

Earth's Natural Resources: Mastery Check

Learning target: I can classify resources by how fast nature replaces them, judge whether a use is sustainable, explain how geoscience processes concentrate water, oil, ore and geothermal heat, and write an evidence-based explanation of where one California resource is found.

Retrieval and mastery check

About 45 min

Individual

MS-ESS3-1 · assesses

MS-ETS1-2 · practice

independent practice

writing

Name

Date

Period

Directions

Work alone and without notes. For multiple-choice items, circle one letter. For numeric items, show every step and include units. Label every part of the drawing. Part B is worth 7 of the 40 points, so save at least 12 minutes for it. There are 13 items in all.

You will need: This worksheet, Pencil, Ruler for q6, Calculator (optional)

Part A: Retrieval (items 1-12, 33 points)

1. Sort each resource. In the first column write **renewable** or **nonrenewable** on a human timescale. 7 pts
- In the second column write one short reason based on how long nature takes to replace it, compared with a human lifetime.

Renewable or nonrenewable?	Reason: how long nature takes to replace it
a. Water in a river that is refilled by snowmelt every spring	
b. Petroleum in a sandstone reservoir 3 kilometers down	
c. Copper ore in quartz veins above an old subduction zone	
d. Fertile topsoil on a farm	
e. Wood from a pine plantation that is replanted after every harvest	
f. Water in a deep sandstone aquifer under a desert; it soaked in more than a million years ago and almost no rain reaches it today	
g. Heat flowing up from Earth's interior	

Where Earth's water is (U.S. Geological Survey estimates, rounded)

Part of Earth's water	Share
Fresh water, as a share of all water on Earth	about 2.5 percent
Ice caps, glaciers and permanent snow, as a share of fresh water	about 69 percent
Groundwater, as a share of fresh water	about 30 percent
Lakes, rivers, soil moisture, air and living things, as a share of fresh water	about 1 percent

Real reference values. The rest of Earth's water, about 97.5 percent, is salty, mostly in the oceans.

2. Use the table. Imagine all of Earth's water shrunk to 1,000 liters. (a) How many liters would be fresh water? (b) How many liters would be fresh groundwater? (c) How many liters would be in lakes, rivers, soil, air and living things? Show your work, then finish this sentence: 'Of the fresh water that is not frozen, most is _____.'

2 pts

3. Two wells are drilled in the same rainy valley. Well 1 stops in a thick layer of clay. Well 2 goes deeper, through the clay, into a layer of river gravel. Well 1 gives almost no water even though the clay is soaking wet. Which explanation is best?

2 pts

- ☐ A. Clay holds no water at all, so the driller must have made a mistake.
- ☐ B. Clay's pores are tiny and poorly connected, so water barely flows out of it; gravel has large connected pores, so water flows freely into a well.
- ☐ C. The water in clay is salt water, which a well cannot pump.
- ☐ D. Rain soaks into gravel but never reaches clay.

The Las Arenas aquifer (teaching dataset)

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

Quantity	Value
Recharge each year	12 million m ³
Pumping each year (farms and town together)	20 million m ³
Water the wells can still reach today	400 million m ³

Las Arenas is a made-up town. These numbers were invented for this quiz; they are not measurements.

4. Use the Las Arenas dataset. (a) By how much does the water stored in the aquifer change each year? Say whether it rises or falls. (b) If recharge and pumping stay the same, in how many years will the water the wells can reach be gone? (c) Is this use of the aquifer **sustainable**? State the rule you used and the largest yearly pumping that would be sustainable. Show your work. 3 pts

5. Which statement about how **petroleum** forms is accurate? 2 pts

- ☐ A. It formed from dinosaur bones buried on land.
- ☐ B. It formed from tiny marine organisms buried in low-oxygen mud, slowly heated by deep burial over millions of years, then held in porous rock under a seal.
- ☐ C. It forms wherever sea creatures live today, within a few hundred years.
- ☐ D. Pressure alone squeezes buried remains into oil; heat plays no part.

6. Draw a side view (a cross-section) of a **geologic trap** that holds an oil field, with the rock layers bent upward into an arch. Label the **source rock**, the **reservoir rock**, the **cap rock (seal)**, the **oil** and the **water**. Add an arrow showing which way the oil moved after it formed, and write a few words beside the arrow saying why it moved that way. 4 pts

7. Many of the world's largest copper deposits lie along the Andes of South America, a mountain belt where one tectonic plate sinks beneath another. Which chain of processes best explains why the copper is there? 2 pts

- ☐ A. A plate sinks, magma forms and rises into the crust, hot fluids from the magma carry dissolved copper through cracks, and copper minerals are left behind as the fluids cool.
- ☐ B. Rivers wash copper sand down from the mountains, the sand piles up on beaches, and the beaches harden into ore.
- ☐ C. Plankton rich in copper settle on a sea floor, and burial and heat turn them into copper ore.
- ☐ D. Copper is spread evenly through the crust; the Andes simply have more mines because more people live there.

8. A company wants to build a new **geothermal energy** power plant. Which site has the best evidence of a strong geothermal resource? 2 pts

- ☐ A. A flat plain in the middle of a continent, on rock more than a billion years old, with cold springs
- ☐ B. A valley near a plate boundary with young volcanic rock, hot springs and steam vents
- ☐ C. A snowy mountain of old granite, far from any plate boundary or volcano
- ☐ D. A coastal plain where rivers have piled up thick layers of sand and clay

9. True or false: 'Geothermal energy is renewable, so a geothermal field can never be used up.' Circle one, then explain your answer using what happened at The Geysers in northern California. 2 pts

☐ True ☐ False Explain your thinking:

10. Cattle overgraze a hillside farm, and in ten years wind and rain strip away 2 centimeters of topsoil. 2 pts
(a) Explain how soil forms and why the farmer cannot expect those 2 centimeters to come back within a lifetime. (b) Name one practice that would protect the soil that is left.

11. Copper mines today dig up rock with much less copper in it than the rock miners dug a century ago. (a) Explain why, using the words **ore** and **nonrenewable**. (b) Name one way people now get copper without digging new ore, and say why it helps. 2 pts

12. The Hoover Dam team compared five types of dam. Write C (criterion: what success required) or K (constraint: a limit the design had to fit) beside each: (a) store enough Colorado River water for the growing Southwest ___ (b) the cost to build and maintain the dam ___ (c) protect towns downstream from floods ___ (d) the shape of the canyon and its rock ___ (e) harm to the river's ecosystems ____.
- Then explain in one or two sentences why the team chose an arch-gravity dam even though it cost more than an earth or rockfill dam.

Part B: Synthesis (item 13, 7 points)

Two California resources are described below. Every numbered fact is a real reference fact, simplified for this quiz. Choose **one** set, A or B, and use its facts as your evidence.

Evidence sets for Part B (real reference facts)

Fact	Set A: oil in Kern County	Set B: gold in the Sierra Nevada foothills
1	Oil fields crowd into the southern San Joaquin Valley in Kern County, around and west of Bakersfield. The Sierra Nevada, just to the east, is made mostly of granite and has no oil fields.	Gold-bearing quartz veins, called the Mother Lode, form a narrow belt in the western foothills of the Sierra Nevada. There are no hard-rock gold mines on the flat floor of the Central Valley just to the west.
2	Much of the oil formed in the Monterey Formation, a layer of shale built largely from the remains of microscopic marine plankton, laid down in sea basins roughly 6 to 16 million years ago.	The Sierra Nevada is built mostly of granite that cooled from magma. The magma rose above an ancient subduction zone, where an ocean plate sank beneath the western edge of North America.
3	In the deepest part of the basin, several kilometers of younger sediment buried the shale. At those depths the rock is hot enough, roughly 60 to 120 °C, to turn organic matter into oil over millions of years.	The veins formed more than 100 million years ago, when hot water moving through cracks in the rock deposited quartz and gold as it cooled.
4	The oil moved upward through porous sandstone and collected where sandstone layers are bent into folds or cut by faults, beneath layers of shale or clay that seal them.	Gold is about seven times denser than quartz sand. Where weathering broke the veins apart, streams carried the gold and dropped it in gravel where the water slowed. Flakes found in this gravel at Sutter's Mill on the American River in 1848 started the Gold Rush.
5	The Kern River field near Bakersfield has produced oil since 1899. California now produces less than half as much oil each year as it did in the mid-1980s.	Within about ten years, miners had taken most of the gold that was easy to reach in stream gravel. Hydraulic mining then washed whole hillsides into rivers until a federal court ruling largely ended it in 1884.

Real reference facts, rounded and simplified for this quiz.

13. Write a scientific explanation (6-8 sentences) of why the resource in your chosen set is concentrated where it is and not in the neighboring area named in Fact 1. Your explanation must: (1) state a claim; (2) cite at least three numbered facts as evidence; (3) name the past geoscience processes that concentrated the resource, in the order they happened; (4) explain why the neighboring area lacks the resource; (5) describe how a current process, human removal, is changing where the resource is found; and (6) say whether the resource is renewable on a human timescale, and why. Write the letter of your set at the start.

7 pts

This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and extend across the width of the page. There are no margins, text, or other markings on the paper.

Two rules and a clue strip

Rule 1, renewable or nonrenewable: can nature replace it within about a human lifetime? Rule 2, sustainable or not: is it used no faster than nature replaces it? Clue strip: buried plankton-rich marine shale + deep burial + porous sandstone under a seal → oil. Old volcanoes or granite with quartz veins above a sinking plate → copper or gold. Young volcanic rock, hot springs, plate boundary → geothermal heat. Thick gravel or sand + rain or snowmelt → groundwater. Part B frame: 'The resource is concentrated in ___ because ___. Fact __ shows ___. First ___, then ___, finally ___. The neighboring area lacks it because ___. Today people are changing the pattern by ___ (Fact 5). On a human timescale it is ___ because ___.'

Same map, different eras

Kern County's oil and the Mother Lode's gold lie only a few hundred kilometers apart on a map of California. Using both evidence sets, explain how they can be neighbors even though they formed in different eras by different processes, one in rock built from magma and the other in a sediment-filled basin beside it. Then pick the set you did not use in Part B, name the one fact that is the weakest evidence for why the neighboring area lacks the resource, and describe a new measurement (for example a rock core, a temperature log or a map of vein ages) that would make the explanation stronger.