

Water Cycle Check-Up: Twelve Items and a Snow-to-Streets Synthesis

Learning target: I can recall and apply the processes, drivers and changes of state of the water cycle, and explain a seasonal phenomenon using the sun's energy and gravity.

Retrieval and mastery check

About 35 min

Individual

MS-ESS2-4 · assesses

independent practice

writing

Standards connections

MS-ESS2-4 (assesses, the describing half: drivers, pathways and changes of state, with a written model in the synthesis): MS-ESS2-4 is a California Grade 6 PE revisited in this lesson. The mixed items check the elements of the model (processes, drivers, state changes, no fixed order), and the synthesis asks for a written model of water cycling through a season driven by the sun and gravity; the latent-heat boundary is respected (qualitative energy only).

Purpose: assess · **Time:** about 35 minutes · **Format:** individual

Answers with reasoning

Part A: Retrieval (items 1 to 12)

1. Which process is **not** driven by gravity? 1 pt

Answer: C: Evaporation from a lake.

Why: Evaporation is driven by the sun's energy; runoff, infiltration and precipitation are all moved by gravity.

Also acceptable: None.

2. True or false: the clouds you see in the sky are made of water vapor. 1 pt

Answer: False. Clouds are made of tiny liquid droplets and ice crystals; water vapor is an invisible gas.

Why: The vapor-versus-visible-droplet distinction is a core lesson idea.

Also acceptable: Full credit for 'false' with or without the explanation.

3. A puddle dries up completely on a cool 12 °C day. This shows that evaporation 1 pt

Answer: B: happens at the surface at any temperature.

Why: The fastest surface molecules escape at any temperature; 12 °C is far below boiling, so A is wrong; gravity does not lift water, so C is wrong; D contradicts the cool day.

Also acceptable: None.

4. What must happen to water vapor for condensation to occur? Give two everyday examples of condensation. 2 pts

Answer: The vapor must cool (lose energy) so that its molecules slow down and stick together, usually on tiny particles or a cool surface; condensation also happens when air is holding as much vapor as it can. Examples: drops on the outside of a cold drink; fog on a bathroom mirror; dew on grass in the morning; the inside of a window on a cold day; your breath forming a cloud in cold air.

Why: Cooling or saturation is required; any two real examples.

Also acceptable: Accept 'the water molecules slow down and join together.'

- Vapor must cool / lose energy (or air becomes saturated)
- Two correct examples

5. A reservoir loses 6 mm of depth per day to evaporation for 25 rainless days. How much depth is lost in millimeters and in centimeters? Show the calculation. 2 pts

Answer: $6 \text{ mm/day} \times 25 \text{ days} = 150 \text{ mm} = 15 \text{ cm}$.

Why: Rate times time gives depth; $10 \text{ mm} = 1 \text{ cm}$.

Also acceptable: Accept 15.0 cm.

6. Which statement best describes groundwater? 1 pt

Answer: B: Water filling the tiny pore spaces in soil and rock.

Why: Groundwater fills pores; cave rivers exist but hold a small share; roots and frozen ground are not groundwater.

Also acceptable: None.

7. The sun's energy directly powers three of the lesson's processes: evaporation, transpiration and _____. 1 pt

Answer: melting

Why: Melting of snow and ice is the third sun-powered process in the lesson's Key Science Concept.

Also acceptable: Accept 'melting (of ice and snow)'; 'sublimation' is also sun-powered but is not one of the lesson's nine, so accept it with a note.

8. Diagrams often say every water cycle process is powered by the sun or by gravity. Which two processes are actually driven by water **losing** energy, and what causes that loss? 2 pts

Answer: Condensation and crystallization. They happen when water vapor loses energy, which occurs when the air cools, for example as it rises and expands or touches a cold surface; the molecules slow and bond together into droplets or ice crystals.

Why: This is the accuracy point against the textbook's 'sun or gravity' framing.

Also acceptable: Accept 'freezing/deposition' in place of crystallization.

- Both processes named
- Loss of energy caused by cooling

9. About 1.69 percent of Earth's water is groundwater, and about 45 percent of that groundwater is fresh. What percent of all Earth's water is fresh groundwater? Show the multiplication and round to the nearest hundredth of a percent. 2 pts

Answer: $1.69 \text{ percent} \times 0.45 = 0.7605 \text{ percent}$, about 0.76 percent of all Earth's water.

Why: Multiplying the groundwater share by the fresh fraction gives the fresh-groundwater share; this matches the USGS figure of 0.76 percent.

Also acceptable: Accept 0.76 percent; accept 0.761 if not rounded to hundredths, with a one-point deduction for not following the rounding instruction if your class uses points.

10. Draw a large raindrop as it falls through the air. Show its real shape (not a teardrop), draw and label the two forces acting on it, and write one sentence on what happens if the drop grows very large. 2 pts

Answer: A full-credit drawing shows a drop that is rounded on top and flattened on the bottom (like a bun), with an arrow labeled gravity pointing down and an arrow labeled air resistance pointing up on the underside. Sentence: if the drop grows very large, the air pushing up on it flattens it more and tears it apart into smaller drops.

Why: Raindrops are not teardrop-shaped; air resistance flattens the underside, and very large drops break apart. No size cutoff is required.

Also acceptable: Accept 'air pushing up' for air resistance. A small, nearly spherical drop is acceptable if the student notes that small drops stay round and only large ones flatten.

- Flattened-bottom shape, not a teardrop
- Gravity arrow down, air resistance arrow up
- States that very large drops break apart

11. A fog-catching net produces water on foggy mornings because 1 pt

Answer: B: tiny fog droplets stick to the mesh and merge until gravity can pull them down.

Why: Fog droplets are too small to fall; the net lets them collect and combine until they are heavy enough for gravity to run them down into a gutter.

Also acceptable: None.

12. True or false: the water cycle begins at the ocean and every water molecule follows the same route. 1 pt

Answer: False. The cycle has no starting point, and water takes many different routes; some rain falls back into the ocean, some soaks underground, some evaporates from a river before reaching the sea.

Why: The 'one required loop' idea is a common misreading of cycle diagrams.

Also acceptable: Full credit for 'false' with or without the explanation.

Part B: Synthesis

Early in January a storm leaves a city in the northeastern United States under 1.2 meters of snow, and no one hauls it away. By late May the pavement is dry and no snow is left anywhere, yet the river through the city is running high and brown.

13. Explain where the snow went and what made it move. Your explanation must (a) name the energy source and the force involved and say what each one did, (b) name every change of state that happened, (c) describe at least two different destinations for the water, and (d) explain why the river is high even though the snow is gone. Use at least five of these terms: *melting, evaporation, sublimation, runoff, infiltration, groundwater, water vapor, condensation*. 8 pts

Answer: Model response: The snow left because the sun supplied energy and gravity pulled on the water. As the days lengthened, the snow absorbed more of the sun's energy. Most of it melted (solid to liquid), and some sublimated straight into the air as water vapor (solid to gas) on cold, sunny days. Once the snow was liquid, gravity took over: meltwater ran off across the streets into storm drains and the river, and some soaked into the ground by infiltration, becoming groundwater that moves slowly downhill through the soil's pores. Some of the meltwater on the pavement evaporated (liquid to gas) into the air as invisible water vapor, where it will later cool and condense into clouds somewhere else. So the water went to at least three destinations: the air as vapor, the river (and on to the sea), and underground as groundwater. The river is high in late May even though the streets are bare because melt from the whole region drained into it over the spring and because groundwater that infiltrated weeks earlier is still seeping into the river; the brown color is soil carried by the runoff.

Why: Score against the four requirements and the term count. The sun must be an energy source, not a pull; gravity must be the mover of liquid water; the changes of state are melting, evaporation and (optionally) sublimation; at least two destinations; the river explained by delayed melt and groundwater.

Also acceptable: A student who adds that the melt may have refrozen at night (liquid to solid, crystallization or freezing) and melted again by day is correct. An answer that explains the river with rain alone has not used the phenomenon; give credit only for the parts that address the snow.

- Sun supplies energy for melting (and sublimation/evaporation); gravity moves liquid water downhill and underground
- Changes of state named: melting, evaporation (sublimation optional)
- At least two destinations (air, river/sea, ground)
- River is high because of runoff from melt and slow groundwater inflow
- At least five required terms used correctly

Teacher notes

Points total 25 (items 1 to 12 are 17 points; the synthesis is 8, matching items 1 to 6 together). Expected numeric answers: q5 150 mm = 15 cm; q9 0.76 percent (the USGS fresh-groundwater figure). q7 accepts sublimation with a note because the lesson's nine processes do not include it. q8 and q12 check the two places where the textbook's Key Science Concept spread (printed 240-241 / PDF 276-277) can mislead: 'every process is sun or gravity' and the single drawn loop. q10 follows the lesson's Figure 3A (printed 238 / PDF 274) for shape and forces but asks for no size cutoff, since published breakup sizes are inconsistent. The synthesis scene retells, in new words and metric units, the textbook's own snowy-city opener, so it works as a transfer from the chapter's Sierra phenomenon; students who did Worksheet 1 should notice that they can now explain what they only guessed at then, and comparing the two responses is a good closing activity.

Scaffold offered to students: Checklist for the synthesis

Before you write q13, make four quick notes in the margin: (1) Energy source and force: the sun supplies energy; gravity pulls. (2) Changes of state: snow to liquid (melting), liquid to gas (evaporation), and snow straight to gas (sublimation). (3) Destinations: the air, the river, the ground, the sea. (4) The river: melt runs off; groundwater keeps feeding it. Then turn the notes into sentences.

Extension: Reverse the season

Write a second synthesis paragraph for the same city from October to January, explaining how the water that left in spring could come back as the January snow. Include where the vapor came from, what had to happen to it to form a cloud, why it fell as snow instead of rain, and why the cycle has no true beginning. Use at least four lesson terms you did not use in q13.