

Reading the Schoolyard: Evaporation and Transpiration in Sun and Shade

Investigation question: How much faster does water leave an open tray, and a living plant, in full sun than in shade, and what does that tell us about what powers the upward half of the water cycle?

Classroom field investigation

Groups of 4

2 sessions

Setup 10 · Activity 65 · Cleanup 10 min

MS-ESS2-4 · practice

Name _____

Group _____

Date _____

Your role today

- ☐ **Site scout:** Chooses the sunny and shaded spots within the teacher's boundaries, checks that they will stay sunny or shaded for most of the day, records the air temperature at each, and draws the site map.
- ☐ **Tray technician:** Levels and fills both trays, measures the water depth at the center to the nearest millimeter at the start and at the end, and weights the trays so they do not blow away.
- ☐ **Bag technician:** Counts the leaves on each branch, slides on the bags, ties them loosely, hangs a bottom corner down to collect water, and pours the collected water into the measuring syringe or cylinder at the end.
- ☐ **Recorder and timekeeper:** Writes every time, temperature and measurement in the table as it is taken, keeps the group on schedule, and leads the evidence walk notes.

Safety

- Only teacher-approved plants may be used. Never put a bag on, or handle, an unmarked plant: oleander is common in California landscaping and is poisonous, poison oak grows wild at the edges of many school grounds, and plants with milky sap can irritate skin and eyes.
- Bags go over branches only, never over or near anyone's head or face. Keep the bags away from younger students who may be in the yard.
- On hot days wear hats, use sunscreen, carry water and limit time in full sun to the measurements. Watch for bees and wasps around flowering plants; do not swat.
- Stay inside the marked boundaries and within sight of the teacher. No climbing to reach branches.
- Do not eat or drink anything collected, and wash hands after handling plants, soil and bags.
- Be gentle with living plants: loose knots, no broken branches, and remove every bag within 24 hours so leaves do not overheat or rot.

Procedure

1. Session 1, in class (5 minutes). Write your prediction in q1: which tray will lose more water, which bag will collect more, and why, in water cycle terms.
2. Outdoors: the Site scout chooses the sunny spot and the shaded spot and records the air temperature at each. Draw the site map, including the Sun's direction and where the shade falls now.

3. Tray technician places one tray in each spot on level ground, weights it, fills it with the same amount of water (enough for about 10 mm depth), and measures the depth at the center to the nearest millimeter. Recorder writes the depth and the time for each tray.
4. Bag technician picks a leafy branch end in sun and one in shade on the same plant (or on two plants of the same kind), counts and records the leaves inside each bag, slides a dry bag over each branch end, ties the mouth loosely around the stem, and arranges the bag so one bottom corner hangs lowest. Tie the third bag the same way on a leafless twig or a stick in the sun; this is the control.
5. If there is time at the end of the period or after lunch, check the bags without opening them and note any fog or droplets, and glance at the trays. Record the time of the check.
6. Session 2, the next day at about the same time (25 minutes outdoors). Record the weather and the air temperatures again. Measure each tray's depth at the center the same way and record the end time.
7. Open each bag at its lowest corner over the syringe or cylinder, pour out and measure the collected water to the nearest 0.5 mL. Record the mL and whether the leaves look healthy. Remove the string and bags carefully.
8. Evidence walk (10 minutes): walk the allowed area and record at least four signs of water cycle processes, with the process and its driver, in the evidence table (for example damp soil in shade but dry in sun, dew on grass, a shrinking puddle, water stains below a drain spout, moss on a north wall).
9. Back in class: compute depth lost for each tray and divide by the hours to get mm per hour; compute mL per leaf for each bag. Copy your group's results to the class table and answer the analysis questions.

Record your observations

Lab 2 recording sheet: Evaporation and transpiration in sun and shade

Record times, temperatures and measurements as you take them. Depths to the nearest millimeter, volumes to the nearest 0.5 mL. Answer q1 before you go outside.

1. Prediction: which tray will lose more water, and which bag will collect more? Explain both predictions using what you know about evaporation and energy from the Sun.
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Site and weather

	Start (session 1)	Check (optional)	End (session 2)
Date and time			
Air temperature, sunny spot (°C)			
Air temperature, shaded spot (°C)			
Sky (clear / partly cloudy / overcast)			
Wind (calm / breezy / windy)			

-  Site map: sketch the area from above. Mark the two trays, the three bagged branches, the Sun's direction at setup, and shade the parts that were in shadow when you set up.



Evaporation trays

Tray	Start depth (mm)	End depth (mm)	Depth lost (mm)	Hours between measurements	Rate (mm per hour)
Sun					
Shade					

Transpiration bags

Bag	Leaves inside	Fog or drops at the check? (none / some / lots)	Water collected (mL)	mL per leaf	Leaves healthy at the end? (yes/no)
Leafy branch, sun					
Leafy branch, shade					
Leafless control, sun	0				

Evidence walk: signs of the water cycle in the schoolyard

Where	What we saw	Water cycle process	Driver (Sun / gravity / cooling)

2. Describe what you found in the three bags when you collected them. What does the leafless control bag tell you about where the water in the leafy bags came from?

Analysis questions

3. Calculate the evaporation rate for each tray in mm per hour, then calculate how many times faster the sunny tray lost water than the shaded tray (sun rate $\div$ shade rate). Show your work and the units.

4. Trace the water in the sunny leafy bag from the soil to the drops in the bag. Name each step, the change of state where there is one, and what drove it.

5. The water in the trays never came close to boiling, yet it left. Use the particle model to explain how liquid water in the tray became vapor, and why the sunny tray did it faster.

6. Look at the class table. Did every group find the same direction of difference between sun and shade? Give two reasons the sizes of the differences vary from group to group, and say whether those reasons weaken the main conclusion.

7. A large tree can carry tens of thousands of leaves. Use your sunny bag's mL per leaf to estimate how many liters of water a tree with 20,000 leaves might move into the air in the same number of hours (1 L = 1,000 mL). Show your work, then give one reason the real number could be very different.

8. California stores a lot of its water in open reservoirs in the hot Central Valley. Using your tray data, explain what happens to some of that stored water every summer day and why a reservoir in a cool, shaded mountain canyon would lose less. What could a water manager do about it?

9. Choose the best piece of evidence from your evidence walk. Explain which process it shows, what powered that process, and what you would measure to turn your observation into data.
