EARTHB-CA · Earth Science B — Water, Climate, Resources and Hazards (California)

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

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

Name _____ Period _____

Lesson 1.1 — Snowpack, Reservoirs and a Thirsty State

FLUENCY

1. Lake Oroville holds up to 3,537,577 acre-feet. In September 2021 it held 787,600 acre-feet (CDEC). What percentage of capacity was that?

2. Shasta Lake (capacity 4,552,000 acre-feet) held 2,662,479 acre-feet in April 2015. What percentage of capacity was that?

3. Convert Shasta's full capacity of 4,552,000 acre-feet to cubic kilometers (1 acre-foot = 1,233.48 m^3).

APPLICATION

4. Shasta held 4,364,000 acre-feet in April 2024 and 2,766,000 in September 2024 (CDEC monthly values). How much storage was released or lost over the summer, and what fraction of capacity is that?

5. Snow 1.5 m deep has a density about 0.3 times that of water (a typical spring value). How deep would the water be if it melted (its snow water equivalent)?

6. Explain the snow-albedo feedback in a dry winter 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 snow-poor winter and ends with the land surface in the San Joaquin Valley sinking. Name the system at each step.

REVIEW

8. Compare a magnitude 5.5 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 200 g of an isotope whose half-life is 8 years. How much remains after 32.0 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. A sample has mass 179.2 g and volume 20.0 cm^3. Find its density and, using a density table, suggest what it could be.

9. An isotope has a half-life of 28.8 days. How long until only 1/8 of the original sample remains?

Lesson 1.3 — Groundwater and the Sinking Valley

FLUENCY

1. Near Mendota the land sank about 9 m between 1925 and 1977. What was the average rate in cm per year?

2. A benchmark sank 0.60 m in 6 years (illustrative). What is the rate in cm per year?

3. Land sinking 5 cm per month would sink how much in a year?

APPLICATION

4. A clay layer under 1 km^2 compacts permanently by 0.5 m. How much storage space is lost, in m^3 and acre-feet?

5. In the sponge-and-clay model the stack fell 6 mm when drained and rose back 4 mm when re-wetted. How much subsidence was permanent, and which layer caused it?

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

CHALLENGE

7. Subsidence of 17 cm/yr continues for 20 years under a canal. By how much does the canal floor sink, and why does that reduce how much water the canal can carry?

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 55.0 g and volume 20.0 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. Shasta holds 1,138,000 acre-feet out of 4,552,000. What percentage of capacity is that?
   A. 12.5%
   B. 25%
   C. 40%
   D. 75%
2. True or false: The Sierra snowpack acts as a natural reservoir that releases water in spring and summer.
3. Which is a reinforcing feedback?
   A. Less snow → darker ground absorbs more sunlight → faster melting
   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 is most subsidence from pumping clay layers permanent?
   A. Clay dissolves
   B. Clay particles compact into a tighter arrangement and do not rebound
   C. The water turns to ice
   D. The land is eroded
7. What does SGMA (2014) require of overdrawn basins?
   A. Stop all pumping at once
   B. Reach sustainable groundwater use within about 20 years
   C. Build new dams
   D. Sell water rights to cities
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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