

Fixing Marisol's Exit Ticket: Where the Resource Ideas Go Wrong

Learning target: I can find the errors in another student's explanations about natural resources, explain what went wrong, and rewrite each statement so it is accurate.

Error analysis

About 35 min

Individual

MS-ESS3-1 · practice

writing

independent practice

discussion

Standards connections

MS-ESS3-1 (practice): Diagnosing wrong explanations for where petroleum, copper and groundwater come from, and why resources are or are not renewable, sharpens the accurate explanation this PE asks students to construct.

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

Answers with reasoning

Marisol's exit ticket (fictional student work) — 1. A renewable resource is one that can never run out, like groundwater and trees. 2. Petroleum is found under places where lots of fish and plankton live today, because oil comes from sea creatures. 3. Copper ore forms where magma above a subduction zone releases hot fluids that cool in cracks, so copper mines are found near present or past plate boundaries. 4. As sediment piles up on buried sea creatures, the pressure makes them hot, and that heat turns them into oil. 5. Soil is renewable because it is always there; farming can wear it out for a while, but it comes right back. 6. Geothermal energy is renewable, but a plant uses it sustainably only if it puts the cooled water back and does not pump hot water out faster than the rock can reheat it. 7. All groundwater is nonrenewable, so a town should never use wells.

Part A: Judge each statement

1. Complete the table for all seven statements. Be precise in the middle column: quote the exact words that cause the problem.

Answer: 1: wrong; 'can never run out' and the flat labeling of groundwater and trees; accurate idea: renewable means nature replaces the resource within about a human lifetime, a renewable resource can still run short if it is used faster than it is replaced, and groundwater and trees can each be renewable or not depending on how fast that aquifer refills or that forest regrows. 2: partly correct; 'live today'; oil formed from plankton in ancient seas millions of years ago and is found where those old seafloors were buried and trapped. 3: correct; none. 4: partly correct; 'the pressure makes them hot'; the temperature rises because deeper rock is hotter (heat flows up from Earth's interior), and the heat over millions of years makes the oil; pressure rises too but does not do the chemical work. 5: wrong; 'always there', 'comes right back'; soil forms from weathered rock plus organic matter over decades to thousands of years, so fertile topsoil is nonrenewable on a human timescale. 6: correct; none. 7: wrong; 'all' and 'never'; whether groundwater is renewable depends on how long the aquifer takes to refill; shallow aquifers in rainy regions refill each year, and a town can use them sustainably by pumping no more than the recharge.

Why: The table is the diagnosis; it should quote the offending words precisely. Statements 3 and 6 are the controls and must be marked correct.

Also acceptable: Accept 'wrong' for statement 2 or 4 if the student's middle column still isolates the specific phrase and keeps the true part in the last column.

- Statements 3 and 6 marked correct
- Statements 1, 5 and 7 marked wrong with the absolute words quoted
- Statements 2 and 4 marked partly correct with the specific phrase quoted
- Each accurate idea is scientifically right

Part B: Rewrite the ones that need it

Rewrite each statement below so it is fully accurate. Keep Marisol's correct parts. Each rewrite should be one to three sentences and should include the reason, not just the corrected claim.

2. Rewrite statement 1. Your version must say what decides whether a resource is renewable, explain why a renewable resource can still run short, and say something true about groundwater and about trees.

Answer: Model: 'A renewable resource is one that nature replaces within about a human lifetime. Renewable does not mean it can never run out: if people use it faster than nature replaces it, the use is unsustainable and the supply shrinks. Groundwater is renewable where rain and snowmelt refill a shallow aquifer within a few years, and nonrenewable where a deep desert aquifer holds water that soaked in thousands of years ago. Trees in a plantation that regrows in about 25 years are renewable, and cutting them is sustainable if the harvest keeps pace with regrowth; a forest of trees that took centuries to grow is not renewable on a human timescale.'

Why: The rewrite must replace 'can never run out' with nature's replacement time, keep sustainability as a separate question, and give the two-sided truth for both examples.

Also acceptable: Accept 'can still run short if overused' in place of a full groundwater example if the replacement-time idea is explicit.

- Defines renewable by nature's replacement time compared with a human lifetime
- Says a renewable resource can still run short when use outpaces replacement
- Groundwater described as either, depending on how long the aquifer takes to refill
- Trees described as either, depending on regrowth time

3. Rewrite statement 2. Keep the true part (oil does come from sea organisms). Fix the part about *where* and *when*.

Answer: Model: 'Petroleum does come from sea organisms, mostly microscopic plankton, but not the ones living today. The remains piled up in oxygen-poor mud on the floor of ancient seas millions of years ago, were buried kilometers deep, and were heated into oil, which then collected in traps. So oil is found where those ancient seafloors are now, which may be a desert like the Ghawar region of Saudi Arabia, not where fish happen to live today.'

Why: Keeps the correct origin, corrects the present-tense location, and adds the time scale and the burial-and-trap steps that decide where oil is.

Also acceptable: Naming the Gulf of Mexico or the Persian Gulf region as an ancient-sea example is acceptable in place of Ghawar.

- Keeps the marine-organism origin
- Replaces 'today' with ancient seas millions of years ago
- States that oil is found where old seafloors were buried and trapped, with an example such as a desert

4. Rewrite statement 4. What really raises the temperature of buried remains, and what does the pressure do?

Answer: Model: 'As sediment piles up, the buried remains are carried deeper, and rock gets hotter with depth because heat flows up from Earth's interior; at about 2 to 4 kilometers the remains reach 60 to 120 °C, and over millions of years that heat breaks them down into oil. Pressure also increases with depth and squeezes the sediment into rock, but it is the heat, not the pressure, that makes the oil.'

Why: The textbook's wording can be read as pressure causing the heating; the accurate statement is that temperature rises with depth. Pressure compacts the sediment.

Also acceptable: Accept a rewrite without the specific numbers if the heat-with-depth idea is clear.

- Attributes the temperature to depth (heat from Earth's interior)
- Attributes the oil-making to heat over time
- Says what pressure actually does, or at least that it does not create the heat

5. Rewrite statement 5. Your version must say how soil forms, roughly how long it takes, and what that means for a farm that loses its topsoil.

Answer: Model: 'Soil forms when rock at the surface weathers into small particles and decaying plants and animals add organic matter and nutrients, with help from water, air and living things. Building a fertile layer takes decades to thousands of years, so if a farm loses its topsoil to erosion or overgrazing it will not come right back; on a human timescale, fertile topsoil is nonrenewable, so what is left has to be protected.'

Why: Three required elements: how soil forms, the time scale, and the consequence for a farm.

Also acceptable: Accept 'hundreds to thousands of years' or 'centuries' for the time scale.

- Describes weathering plus organic matter as the formation process
- Gives a time scale of decades to thousands of years (or longer)
- Concludes that lost topsoil takes far longer than a lifetime to replace, so it is nonrenewable on a human timescale

6. Rewrite statement 7. Keep the kernel of truth (some groundwater is being used up) and fix the words 'all' and 'never'. Use the words **recharge** or **replenish** in your rewrite.

Answer: Model: 'Some groundwater is being used up: deep aquifers that refill extremely slowly, like parts of the Great Artesian Basin under central Australia or many desert aquifers, hold water that took thousands of years or more to soak in, so for people that water is nonrenewable. But shallow aquifers in regions with plenty of rain are replenished every year, so their water is renewable, and a town can use wells sustainably as long as it pumps no more than the recharge. So the right rule is not never use wells; it is know how fast your aquifer refills and keep pumping at or below the recharge.'

Why: Keeps the kernel of truth, removes 'all' and 'never', and uses the required term.

Also acceptable: A student may name the Great Artesian Basin or a desert aquifer, or none; an example is not required.

- Uses 'recharge' or 'replenish'
- Keeps the truth that some aquifers are being depleted
- States that shallow, well-recharged aquifers can be used sustainably
- Replaces 'never' with a rule that compares pumping with recharge

Part C: Find the pattern

7. Statements 1, 5 and 7 all make the same kind of mistake, even though one calls things renewable and another calls things nonrenewable. Describe the mistake in one sentence, then explain how statement 6 (which is correct) avoids it.

Answer: The mistake: treating renewable or nonrenewable as an all-or-nothing label for a whole kind of stuff (groundwater, trees, soil) that also settles whether it can run out, instead of asking how long nature takes to replace that particular resource and, separately, whether people are using it faster than that. Statement 6 avoids the mistake because it keeps the two questions apart: geothermal energy is renewable because heat keeps flowing, and the plant's use is sustainable *only if* it returns the water and pumps no faster than the rock reheats it.

Why: This is the lesson's central accuracy point and the correction to the textbook's 'such great supply' wording: renewable comes from nature's clock, and sustainable comes from comparing the use rate with the replacement rate.

Also acceptable: Accept 'she forgot to ask how long nature takes to make more, and whether we use it faster than that' as the one-sentence description.

- Describes the error as an absolute label that skips nature's replacement time or merges it with whether the resource can run out
- Explains that statement 6 gives the label and the condition for sustainable use separately

8. Statements 2 and 4 make a different kind of mistake: both are about *how* and *when* a resource forms. Describe what Marisol has mixed up, and say why getting the 'when' right matters for predicting where oil is found.

Answer: Marisol mixes up present conditions with past processes: she places oil where sea life lives now (statement 2) and makes pressure the heat source instead of depth (statement 4), as if the oil were being made at the surface today. Getting the 'when' right matters because oil is found where seas were millions of years ago and where the remains were then buried and trapped; geologists predict oil fields from ancient seafloors and buried rock layers, not from where fish swim today, and a desert can hold a huge field while a busy fishing ground has none.

Why: The second family of errors is about time and mechanism; the payoff is that explanations of distribution must reach into the past.

Also acceptable: Accept an answer focused on statement 2 alone if the 'when' point is made clearly.

- Identifies the confusion of today's conditions with past processes (or surface with depth)
- Explains that the location of oil follows ancient seas plus burial, so predictions use the past

9. Write one sentence of feedback you would give Marisol that would help her with all seven statements at once.

Answer: Any accurate one-sentence feedback that targets the two error families, for example: 'Before you label a resource or say where it forms, ask three questions: how long does nature take to make more, are we using it faster than that, and what happened there millions of years ago?' or 'Replace every always, never and all with nature's refill time and a comparison of use with replacement, and put oil, copper and deep groundwater in the past tense.'

Why: The feedback should be transferable, not a correction of one statement.

Also acceptable: Accept feedback phrased as a question Marisol should ask herself.

- One sentence
- Addresses nature's clock and the use-versus-replacement comparison, or the past-process idea, or both
- Would help with more than one statement

Teacher notes

Statements 3 and 6 are correct on purpose, so that students cannot assume everything needs fixing; 6 is the model statement because it gives the label (geothermal energy is renewable) and the condition for sustainable use separately, matching the chapter's definitions. The error families are (a) absolute labels that skip nature's replacement time or merge the label with whether a resource can run out (1, 5, 7) and (b) today's conditions or pressure standing in for past processes and heat with depth (2, 4). Both families correspond to places where the textbook's own wording is loose: it calls Earth's interior heat inexhaustible, says most groundwater is nonrenewable without saying it depends on the aquifer, and says temperature rises as pressure rises. If students defend statement 7 by citing the Great Artesian Basin, credit the example and push on the word 'all.' Use q7 and q9 as the exit discussion.

Scaffold offered to students: Three test questions

For any statement about renewable or nonrenewable, ask two questions: 'How long does nature take to replace this, compared with a human lifetime?' (that decides the label) and 'Are people using it faster than nature replaces it?' (that decides whether the use is sustainable). A statement that mixes the two, or skips the first, is at least partly wrong. For any statement about where a resource forms, ask: 'Is this about today's conditions or about conditions millions of years ago?' Oil, copper ore and most deep groundwater were made by past conditions. For any statement with 'always', 'never' or 'all', ask: 'Can I think of one exception from the lesson?' A shallow aquifer that refills every spring is the exception to statement 7.

Extension: Write the trap statements

Write three new statements about this lesson's resources that are *almost* right: each should contain one tempting error of the same two kinds found here (mixing up the renewable label with whether a use is sustainable, or confusing today's conditions with past processes). Trade with a partner and diagnose each other's statements. Then write a sentence explaining which kind of error was harder to spot and why you think that is.