

Follow the Atoms, Follow the Energy: A Sealed-Jar Model

Investigation question: Inside a sealed jar holding a water plant, water, air and a snail in sunlight, where does every atom go, where does the energy go, and what crosses the boundary in each direction?

Collaborative systems modeling

Groups of 4

1 session

Setup 5 · Activity 40 · Cleanup 5 min

MS-LS1-6 · assesses

MS-LS2-3 · practice

Name _____

Group _____

Date _____

Your role today

- ☐ **Boundary keeper:** Draws and labels the jar boundary and its zones (air, water, plant, snail), and challenges any token or card that crosses the line without being recorded.
- ☐ **Atom mover:** Builds molecules from tokens, rearranges them at each stage, and keeps every token on the poster, never in a pocket or on the floor.
- ☐ **Energy tracker:** Moves the energy cards: brings light cards in across the boundary, attaches them to sugar, and carries heat cards out when energy is released.
- ☐ **Counter and recorder:** Counts carbon, hydrogen and oxygen tokens inside the boundary at every stage, records the counts and the location of the energy cards, and calls a halt if a count changes.

Safety

- No hazards beyond ordinary classroom materials. Pony beads are a choking hazard for young children; keep the sets bagged and off the floor.
- If a live jar with pondweed and a snail is used at the front, wash hands after handling it and return the organisms to the aquarium afterward; do not seal a live animal in a jar for more than the class period.

Procedure

1. Lay the string on the poster in a large jar shape. This is the system boundary. Inside it, draw and label four zones: AIR at the top, WATER below, a PLANT in the water, and a SNAIL on the plant. Everything outside the string is 'outside the system.' Nothing may cross the string without an arrow being drawn and a note in the record.
2. Stage 1, starting jar: in the AIR zone build 12 carbon dioxide molecules (each C with two O). In the WATER zone build 12 water molecules (each O with two H). Count C, H and O inside the boundary and record them on the sheet. There are no energy cards inside yet.
3. Stage 2, light arrives: the energy tracker brings 12 LIGHT cards (yellow side up) across the boundary into the PLANT zone and draws a dashed arrow across the string to show it. Record where the energy cards are.

4. Stage 3, photosynthesis, round one: in the PLANT zone, take 6 CO₂ and 6 H₂O apart and rebuild the tokens as one sugar: put 6 C, 12 H and 6 O into SUGAR card 1. The 12 leftover O tokens become 6 O₂ molecules; move them to the AIR zone and draw a solid arrow from plant to air. Tuck 6 LIGHT cards inside SUGAR card 1, yellow side up; a card inside a sugar card counts as 'stored.' Count all atoms inside the boundary and record.
5. Stage 4, photosynthesis, round two: repeat stage 3 with the remaining 6 CO₂ and 6 H₂O to fill SUGAR card 2 with the other 6 energy cards. Count and record. Now the AIR zone should hold 12 O₂ and no CO₂, and the WATER zone no free water molecules.
6. Stage 5, the plant uses sugar 1 now: the plant reacts SUGAR card 1 with 6 O₂ from the air. Take the 24 tokens out of the card, rebuild 6 CO₂ (to AIR) and 6 H₂O (to WATER), and take out the 6 energy cards. Flip them to the orange HEAT side; the plant used that energy to grow and move materials, and all of it ends up leaving the jar as heat. Carry the 6 HEAT cards across the boundary and draw a dashed arrow out. Count and record.
7. Stage 6, the plant keeps sugar 2 as biomass: SUGAR card 2 stays in the PLANT zone. Label it 'stored as starch or built into cell wall.' This is the plant's body. Record where its 6 energy cards are (still inside the plant, stored).
8. Stage 7, the snail eats: move SUGAR card 2 from the PLANT zone to the SNAIL zone with a solid arrow. The atoms and the stored energy cards are now part of the snail. Count and record; nothing has crossed the boundary.
9. Stage 8, the snail uses the sugar: the snail reacts SUGAR card 2 with the remaining 6 O₂. Rebuild 6 CO₂ and 6 H₂O into the AIR and WATER zones, flip the 6 energy cards to HEAT, and carry them out across the boundary with a dashed arrow. Final count: record it and compare with stage 1.
10. Draw the finished model on the recording sheet: the boundary, the four zones, solid arrows for every matter movement and dashed arrows for every energy movement, each arrow labeled with what moved. Then answer the questions.

Record your observations

Lab 2 recording sheet: Follow the atoms, follow the energy

After each stage, count every token inside the string boundary and write where the energy cards are and which side is up. If a count changes between stages, stop and find the missing token before going on.

Atom and energy count at each stage

Stage	C inside	H inside	O inside	Energy cards inside and where	Light / stored / heat?
1. Starting jar (12 CO ₂ in air, 12 H ₂ O in water)					
2. 12 light cards enter the plant					
3. Photosynthesis round one (sugar 1 made)					
4. Photosynthesis round two (sugar 2 made)					
5. Plant uses sugar 1 with oxygen					
6. Plant keeps sugar 2 as biomass					
7. Snail eats the plant (sugar 2 moves)					
8. Snail uses sugar 2 with oxygen					

Molecules in each zone at the start and at the end

Zone	Start: molecules present	End: molecules present	Same or different?
Air			
Water			
Plant			
Snail			

-  Draw the finished jar model: the boundary, the four zones, a solid arrow for each movement of matter and a dashed arrow for each movement of energy. Label every arrow with what moved (for example 'O₂ to air', 'light in', 'heat out').



1. Compare your atom counts at stage 1 and stage 8. What happened to the number of C, H and O atoms inside the boundary during the whole run?

2. List everything that crossed the boundary, in each direction, during the run. Was any of it matter?

Analysis questions

3. At stage 4 the plant's two sugar cards hold 12 carbon atoms. Where exactly were those 12 carbon atoms at stage 1, and what did the plant have to do to get them?

4. At stage 7 the snail's body contains sugar 2. Trace one carbon atom in that sugar from stage 1 to stage 7 in a chain of locations (air → ... → snail).

5. Light cards came in; heat cards went out. Explain why a solid arrow (matter) would be the wrong kind of arrow for both, and what the energy was doing while it was 'stored' inside a sugar card.

6. Suppose the jar had been kept in the dark from the start. Which stages could still happen and which could not? What would the final atom count be?

7. The real plant's body is mostly cellulose and other cell-wall materials made by linking many sugar units into chains, with the atoms of one water molecule left out at each link. If you linked sugar 2 to a neighboring group's sugar card, which tokens would you have to set aside, and would any atom be lost?

8. Write a four-sentence explanation of how the snail's body was built from air and water, naming what supplied the atoms and what supplied the energy at each step.
