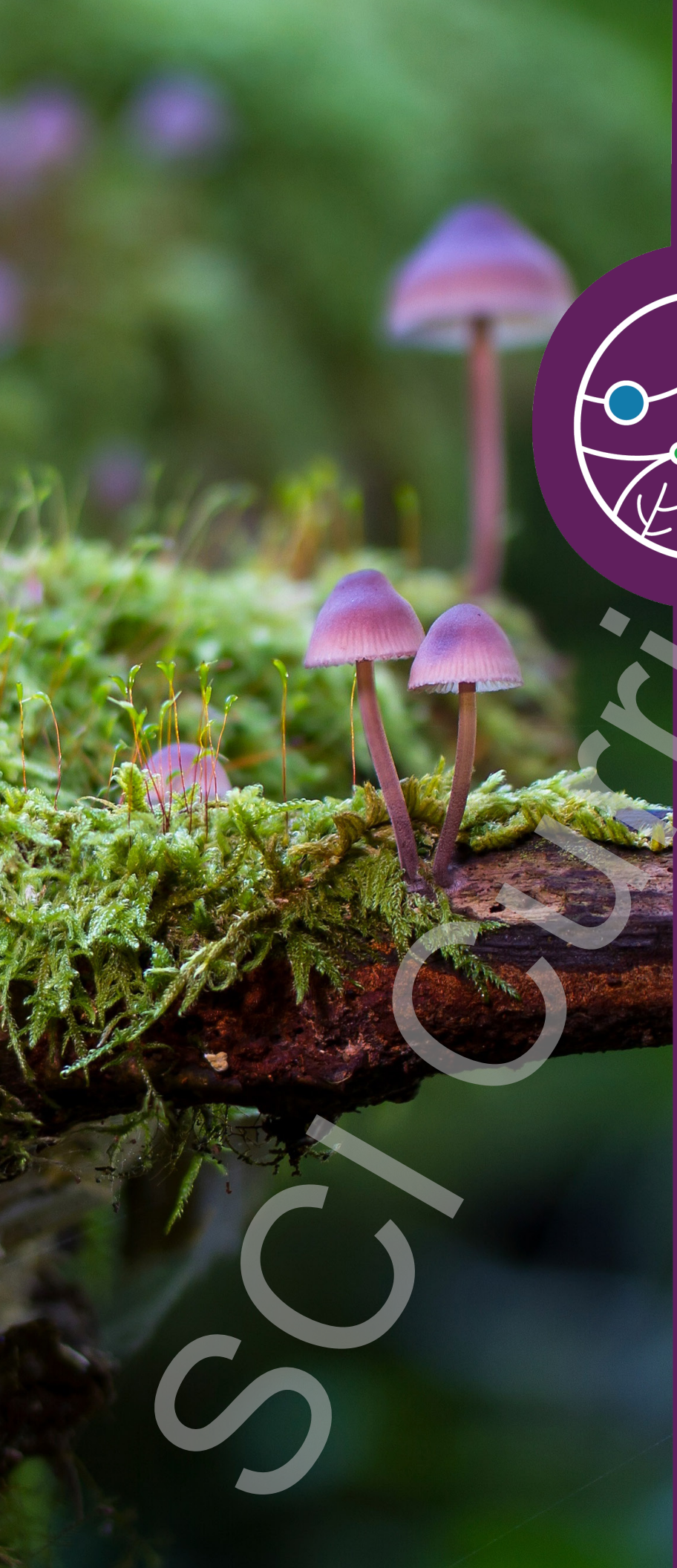


Scientific Connections through Inquiry

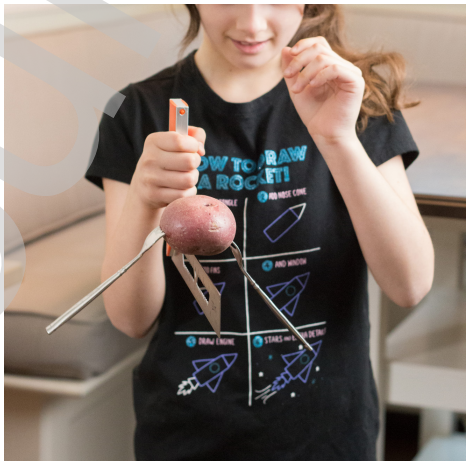
Edition 1

LEVEL 3

Center of Gravity

Balancing a Potato

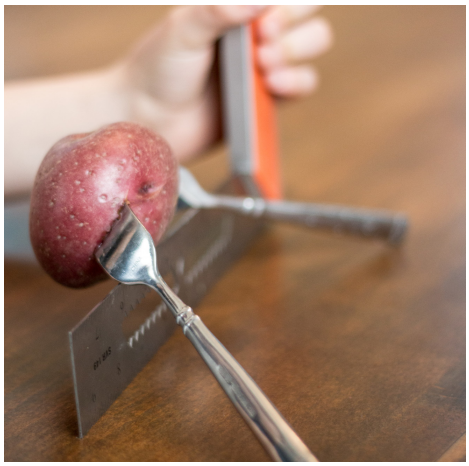
Give your student a straightedge, a small-to-medium-sized potato, and two metal table forks, and present the challenge: Balance the potato on the straightedge using the forks as an aid. The forks may be inserted into the potato, but they may not be bent or used to cut or break the potato in any other way.



ACTIVITY NOTE

If the potato is too large or the forks too light, this may not work. You may want to check ahead to be sure that it does.

The solution they may or may not discover on their own is to insert the two forks into the potato so that they form an upside-down "V" with the potato at the "point". The potato, with the two forks hanging down, will now balance, perhaps rocking back and forth, on the straightedge.



Ask your student to ponder this balancing act and come up with an explanation as to why it works. If a hint is necessary, ask: Where is the center of weight of the potato-fork combination? Lay the potato-fork arrangement flat-wise across the straightedge; the fork handles sticking out of one side, the potato sticking out to the other. Your student will find that the fork-handle side is heavier and tips down, the potato tipping up. Again: Why/how does the potato-fork arrangement balance on a straightedge?

SCIENCE NOTE

You may need to emphasize and clarify the distinction between the center of gravity and the force of gravity itself. Center of gravity refers only to the center of balance or weight distribution for a given solid object (or system that is held together in one way or another).

With Q&A discussion, guide your student's reasoning toward a concise statement such as: the potato-fork arrangement balances on the straightedge because the fork handles are heavier than the potato.

Go on to explain and guide your student in reasoning that there is a location in the potato-fork arrangement (or any other solid object) where it will balance perfectly. That is, the effective weight in all directions from that point would be equal. This point is the object's CENTER OF GRAVITY. The center of gravity of any object will seek the lowest point possible. The center of gravity for the potato-fork arrangement is below the point of support. When the potato starts to tip off the straightedge, the potato-fork arrangement's center of gravity is actually being raised and will seek to go back down! This is how the potato-fork arrangement stays on the straightedge.

Nature's Great Cycle

The Role of Decomposers

As your student gains familiarity with the diversity of fungi, pose questions such as: Why should fungi exist? Are they an essential part of nature? Would the world be just as well off without fungi? Give your student plenty of time to reflect and answer as they will.

DISCUSSION NOTE

"Rot", "decay", and "decompose" are synonyms for the same process.

If necessary, draw your student to picture what a woodland would be like if it were not for fungi feeding on the dead material and causing it to rot away. You may also add and re-emphasize that the final end products of such decomposition (oxidation) are carbon dioxide, water, and mineral nutrients originally absorbed from the soil and air by growing plants. Your student's visualizations of a world without fungi should lead to their picturing natural lands becoming increasingly cluttered and carpeted with dead wood, leaves, and other biological material, including fecal wastes and bodies of dead animals.

Add that there is even more to the picture than this. Challenge your student to decipher what it is. (Think time) If necessary, have them reflect back to the needs of plants: light energy, carbon dioxide, water, and certain mineral nutrients from the soil. Focus on the mineral nutrients. If these nutrients were not released from the dead biological material back to the soil by way of decomposition, would the soil's supply of them not run out? Indeed it would, and the growth of plants would be stunted accordingly.

From here, ask your student if they can visualize a vast system of recycling in nature. Ask them to diagram it on student book page "Nature's Great Cycle". It will be much more meaningful for them to put the pieces together for themselves, so allow them to lead your discussion and only provide a sounding board and hints as needed. They should describe, and then diagram, an ongoing cycle of chemical nutrients drawn from air, soil, and water by plants, manufactured into biological material using light energy, passed to animals of all sorts through their feeding, and finally back to the environment through the feeding and decomposition by fungi.

SCIENCE NOTE

Fungi, themselves, die and likewise decompose.

Don't let your student omit that the whole system depends on light energy from the sun. Without that, the whole system of life on Earth would diminish to nothingness as all biological material was eaten up and oxidized for energy.

Measuring Volume

How to Find Volume

Your student may have learned in math that they can calculate the volume of rectangular shapes by multiplying length times width times height. However, since this requires 3 careful measurements and multiplication, it is laborious at best, and for irregularly shaped objects it is impossible.

A much easier and faster way of determining the volume of small objects is to use the displacement method, which may be taught as follows:

ACTIVITY NOTE

Making the starting level in the graduate 70mL is somewhat arbitrary. It might be any level so long as it is enough to submerge the object fully and not have the water go above the markings. Making it a round number eases measuring and subtraction.

Fill a glass to the brim with water. Ask your student to stick their fingers in. What happens? The water overflows! Your fingers DISPLACE water, causing its level to rise and overflow the edge. Ask: Can we use displacement as a way of measuring volume? (Think Time) Using Q&A discussion, bring your student to recognize that the volume of water displaced is exactly equal to the volume of the object inserted. If you put an object of a certain volume into water, the same volume of water must move out of the way to make room for it.

This means if they measure the volume of water displaced by submerging an object, they will have the volume of the object.

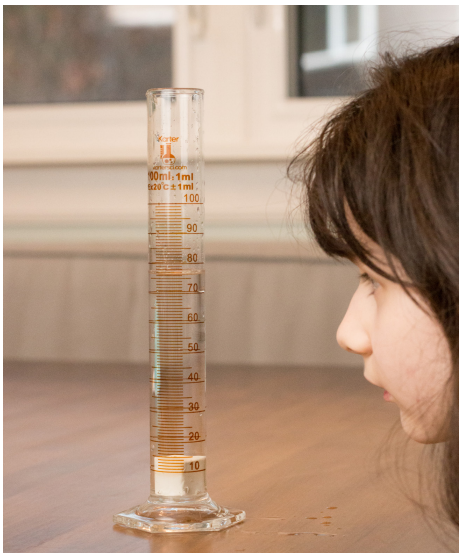
Volume From Displacement

Explore how volume can be easily measured using displacement.

Fill a 100mL graduated cylinder with water to exactly the 70mL mark.

Form a piece of clay into a cube. Measure the cube in centimeters and calculate its volume.

Next, fully submerge the cube in the water being careful to eliminate air bubbles that may cling to it, and read the higher water level. Suppose it is 78mL. From these readings, ask your student to give the volume of the item. They will see that it is a matter of simple subtraction. Since the item displaced (raised the water level by) 8mL, its volume must be 8mL. And since 1 milliliter is the same volume as 1 cubic centimeter, its volume must be 8 cm^3.

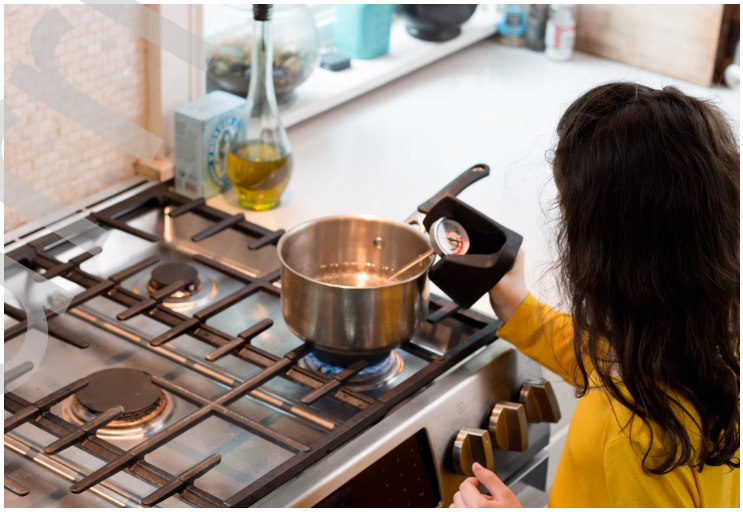


Temperature Lag

Temperature Lag

Your student may note that their experience (and records, if they have their book of recorded observations from a previous level's Seasonal Changes and the Earth's Orbit (D6)) show that the hottest period of summer (from the perspective of the northern hemisphere) occurs during July and August, the two to eight weeks following the Summer Solstice. Similarly, the coldest period of winter occurs during January and February, two to eight weeks following the Winter Solstice. Strictly from the amount of solar radiation received, one should logically expect the high and low temperatures to center around the solstices. Why is this not the case? (Think Time)

Set a pot of water on the stove. Measure the temperature using your thermometer and record it on student book page "Heating Water". Turn on the burner and immediately record the temperature. Record the temperature again at five minutes.



ACTIVITY NOTE

The maximum temperature your water would reach will be its boiling point, approximately 100°C. The minimum temperature it would reach will be room temperature. If desired, you may continue to take measurements until these values are reached, but it may take a significant amount of time and isn't necessary to note the temperature lag.

Ask your student, did the temperature of the water immediately change to its maximum when you turned on the burner? No! It takes time for the water to heat up.

Record the temperature again. Turn off the burner and immediately record the temperature. Record the temperature again at five minutes after turning off the burner.

Ask your student, did the temperature of the water immediately change to its minimum when you turned off the burner? No! It takes time for the water to give off heat and cool.

This is known as a TEMPERATURE LAG effect. The temperature change of the water lags behind the heat from the burner. The same is true for the Earth. Seventy percent of the Earth's surface, a bit more than two-thirds, is covered by water. Like the pot of water on the stove, water on Earth (oceans, lakes, etc.) causes the temperature change to lag behind the intensity of the sun's heating.

Record your observations on student book page "Heating Water".