

From Snowflake to Faucet: How California Drinks Its Mountains

Learning target: I can use evidence from a passage to explain how the sun's energy and gravity move water from a mountain snowpack to the places people use it.

Reading with evidence

About 40 min

Individual

MS-ESS2-4 · practice

reading

writing

Standards connections

MS-ESS2-4 (practice): MS-ESS2-4 is a California Grade 6 PE revisited in this seventh-grade lesson. The passage traces one real pathway of the water cycle, the Sierra snowpack to the Central Valley, and the questions ask students to identify which steps the sun powers and which gravity powers, building the reasoning they need for the model.

Purpose: build · **Time:** about 40 minutes · **Format:** individual

Answers with reasoning

From Snowflake to Faucet

[1] Every winter, storms roll in from the Pacific Ocean and climb the western slope of California's Sierra Nevada. Their air carries water that left the ocean surface as invisible vapor, lifted by energy from the sun. As the air is pushed up the mountains it cools, and the vapor can no longer stay a gas. Its molecules slow down, gather on specks of dust and sea salt, and become cloud droplets. Higher up, where the air is below freezing, the water forms ice crystals instead, and they grow until gravity wins and they fall as snow. By early April in a good year, the high Sierra snow can be several meters deep.

[2] That snow is not just scenery. It is often called California's largest reservoir: a reservoir the state did not have to build. Water managers measure it by pushing a hollow tube down to the soil, weighing the snow inside, and converting the weight to the depth of water the snow would make if it all melted at once. In a typical year the melting snowpack supplies roughly 30 percent of the water used by California's farms and cities. It works as a reservoir because it holds the winter's water in place, as a solid, until the season when people need it most.

[3] The release begins in spring. As days lengthen and the sun climbs higher, the snow surface absorbs more energy. Ice crystals gain energy, loosen from their rigid pattern, and become liquid: melting. Some water skips the liquid stage entirely; on cold, dry, sunny days, surface molecules gain enough energy to leave the snow directly as vapor, a process called sublimation. Most of the snowpack, though, melts. From here on, gravity does the work.

[4] Meltwater has two ways down. Some flows over the surface as runoff, joining creeks and then big rivers such as the American, the Feather and the San Joaquin. Some soaks into soil and fractured rock as infiltration, becoming groundwater that creeps downhill far more slowly, feeding springs and keeping streams flowing weeks after the last snow patch is gone. This is why a Sierra creek can run strong in July under a cloudless sky: it is drinking from April's melt and from groundwater still on its way.

[5] Not all of the melt reaches the valley. The Sierra's forests are thirsty. Trees pull water from the soil and carry it up to their leaves and needles, where it evaporates and escapes through tiny pores as vapor. This transpiration, together with evaporation from wet soil, lakes and reservoirs, sends a large share of the mountain's water back into the air before it reaches a faucet. Water managers must subtract these losses when they forecast the supply downstream.

[6] The water that does arrive is caught behind dams such as Folsom and Oroville, then released into canals and pipes. Gravity still helps: canals slope gently downhill so the water moves on its own, and pumps are used only where water must be lifted uphill, such as over a ridge. Beneath the Central Valley, water that soaked in over thousands of years fills aquifers, layers of sand and gravel whose connected pores hold water that wells can reach. In a normal year groundwater supplies roughly 40 percent of the state's water; in a drought, when the snowpack is thin, the share rises and the aquifers are pumped faster than they refill.

[7] Trace the whole trip and you will see the two drivers of the water cycle take turns. The sun lifts: it powers evaporation from the ocean, melting on the mountain, and transpiration from the forest. Gravity drops and drags: it pulls snow from the clouds, meltwater down the slopes, and groundwater through the pores. In between, cooling does the quiet work of turning vapor back into droplets and crystals. The water in a glass in Fresno may have been Pacific vapor in December, a snowflake in January, a creek in May, and groundwater in June. Nothing about the trip was one-way, either: some of that water has already evaporated from a reservoir and is back in the air, ready to fall again.

Questions: cite the passage

1. According to paragraph 1, what has to happen to the air for the vapor it carries to become cloud droplets? Quote the words that describe what the molecules do.

Answer: The air has to be pushed up the mountain and cool. Quote: the vapor's 'molecules slow down, gather on specks of dust and sea salt, and become cloud droplets.'

Why: Paragraph 1 gives cooling as the cause and the molecular behavior as the mechanism; the quote must include slowing and gathering on particles.

Also acceptable: Accept 'it cools so the vapor can no longer stay a gas' with the quote.

- States the air cools (as it rises)
- Quotes or closely paraphrases the molecules slowing and gathering on dust or salt

2. Paragraph 2 calls the snowpack 'a reservoir the state did not have to build.' Using the paragraph, explain what makes a snowpack work like a reservoir.

Answer: A reservoir stores water until it is needed. The snowpack holds the winter's water in place as a solid and releases it slowly in spring and summer, the season when farms and cities need it most, so it does the job of a reservoir without a dam.

Why: Full credit links storage (solid, held in place) to timed release (melting when water is needed).

Also acceptable: Accept 'it holds water until summer like a dam does.'

- Storage: holds water as solid snow
- Release: melts in the season of greatest need

3. Paragraph 3 describes two different ways water can leave the snowpack. Name both, give the change of state for each, and state what supplies the energy for both.

Answer: Melting (solid to liquid) and sublimation (solid directly to gas). The sun supplies the energy for both; the snow surface absorbs more of it as days lengthen.

Why: Paragraph 3 names both processes and the sun as the energy source.

Also acceptable: Accept 'sunlight' or 'the sun getting higher' as the energy source.

- Melting, solid to liquid
- Sublimation, solid to gas
- Energy from the sun

4. Paragraph 4 says a creek can 'run strong in July under a cloudless sky.' Explain how, using the two pathways named in that paragraph. Which pathway is slower, and why does that matter for July?

Answer: Meltwater reaches the creek by runoff over the surface and by infiltration into soil and rock, where it becomes groundwater that moves downhill slowly and feeds springs and streams. Groundwater is the slower pathway because it has to creep through pores. That matters in July because the slow groundwater is still arriving weeks after the snow is gone, so the creek keeps flowing even with no rain or snow.

Why: Students should name both pathways and connect the slowness of groundwater flow to the creek's July flow.

Also acceptable: Accept 'the melt from April is still on its way underground.'

- Names runoff and infiltration/groundwater
- Identifies groundwater as slower
- Explains the delay feeds the creek in July

5. According to paragraph 5, name three ways water returns to the atmosphere before reaching a faucet. Which of the three involves living things?

Answer: Transpiration from forest trees, evaporation from wet soil, and evaporation from lakes and reservoirs. Transpiration involves living things (trees pull water up and release it as vapor through pores in their leaves and needles).

Why: Paragraph 5 lists all three; the living-things pathway is transpiration.

Also acceptable: Accept 'evaporation from the ground' for soil.

- Three return pathways
- Transpiration identified as the living-things pathway

6. Paragraph 2 says snowmelt supplies roughly 30 percent of the water people use in a typical year, and paragraph 6 says groundwater supplies roughly 40 percent. If a city uses 100 million liters in a typical year, about how many liters come from snowmelt and how many from groundwater? Then explain why these two numbers can both be 'roughly' right and still overlap.

Answer: Snowmelt: 30 percent of 100 million L = $0.30 \times 100,000,000 = 30$ million L. Groundwater: $0.40 \times 100,000,000 = 40$ million L. They can overlap because some groundwater started as snowmelt that infiltrated, and because the figures are rounded statewide averages that change from year to year, not exact measurements for one city.

Why: The arithmetic is straightforward; the explanation should show that the categories are not separate boxes (snowmelt can become groundwater) and that 'roughly' signals rounding and variation.

Also acceptable: Accept either reason (overlap of sources, or rounding/variation) for the second part; both is strongest.

7. Paragraph 6 says canals slope downhill and pumps are used only where water must be lifted uphill.

What does this tell you about the role of gravity in the human-built part of the water's journey?

Answer: Gravity is still doing most of the moving even in the human-built system. Engineers design canals to slope downhill so the water flows on its own, and they add pumps only where gravity cannot help (lifting water uphill, such as over a ridge). Gravity is free and reliable; pumps cost energy.

Why: The inference is that people arrange the system so that gravity does the work wherever possible.

Also acceptable: Accept 'people copy the water cycle: let water run downhill.'

- Gravity moves the water in canals
- Pumps are the exception, used only to go uphill

8. Paragraph 7 says 'the sun lifts' and 'gravity drops and drags,' and that cooling does 'quiet work' in between. Using evidence from at least three different paragraphs, sort the steps of the water's trip from Pacific vapor to a glass in Fresno into these three groups: sun-powered, gravity-powered, and cooling. Then explain why the passage says 'nothing about the trip was one-way.'

Answer: Sun-powered: evaporation from the Pacific (paragraph 1), melting and sublimation of the snowpack (paragraph 3), transpiration from forests and evaporation from soil and reservoirs (paragraph 5). Gravity-powered: snow falling from clouds (paragraph 1), runoff and infiltration down the slopes and groundwater flow (paragraph 4), water moving through sloped canals (paragraph 6). Cooling: vapor becoming cloud droplets and ice crystals as the air rises and cools (paragraph 1). The trip is not one-way because water keeps leaving the path and starting over: some evaporates or transpires back to the air before reaching the valley (paragraph 5), and some evaporates from a reservoir and is back in the air, ready to fall again (paragraph 7), so there is no single start or finish.

Why: Full credit: all three groups populated with correct steps, evidence from at least three paragraphs, and the 'not one-way' explanation tied to water re-entering the atmosphere at several points.

Also acceptable: Placing 'snow falling' under cooling is a reasonable confusion (crystals form by cooling, fall by gravity); credit it if the student separates forming from falling.

- Correct sun-powered steps with paragraph numbers
- Correct gravity-powered steps with paragraph numbers
- Cooling step identified
- Explains that water leaves the path and re-enters the cycle at many points

Teacher notes

The passage is about 680 words and original. Facts used: Sierra snowmelt provides roughly 30 percent of California's water supply in a typical year, and groundwater roughly 40 percent in a normal year and more in drought (California Department of Water Resources figures, rounded); snow surveys use a hollow tube and report snow water equivalent; Folsom and Oroville are real reservoirs, and the American, Feather and San Joaquin are real rivers. Sublimation (paragraph 3) is beyond the lesson's nine processes but is accurate and easy. The passage deliberately states, against the textbook's page 240 wording, that condensation and crystal formation are driven by cooling rather than by the sun; use q8 to make that explicit. Paragraph 7 calls the sun and gravity the two drivers, not two forces: the sun supplies energy, and only gravity is a force. Lesson sections this draws on: Heating (printed 234-235 / PDF 270-271), Cooling (236-237 / 272-273), Gravity (238-239 / 274-275), Key Science Concept (240-241 / 276-277).

Scaffold offered to students: Track the water with two symbols

On your second read, draw a small sun in the margin every time the passage says water gains energy (evaporates, melts, sublimates, transpires) and a small downward arrow every time gravity moves water (falls, runs off, soaks in, flows underground). Draw a snowflake or a drop where water cools into crystals or droplets. Questions 3, 4, 7 and 8 can be answered by looking at your margin symbols.

Extension: A dry year

Imagine a winter in which the storms bring rain to the Sierra instead of snow because the air is a few degrees warmer. Using ideas from paragraphs 2, 4 and 6, write a paragraph predicting what changes for the rivers in spring, for the reservoirs in summer, and for the aquifers by the end of the year. Include one thing water managers might do differently.