RLP-ESA · RLP Earth Science A — The Universe, Deep Time and a Changing Surface

Unit 2: Deep Time: Earth's Formation and the Age of Rocks

Practice Workbook. The same problems, in the same order, as the Practice sections of the online lessons.

Name _____ Period _____

Lesson 2.1 — Reading Time in Rock Layers

FLUENCY

1. Layers from bottom to top are sandstone, shale and limestone, undisturbed. Which is oldest, and which principle tells you?

2. A granite dike cuts through three layers but stops at an erosion surface with flat layers above it. List the events in order.

3. A conglomerate contains pebbles of basalt. Which is older, the basalt or the conglomerate?

APPLICATION

4. A 30 m thick shale layer formed from mud settling at about 1 cm per 1,000 years (an illustrative rate). About how long did it take to form?

5. Tilted layers are cut off by a flat erosion surface, with flat layers above. What kind of feature is this, and what does it tell you about time?

6. Two canyons 50 km apart both contain a layer with the same distinctive trilobite fossils. What can a geologist conclude, and by which principle?

7. In the St. Francois Mountains of Missouri, the Lamotte Sandstone (laid down in the Late Cambrian, which began about 497 million years ago) rests on eroded volcanic rock about 1,450 million years old. What kind of unconformity is this, and at least how much time does the buried surface represent?

CHALLENGE

8. A fault offsets layers A-D but not layer E above it; a dike cuts E and the fault. Put all events in order and explain why relative dating alone cannot say how long the gap between D and E lasted.

REVIEW

9. Convert 300 mL to L.

10. Review (Unit 1): an object orbits the Sun with a semi-major axis of 16 AU. What is its period?

Lesson 2.2 — Half-Life: The Clock Inside Rocks

FLUENCY

1. An isotope has a half-life of 4 days. How long until only 1/64 of the original sample remains?

2. A sample starts with 640 g of an isotope whose half-life is 8 years. How much remains after 32.0 years?

3. A sample starts with 640 g of an isotope whose half-life is 30 years. How much remains after 150.0 years?

4. A sample starts with 80 g of an isotope whose half-life is 30 years. How much remains after 120.0 years?

APPLICATION

5. A volcanic ash layer has 7 atoms of argon-40 (from decay) for every atom of potassium-40 left (assume the branching correction is done). How old is it? Half-life 1.25 billion years.

6. Charcoal from an ancient fire pit has 12.5% of the carbon-14 of living wood. How old is it?

7. A zircon has 0.50 lead-206 atoms per uranium-238 atom. Find its age (half-life 4.468 billion years).

8. A zircon from a Missouri granite in the St. Francois Mountains is 1.47 billion years old. What lead-206 to uranium-238 ratio should it hold (half-life 4.468 billion years, no starting lead)?

CHALLENGE

9. Only one-third of the original potassium-40 remains in a rock. How old is it (half-life 1.25 billion years)? Show why the answer is between one and two half-lives.

REVIEW

10. Review (Unit 1): a galaxy recedes at 7,000 km/s. With H_0 = 70 km/s/Mpc, how far away is it?

Lesson 2.3 — How Old Is Earth? Weighing the Evidence

FLUENCY

1. A wood sample has 50% of the carbon-14 of living wood. Using a half-life of 5,730 years, estimate its age.

2. An isotope has a half-life of 28.8 days. How long until only 1/16 of the original sample remains?

3. A meteorite is 4.54 billion years old. What ratio of lead-206 to uranium-238 would you expect (half-life 4.468 billion years, no starting lead)?

4. Earth's oldest intact rocks are about 4.0 billion years old and Earth is about 4.54 billion years old. How long is the gap?

APPLICATION

5. A zircon from the Jack Hills has 0.979 lead-206 atoms per uranium-238 atom. Find its age and state the assumption.

6. Explain why meteorites give the age of Earth's formation even though they are not pieces of Earth.

7. A lunar highland rock is 4.46 billion years old; the oldest intact Earth rock is 4.03 billion. Give two reasons Earth has no surface rocks as old as the Moon's.

CHALLENGE

8. Uranium-235 decays to lead-207 with a half-life of 0.704 billion years. What lead-207/uranium-235 ratio should a 4.40-billion-year-old zircon have, and why do geologists check both clocks?

REVIEW

9. Review (Unit 1): a comet has a period of 27 years. What is its semi-major axis?

Lesson 2.4 — Earth and Life Changed Together

FLUENCY

1. On a timeline where 1 square = 10 million years, how many squares from today is the Great Oxidation Event (2,400 million years ago)?

2. At the same scale, how far from today are the first land plants (about 470 million years ago)?

3. If one square is 10 cm long, how long is the whole 4.6-billion-year timeline in meters?

4. On the same 10-million-years-per-square timeline, how far from today are Missouri's St. Francois Mountains volcanoes (about 1,470 million years ago)?

APPLICATION

5. Life existed from at least 3.5 billion years ago, but animals appear widely only from the Cambrian (539 million years ago). For what fraction of Earth's 4.6-billion-year history was life microbial only?

6. Give two kinds of rock evidence that oxygen built up in the atmosphere about 2.4 billion years ago.

7. Explain one two-way link between land plants and climate.

CHALLENGE

8. Homo sapiens appeared about 300,000 years ago. On a 46 m timeline of Earth's history, how many millimeters does our species occupy?

REVIEW

9. Convert 60 km/h to m/s.

10. Review (Unit 1): a star's spectrum peaks at 725 nm. What is its surface temperature?

Unit 2 checkpoint

1. A fault cuts layers 1-4 but not layer 5 above them. What can you conclude?
   A. The fault is older than layer 1
   B. The fault is younger than layer 4 and older than layer 5
   C. Layer 5 is the oldest
   D. The fault and layer 5 are the same age

2. After 4 half-lives, _____% of the parent isotope remains.

3. A rock has 3 daughter atoms per parent atom. How many half-lives have passed?
   A. 1
   B. 2
   C. 3
   D. 4

4. True or false: Heating a rock changes the half-life of the uranium in it.

5. Which method would you use to date a 20,000-year-old campfire?
   A. Uranium-lead
   B. Potassium-argon
   C. Carbon-14
   D. Crater counting

6. True or false: Earth's oldest intact rocks are younger than Earth itself.

7. Why do scientists date the solar system from meteorites?
   A. Meteorites are radioactive
   B. They formed with the planets and were never recycled
   C. They come from other stars
   D. They are the youngest rocks

8. The Great Oxidation Event happened about _____ billion years ago.

9. True or false: Banded iron formations formed as oxygen from early life reacted with iron dissolved in seawater.

10. Which is an example of life changing the geosphere?
    A. The Moon forming
    B. Roots and soil acids speeding the weathering of rock
    C. A meteorite impact
    D. Radioactive decay

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