

Rock Cycle Check: Retrieval Practice and a Short Synthesis

Learning target: I can recall how the three rock types form, trace routes through the rock cycle, match each process to its energy source, and explain the cycling of Earth's materials in a short written synthesis.

Retrieval and mastery check

About 35 min

Individual

MS-ESS2-1 · assesses

independent practice

writing

Standards connections

MS-ESS2-1 (assesses, the describing half: students explain, with a sketch, the processes that cycle Earth's materials and the energy that drives them): Items span melting, crystallization, weathering, deformation and sedimentation and require students to name the energy flow behind each; the synthesis asks for two different routes through the cycle with energy sources. Together these produce evidence toward the PE without any mineral identification.

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

Answers with reasoning

Part A: Retrieval (24 points)

1. Which statement about metamorphic rock is correct? 2 pts

Answer: B: It forms when heat and pressure change a rock's texture or minerals while the rock stays solid.

Why: A describes melting, which leads to igneous rock; C describes sedimentary rock; D is false because any rock type, including igneous, can be metamorphosed.

Also acceptable: None.

2. An igneous rock has interlocking crystals about 6 mm across. What does this tell you? 2 pts

Answer: B: It cooled slowly from magma underground.

Why: Crystals of 6 mm are coarse-grained, which requires a long cooling time, possible only when magma is insulated below the surface.

Also acceptable: None.

3. True or false: A rock must become sedimentary rock before it can become metamorphic rock. 1 pt

Answer: False.

Why: Any rock type, including igneous rock, can be changed directly into metamorphic rock by heat and pressure; there is no required order.

Also acceptable: None.

4. Loose sediment becomes sedimentary rock by two steps: _____, when the weight of overlying layers squeezes the grains together, and _____, when minerals carried by water glue the grains to each other. 2 pts

Answer: Compaction; cementation.

Why: The order matches the descriptions: squeezing by weight is compaction, gluing by minerals from water is cementation.

Also acceptable: Accept 'compacting' and 'cementing'.

5. Which energy source drives weathering, erosion and deposition at Earth's surface? 2 pts

Answer: B: Energy from the Sun, with gravity pulling material downhill.

Why: Surface processes are powered by sunlight, which drives rain, wind and ice, plus gravity; the other options are interior-driven or irrelevant.

Also acceptable: None.

6. Pumice is a frothy rock that is mostly glass with tiny holes. Explain how it cooled and why it has almost no visible crystals. 2 pts

Answer: Pumice forms when gas-rich magma is blasted out in an explosive eruption and cools almost instantly in the air. Cooling that fast leaves no time for new crystals to grow, so the melt freezes as glass, and the escaping gas leaves holes.

Why: Full credit needs the fast surface cooling and the link between no time and no crystals. (Pumice can carry a few crystals that grew before the eruption, so 'almost no' is the accurate phrasing.)

Also acceptable: Accept 'extrusive' with the speed explained; mentioning the gas holes is a bonus.

- Says it cooled very fast at the surface / in an eruption
- Links fast cooling to lack of crystal growth (glass)

7. A cliff of sandstone loses about 2 mm of rock from its face each year to weathering and erosion. At that rate, how many years would it take to wear back 10 meters? Show your work, including the unit conversion. 3 pts

Answer: $10 \text{ m} \times 1,000 \text{ mm per m} = 10,000 \text{ mm}$. $10,000 \text{ mm} \div 2 \text{ mm per year} = 5,000 \text{ years}$.

Why: Distance divided by rate gives time once units match. The common error ($10 \div 2 = 5 \text{ years}$) skips the conversion.

Also acceptable: Accept 5,000 years with the conversion shown in either direction (converting 2 mm to 0.002 m gives $10 \div 0.002 = 5,000$).

8. Draw two circles side by side. In the first, sketch the crystals of an **intrusive** igneous rock as they would look under a hand lens; in the second, sketch an **extrusive** igneous rock. Label each circle with where the rock cooled and how fast. 3 pts

Answer: Circle 1 (intrusive): a few large interlocking crystals filling the circle, with different shading for different minerals, labeled 'cooled slowly, deep underground'. Circle 2 (extrusive): many tiny crystals (dots or a nearly uniform fine texture), possibly with a few gas holes, labeled 'cooled quickly, at the surface'.

Why: Score the contrast in crystal size and the two labels; artistic quality does not matter. Crystals should be drawn interlocking (no gaps) in both, since both are igneous.

Also acceptable: A glassy extrusive sketch with no crystals and gas holes (pumice-like) is acceptable if labeled 'cooled almost instantly'.

- Large crystals in the intrusive circle, tiny ones in the extrusive circle
- Each circle labeled with place and speed of cooling

9. A geologist says, 'The rock cycle has no beginning and no end.' Explain what she means, with one example of a rock changing into a type that is not the 'next' one in a simple loop. 2 pts

Answer: She means that rock material has been cycling for Earth's whole history and will keep cycling; no rock type is a starting point or a finish line, and any rock can become any other by the right process. Example: a metamorphic rock can be weathered straight into sediment after uplift, skipping the melting and igneous stages; or an igneous rock can be metamorphosed directly without ever becoming sediment.

Why: Full credit needs both the 'no start or end' idea and a valid skip-a-step example.

Also acceptable: Any correct non-loop route earns the example point.

- Explains that there is no start or end point
- Gives a valid example of a route that is not the simple loop

10. Which observation is the strongest evidence that a rock is sedimentary? 2 pts

Answer: B: It is made of rounded grains glued together in flat layers, some containing shell fragments.

Why: Rounded cemented grains, layering and shells are the sedimentary signature; A is not diagnostic, C describes igneous texture, D describes metamorphic texture.

Also acceptable: None.

11. Which energy source drives the deformation of rock into banded metamorphic rock, and why can the Sun not do this job? 2 pts

Answer: Heat from Earth's interior, together with the tectonic forces that push plates together, drives deformation. The Sun cannot do it because sunlight does not reach kilometers underground; it heats only the surface and the air, so it cannot supply the deep heat or the enormous pressure needed to bend solid rock and line up its crystals.

Why: The answer must name the interior and explain the Sun's limit to the surface.

Also acceptable: Accept 'plate collisions' as the driver if tied to Earth's interior.

- Names Earth's interior (or tectonic forces powered by it)
- Explains that the Sun's energy acts only at or near the surface

12. Name the one process that must happen before any rock can become igneous rock.

1 pt

Answer: Melting (the rock must become magma or lava first).

Why: Igneous rock by definition crystallizes from a melt.

Also acceptable: Accept 'it must turn into magma'.

Part B: Synthesis (6 points)

13. A clam shell lies on a beach. Describe **two different routes** by which the material in that shell could end up as part of an igneous rock. For each route, name every rock type or material along the way, the process for each change, and the energy source behind each process. One route must pass through a metamorphic stage and the other must not.

6 pts

Answer: Model response. Route 1 (through a metamorphic stage): the shell is buried with other shells on the seafloor (deposition, gravity and Sun-driven water) and compacted and cemented into a shelly sedimentary rock (gravity, water). Plate collision drags the rock deep, where heat and pressure change it into metamorphic rock while solid (Earth's interior). Dragged deeper still, or heated by nearby magma, it melts into magma (Earth's interior), which later cools and crystallizes into igneous rock (heat from the interior being lost). Route 2 (no metamorphic stage): the shell is weathered into fragments and dissolved material at the surface (Sun), carried and deposited (Sun and gravity), and compacted and cemented into sedimentary rock. That rock is buried so deep, or so close to an intrusion, that it melts directly into magma without a metamorphic stage (Earth's interior), and the magma cools into igneous rock. Both routes end at the same rock type by different paths, showing the cycle is a web.

Why: Score 6 points: one point each for a complete chain of stages in each route (2), the processes named correctly in each (2), the energy sources correctly matched in each (1), and the metamorphic stage present in exactly one route (1). Melting must appear in both routes, since igneous rock requires a melt.

Also acceptable: A route that sends the shell's dissolved material to crystallize as rock from evaporating water, then melts it, is a valid non-metamorphic route. A route that skips the sedimentary stage entirely (shell weathered to sediment, sediment buried and melted) is scientifically weak because loose sediment is lithified before it reaches melting depths; accept with a note if the rest is correct.

- Two distinct routes, each ending in igneous rock
- Every change has a named process
- Every process has a correct energy source
- One route includes a metamorphic stage and the other does not
- Melting appears before the igneous stage in both routes

Teacher notes

Total 30 points: Part A 24 (q1 2, q2 2, q3 1, q4 2, q5 2, q6 2, q7 3, q8 3, q9 2, q10 2, q11 2, q12 1) and Part B 6. Items q1, q3, q9 and q11 target the chapter's main misconceptions (metamorphism as melting, a required order, the Sun as a deep energy source), so scan those first when scoring. The q7 figure of 2 mm per year is a teaching rate; real cliff retreat ranges from far less to far more. Use the q8 sketches alongside the W4 model drawings as the chapter's visual evidence. For q13, the two routes are the clearest check of whether students see the cycle as a web; a student who writes two nearly identical routes has not met the 'different routes' requirement. This sheet avoids mineral names on purpose, in keeping with the PE's assessment boundary. A 'no metamorphic stage' route that melts sedimentary rock directly is a model shortcut: in nature, rock heated toward melting is usually metamorphosed on the way, so accept the shortcut as the textbook model allows and credit students who point this out.

Scaffold offered to students: Memory hooks

If you get stuck, use these hooks. Rock types by how they formed: igneous = from a melt; sedimentary = from pieces, shells or dissolved material deposited and cemented; metamorphic = changed while solid. Crystal size: slow and deep means big; fast and shallow means small. Energy: Sun at the surface (weathering, erosion, deposition); Earth's interior underground (melting, metamorphism, uplift); gravity pulls things down everywhere. For q13, start the shell on the seafloor and ask at each step: 'What has to happen next, and what energy makes it happen?'

Extension: Write the item that would catch you

Look back at the item you found hardest. Write a new question on the same idea that would catch someone who still holds the misunderstanding you nearly made, including the answer and a sentence on why the wrong choice is tempting. Then write a second question on an idea this sheet did not test at all (for example, how dissolved material becomes rock, or how uplift brings deep rock to the surface), with its answer. Trade with a partner and answer each other's questions.