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

Unit 4: Rocks, Water and a Changing Surface

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

Name _____ Period _____

Lesson 4.1 — Minerals, Rocks and the Rock Cycle

FLUENCY

1. What is the mass of 20.0 cm^3 of ice (density 0.917 g/cm^3)?

2. What volume does 18.4 g of olive oil (density 0.92 g/cm^3) occupy?

3. What is the mass of 40.0 cm^3 of copper (density 8.96 g/cm^3)?

4. A pale mineral grain has mass 26.5 g and volume 10.0 cm^3. Find its density and identify it from: quartz 2.65, calcite 2.71, dolomite 2.84, galena 7.4.

APPLICATION

5. A rock of mass 52.0 g raises the water in a cylinder from 60.0 mL to 79.3 mL. Find its density and suggest a rock type (granite about 2.7, basalt about 3.0).

6. Galena (7.4 g/cm^3) and quartz (2.65 g/cm^3) grains of the same volume are carried by an Ozark stream. How many times heavier is the galena grain, and where does each settle as the stream slows?

7. A rock has large interlocking crystals; another has sand grains cemented together in layers; a third has wavy bands of aligned minerals. Classify each and say how it formed.

CHALLENGE

8. A chunk of ore is galena (7.4 g/cm^3) in dolomite (2.84 g/cm^3). It has mass 30.0 g and volume 6.0 cm^3. What fraction of its volume is galena, and what mass of galena does it contain?

9. Dumbo, the largest boulder at Elephant Rocks State Park, is 27 ft tall, 34 ft long and 17 ft wide, and Missouri State Parks gives its weight as 680 tons. Treat it as an ellipsoid, V = (π/6) × length × width × height, with granite at 2.67 g/cm^3. Find its volume in m^3 and its mass in short tons (1 short ton = 907.18 kg). Does the published weight check out?

REVIEW

10. Compare a magnitude 5.0 earthquake with a magnitude 4.0 earthquake. About how many times larger is the ground-motion amplitude, and about how many times more energy is released?

11. A wood sample has 70% of the carbon-14 of living wood. Using a half-life of 5,730 years, estimate its age.

Lesson 4.2 — Running Water: A Stream-Table Investigation

FLUENCY

1. A stream is 20 m wide, 1.5 m deep and flows at 1.2 m/s. What is its discharge?

2. A stream table is raised 5 cm over a 100 cm length. What is its slope as a percentage and as an angle?

3. A creek is 4 m wide, 0.5 m deep and flows at 0.6 m/s. Find the discharge.

APPLICATION

4. A river with discharge 36 m^3/s carries 500 mg of suspended sediment per liter. How much sediment does it carry per second and per day?

5. In a flood, the same river's discharge rises to 400 m^3/s and sediment concentration to 5,000 mg/L. How many times more sediment per second does it carry than at 36 m^3/s and 500 mg/L?

6. In your stream table, name the independent variable, the dependent variable and three controlled variables.

7. On the Current River at Van Buren (USGS 07067000), the highest daily mean flow in water year 2026 was 9,330 ft^3/s and the lowest 745 ft^3/s. Convert both to m^3/s (1 ft^3 = 0.02832 m^3) and find the ratio. Why is the ratio small for a river this size?

CHALLENGE

8. Explain, using energy, why a steep Ozark creek leaving its narrow hollow onto a wide, flat valley floor drops coarse gravel near the mouth of the hollow and carries finer sand and mud farther.

REVIEW

9. Compare a magnitude 6.5 earthquake with a magnitude 5.0 earthquake. About how many times larger is the ground-motion amplitude, and about how many times more energy is released?

10. Review (Unit 3): an S-P lag of 9.0 s means the earthquake is how far away (d = 8.4 × lag)?

Lesson 4.3 — Why Hillsides Fail: Water, Land Use and Feedbacks

FLUENCY

1. Find the factor of safety for soil with $\mu = 0.6$ on a 20° slope ($FS = \mu \cos\theta / \sin\theta$).
2. Find the steepest stable angle for dry sand with $\mu = 0.65$.
3. A sand cone is 45 mm high with a base radius of 75 mm. What is its angle of repose?

APPLICATION

4. Soil with $\mu = 0.6$ sits on a 25° slope. Find FS when dry, and when pore water reduces the pressing force by 40%. Does the slope fail?

5. Explain why damp sand holds a steeper slope than dry sand, but saturated sand slumps.

6. Write the feedback chain linking forest clearing and open-range grazing in the Ozarks to gravel in the streams and back to the biosphere, naming the Earth system at each step.

CHALLENGE

7. What fraction of the pressing force must pore water remove for a slope with $\mu = 0.7$ at 30° to reach FS = 1?

REVIEW

8. A sample starts with 100 g of an isotope whose half-life is 30 years. How much remains after 90.0 years?

9. Review (Unit 3): how many times more energy does an M7.1 earthquake release than an M6.4?

Lesson 4.4 — Water, the Rock Breaker: Ice, Solution and Heat

FLUENCY

1. Ice has density 0.917 g/cm^3. By what percentage does water expand when it freezes?

2. A crack holds 80 cm^3 of water. What volume does it need when the water freezes?

3. A 3 cm cube is broken into 1 cm cubes. By what factor does the total surface area increase?

APPLICATION

4. How much energy warms 2.0 kg of water by 5.0 °C, and how much would warm 2.0 kg of granite by the same amount? (c: water 4,184, granite 790 J/(kg·°C))

5. A 5.00 g chalk stick loses mass in vinegar and dries to 4.12 g. What percentage dissolved?

6. Write the reaction of calcite with carbonic acid and explain why limestone caves form where rainwater soaks through soil.

7. Big Spring's water carries about 173 mg of dissolved rock per liter (as calcium carbonate). Its mean flow in water year 2026 was 363 ft^3/s (10.3 m^3/s). How many metric tons of rock does it carry away per day?

CHALLENGE

8. Explain how frost wedging and chemical weathering speed each other up in the granite at Elephant Rocks.

REVIEW

9. Compare a magnitude 5.0 earthquake with a magnitude 4.0 earthquake. About how many times larger is the ground-motion amplitude, and about how many times more energy is released?

10. Review (Unit 2): a zircon has 1 lead-206 atom per 3 uranium-238 atoms. How many half-lives have passed?

Unit 4 checkpoint

1. A 40.0 g sample displaces 15.0 cm³ of water. What is its density?
   A. 1.67 g/cm³
   B. 2.67 g/cm³
   C. 3.75 g/cm³
   D. 600 g/cm³
2. Which rock forms when heat and pressure change limestone without melting it?
   A. Granite
   B. Marble
   C. Sandstone
   D. Basalt
3. True or false: In the rock cycle, surface processes are driven mainly by the Sun's energy and gravity.
4. A stream 10 m wide and 2 m deep flowing at 1.5 m/s has a discharge of _____ m³/s.
5. Where does a stream drop its largest grains?
   A. Where it speeds up
   B. Where it slows down
   C. Only in the ocean
   D. Nowhere; it carries them all
6. Water expands by about _____% when it freezes.
7. A slope has FS = 1.3 when dry. Pore water reduces the pressing force by 30%. What is the new FS?
   A. 0.39
   B. 0.91
   C. 1.00
   D. 1.69

8. True or false: Clearing Ozark forests and letting livestock crowd into valley bottoms helped release gravel that is still moving through Ozark streams.
9. Which change would speed chemical weathering of a limestone block the most?
   A. Keeping it dry and cold
   B. Crushing it into small pieces in acidic water
   C. Painting it
   D. Moving it to a desert
10. True or false: Water's specific heat is about five times that of granite.

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