RLP-ESB · RLP Earth Science B — Water, Climate, Resources and Hazards

Unit 1: Earth's Systems and Missouri's Water

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

Name _____ Period _____

Lesson 1.1 — Rivers, Reservoirs and the 2012 Drought

FLUENCY

1. Truman Lake's flood pool holds up to 5,189,985 acre-feet. On December 1, 2012 the lake held 1,088,560 acre-feet (U.S. Army Corps of Engineers). What percentage of its flood-pool capacity was that?

2. The six Missouri River mainstem reservoirs (capacity 73,100,000 acre-feet) held 72,848,000 acre-feet on July 2, 2011. What percentage of capacity was that?

3. Convert the mainstem system's full capacity of 73,100,000 acre-feet to cubic kilometers (1 acre-foot = 1,233.48 m^3).

APPLICATION

4. Between August 1 and November 30, 2012, storage in the Missouri River mainstem reservoirs fell from 56.4 to 48.9 million acre-feet (Corps of Engineers). How much water was that, and what fraction of the system's 73.1 million acre-foot capacity?

5. One cubic foot per second flowing for a day delivers 86,400 ft^3, and one acre-foot is 43,560 ft^3. On January 29, 2013 the Missouri River at Hermann flowed at 26,900 ft^3/s. How many acre-feet passed Hermann that day?

6. Explain the soil-moisture feedback in a hot, dry summer and say whether it is reinforcing or balancing.

CHALLENGE

7. Trace a chain of at least four linked changes, across at least three Earth systems, that starts with a summer of very little rain and ends with a household's shallow well in the Bootheel going dry. Name the system at each step.

REVIEW

8. 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?

9. A sample starts with 100 g of an isotope whose half-life is 30 years. How much remains after 150.0 years?

Lesson 1.2 — Porosity and Permeability: How Aquifers Hold Water

FLUENCY

1. 100 mL of dry gravel takes 38 mL of water to fill its pores. What is its porosity?

2. A 250 mL sand sample holds 80 mL of water in its pores. What is its porosity?

3. 100 mL of water is poured onto dry sand in a holed cup and 72 mL drains out. How much water did the sand retain, as a volume and a percentage?

APPLICATION

4. An aquifer under 50 km^2 of farmland has a specific yield of 0.15. The water table falls 3 m in a drought. How much water was removed, in m^3 and acre-feet?

5. Clay has a porosity of about 50% and gravel about 35%. Explain why gravel is the better aquifer.

6. In the lab, gravel drained in 8 s, sand in 45 s and soil in 190 s. Rank their permeabilities and suggest which would recharge fastest after a storm.

CHALLENGE

7. Gravel with a porosity of 0.38 has its pores completely filled with sand whose own porosity is 0.35. What is the porosity of the mixture? Use it to explain why poorly sorted sediment makes a poorer aquifer.

REVIEW

8. What is the mass of 150.0 cm^3 of water (density 1.0 g/cm^3)?

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

Lesson 1.3 — Groundwater, the Bootheel and the Cone Under Springfield

FLUENCY

1. Under Springfield the water level in the Ozark aquifer was about 350 feet below its predevelopment level in 1987 and about 500 feet below it in 1996. What was the average rate of decline in feet per year?

2. The same water level was nearly 300 feet below predevelopment in 1974 and 350 feet below in 1987. What was the average rate of decline in feet per year?

3. In a Bootheel monitoring well near Malden, the depth to water was 12.53 ft on March 13, 2012 and 19.19 ft on September 11, 2012. How far did the water table drop, and about how fast in feet per month?

APPLICATION

4. The water table falls 2 m under 1 km^2 of Bootheel farmland, in sand with a specific yield of 0.20. How much water was removed from storage, in m^3 and acre-feet?

5. In the sand-box model the water table next to the pumping well fell from 60 mm to 28 mm, then rose to 52 mm five minutes after pumping stopped. What was the drawdown, and what percentage of it had recovered after five minutes?

6. Give two ways the availability of groundwater has shaped where and how people live in Missouri.

CHALLENGE

7. A household well near Malden has its pump intake 18 ft below the ground. Using the Malden record (12.53 ft in March 2012, 19.19 ft in September 2012, 12.97 ft in August 2013), when was the water table below the intake, and why would the deeper irrigation wells nearby keep working?

REVIEW

8. Compare a magnitude 7.5 earthquake with a magnitude 6.0 earthquake. About how many times larger is the ground-motion amplitude, and about how many times more energy is released?

Lesson 1.4 — Modeling a Groundwater Basin

FLUENCY

1. A basin holds 2,000,000 acre-feet. Recharge is 400,000 and pumping 550,000 acre-feet per year. What is the storage after 3 years?

2. For the same basin, how many years until the usable storage is gone?

3. What percentage cut in pumping from 550,000 would balance recharge of 400,000?

APPLICATION

4. Recharge follows a 5-year cycle: 700,000 acre-feet in each of 2 wet years and 200,000 in each of 3 dry years. What is the average recharge, and what pumping rate would be sustainable on average?

5. With pumping at 550,000 and the 5-year cycle above, how much storage is lost over one full cycle? Over 20 years?

6. A district adds managed recharge of 100,000 acre-feet in each wet year and cuts pumping by 15%. What is the average yearly change in storage?

CHALLENGE

7. In the dry years, farmers pump 650,000 instead of 550,000 (and 450,000 in wet years). With the 5-year recharge cycle, what is the average yearly change in storage, and what does this show about droughts?

REVIEW

8. A sample has mass 150.0 g and volume 150.0 cm^3. Find its density and, using a density table, suggest what it could be.

9. Review (Semester A): a stream 6 m wide and 0.5 m deep flows at 1.0 m/s. What is its discharge?

Unit 1 checkpoint

1. Truman Lake holds 1,297,500 acre-feet out of a flood-pool capacity of about 5,190,000. What percentage of capacity is that?
   A. 12.5%
   B. 25%
   C. 40%
   D. 75%

2. True or false: Reservoirs such as Truman Lake and the Missouri River mainstem lakes store water in wet periods and release it in dry ones.

3. Which is a reinforcing feedback?
   A. Dry soil → more heating of the ground and air → even drier soil
   B. More rain → more plants → less runoff
   C. Cooler air → less evaporation → more cloud
   D. Pumping stops → water table rises

4. A 300 mL sample holding 105 mL of water in its pores has a porosity of _____%.

5. True or false: Clay is highly porous but has very low permeability.

6. Why can a shallow well go dry next to a deep irrigation well during a drought?
   A. The shallow well's water is used up forever
   B. The cone of depression around the pumping well lowers the water table below the shallow well's bottom
   C. The water turns to ice
   D. The deep well pulls the shallow well's casing down

7. Who must register with Missouri's Department of Natural Resources and report water use each year?
   A. Every household with a well
   B. Anyone able to withdraw 100,000 gallons of water a day or more
   C. Only cities
   D. Only power plants

8. Recharge 300,000 and pumping 360,000 acre-feet per year change storage by _____ acre-feet per year.

9. In a stock-and-flow model of a basin, which equation is correct?
   A. storage = recharge × pumping
   B. next storage = storage + recharge – pumping
   C. storage = pumping – recharge
   D. next storage = storage – recharge + pumping

10. True or false: 'Every household keeps safe drinking water' is a criterion, not a constraint.

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