

The Plant on the Wire: Gaining Mass with No Soil

Learning target: I can observe a plant that grows with no soil, record what I notice and wonder, and write a first explanation of where its new matter and its energy might come from.

Phenomenon exploration About 25 min Individual MS-LS1-6 · supports discussion writing

Standards connections

MS-LS1-6 (supports): Students meet the puzzle the PE answers: a producer gains matter without soil. They record observations and a first explanation; the full evidence-based explanation of photosynthesis comes in later worksheets.

Purpose: activate · **Time:** about 25 minutes · **Format:** individual

Answers with reasoning

The story

Ms. Alvarez keeps an air plant clipped to a wire by her classroom window. Air plants are **epiphytes**: plants that grow on other plants, rocks or wires and never put roots into soil. The plant has a few short gray roots that only hold it in place. Twice a week a student mists it with plain tap water; it gets nothing else. In September Ms. Alvarez bought a second air plant from the same batch and put it in a dark cabinet. It was misted on the same days with the same amount of water. Every 30 days she let both plants dry for a day and then weighed them on a balance that reads to 0.1 g. The numbers below are a teaching dataset, invented to be realistic; they were not measured in a real classroom.

Mass of two air plants over 120 days (teaching dataset)

Simulated teaching dataset: the numbers are invented to be realistic, not measured.

Day	Window plant mass (g)	Cabinet plant mass (g)
0	14.2	14.3
30	14.9	14.1
60	15.7	13.8
90	16.6	13.4
120	17.5	12.9

Simulated data for teaching. Each plant was weighed 24 hours after its last misting so that leftover water droplets did not count.

Same batch, same water, different places

Window plant (day 120)	Cabinet plant (day 120)
Mass 17.5 g (started at 14.2 g)	Mass 12.9 g (started at 14.3 g)
Leaves firm and gray-green	Leaves limp and pale
Two new leaves grew from the center	No new leaves
Roots still short; nothing touches soil	Roots still short; nothing touches soil

What the two plants looked like on day 120. Both received the same water on the same days.

Part A: Notice and wonder

1. List three things you **notice** in the story, the table or the figure. Use only facts that were observed or measured, and include at least one number.

Answer: Any three observations, for example: the window plant went from 14.2 g to 17.5 g; the cabinet plant went from 14.3 g to 12.9 g; neither plant has roots in soil; both were misted with the same amount of tap water on the same days; the window plant grew two new leaves; the cabinet plant's leaves turned pale and limp.

Why: Noticing must be observation, not explanation. 'It needs light' is an inference and should be redirected to Part B.

Also acceptable: Accept 'the masses were taken 24 hours after misting' as an observation about the method.

- Three distinct observations
- At least one includes a number from the table or figure
- No cause-and-effect claims

2. Write two questions you **wonder** about. At least one must be a question you could answer with a measurement or a test.

Answer: Examples: Does the window plant stop gaining mass if the window is covered? Would the cabinet plant gain mass under a lamp? Is the gained mass water trapped inside the leaves or something solid? Would the plant gain mass in a sealed jar of air? How much faster would it grow with more light?

Why: At least one question must be testable with a measurement or a controlled change.

Also acceptable: A question about the mechanism ('how does the plant use light?') is fine as the second question.

- Two questions
- At least one is answerable with a measurement or test

3. How much mass did the window plant gain from day 0 to day 120? How much did the cabinet plant change? Show your subtraction, with units, and say which direction each change went.

Answer: Window plant: $17.5\text{ g} - 14.2\text{ g} = +3.3\text{ g}$ (gain). Cabinet plant: $12.9\text{ g} - 14.3\text{ g} = -1.4\text{ g}$ (loss).

Why: Simple subtraction with the sign and direction stated. The cabinet plant losing mass while receiving the same water is the central clue.

Also acceptable: Accept 'lost 1.4 g' written without a minus sign if the direction is stated in words.

Part B: What do you think right now?

4. Which statement is closest to what you believe **right now** about the window plant's extra 3.3 g? Circle one. There is no penalty for a choice you change later.

Answer: No single correct answer at this stage; the scientifically supported option is B (new matter mostly from a gas in the air, with light as the energy source). Record the class tally.

Why: This is a belief probe. Option A (water alone) is contradicted by the cabinet plant. Option C confuses energy with matter. Option D cannot explain 3.3 g from classroom dust, nor why the cabinet plant lost mass. Revisit after W5 and W6.

Also acceptable: Credit any choice with an honest reason in q5 and q6.

5. Both plants were sprayed with the same amount of water on the same days. What does that fact tell you about the idea that water **alone** explains the window plant's gain? Use a number from the table.

Answer: The same water went to both plants, yet one gained 3.3 g and the other lost 1.4 g. If water alone explained the gain, both should have gained. So water by itself cannot be the whole explanation; something the cabinet plant lacked (light) must matter.

Why: This is a controlled comparison: water is held constant, light differs. Students should notice that a factor held the same cannot explain a difference.

Also acceptable: A student who says water might still be part of the new matter, just not the whole story, is reasoning well.

- States that both plants got the same water
- Cites the opposite mass changes with a number
- Concludes water alone cannot explain the gain

6. Write your first explanation. Where do you think the window plant's new matter came from, and where did the energy to build it come from? Use the pattern 'I think ... because ...' and refer to at least two observations from the story, table or figure.

Answer: Model response: I think the new matter came mostly from the air and partly from the mist water, because the plant touched nothing else and the cabinet plant got the same water but lost mass. I think the energy came from sunlight, because the only difference between the plants was light, and the plant in the dark could not build new leaves and even lost mass. Light is not stuff, so it cannot become the plant; it must power the building.

Why: This is a first explanation, so credit evidence use and clear reasoning rather than correctness. Watch for 'light became matter' and note it for W7.

Also acceptable: A student who proposes water as the matter source and light as the energy source has a testable, partly correct idea; accept with evidence.

- Uses 'I think ... because ...'
- Names a source of matter and a source of energy
- Refers to at least two observations

Part C: Predict and connect

7. Predict: on day 120 Ms. Alvarez moves the cabinet plant to the window and keeps misting it the same way. What do you expect its mass to do over the next 60 days? Explain your reasoning.

Answer: It should stop losing mass and begin to gain, probably slowly at first because its leaves are pale and damaged. Reasoning: the only difference between the plants was light, and the window plant gained about 0.8 g per 30 days.

Why: Prediction should follow from the student's explanation. A student who predicts no recovery because the plant is too damaged should be credited if the reasoning uses the pale, limp leaves.

Also acceptable: Accept 'it will recover but more slowly than the window plant' with a reason.

- Makes a clear prediction
- Links it to light as the changed condition

8. A valley oak in a California park has a trunk with a mass of several tons, yet it started as an acorn you could hold in one hand. Does your explanation from q6 work for the oak, which does have roots in soil? What would you want to measure to check?

Answer: Yes, with a twist: the oak also gets air, water and light, so the same explanation can apply; the soil might add something, but soil alone cannot explain the air plant. To check, you could measure how much the soil around a growing tree loses mass compared with how much the tree gains, or grow a tree seedling in a pot of weighed soil for a long time.

Why: Students should see that the air plant removes soil from the story, which is exactly why it is a useful phenomenon. The soil-weighing idea leads to the historical willow experiment in W3.

Also acceptable: Accept 'weigh the soil before and after' or 'grow an oak with no soil in water' as the check.

- Applies the explanation to the oak
- Proposes a measurement involving soil, tree mass, air or light

Teacher notes

The dataset is simulated. Real Tillandsia grow slowly; a gain of 3.3 g in 120 days is generous but plausible for a well-lit plant, and the loss in the dark reflects the plant using its stored sugar day and night without replacing it. Weighing after a drying day removes surface water as a confounder; point this out if students suggest the gain is just trapped water. Keep Part B open: do not confirm option B yet. Record the class tally for q4 and revisit it after W5 (the bubble and sensor data) and W6 (the greenhouse ledger). The extension's sealed bag plus carbon dioxide absorber is a thought experiment; if a class tries it, expect the plant to also lose water in a sealed bag, which is the interpretation problem the extension asks for.

Scaffold offered to students: Sentence starters for Part B

If q6 feels hard, build it from these starters: 'The window plant gained ___ g, and the only things it received were ___ and ____.' 'The cabinet plant got the same water but ____, so I think ___ matters.' 'I think the new matter came from ___ because ____.' 'I think the energy came from ___ because ____.' You do not have to be right; you have to use the evidence.

Extension: Design a check

Suppose you want to find out whether the window plant's new matter comes from the air rather than from the mist. Describe a test using a third air plant, a clear sealed bag, and a packet that absorbs carbon dioxide (the kind sold for food storage). Say what you would keep the same, what you would change, what you would measure, and what result would support the 'from the air' idea. Explain one reason the result might be hard to interpret.