CHAPTER 14  Groundwater

1. Water stored in the pore spaces of subsurface rocks and unconsolidated material is called groundwater.

2. What is the correct order, from highest to lowest, of groundwater usage in the United States?
   a. agricultural, industrial, domestic;  b. industrial, domestic, agricultural;
   c. domestic, agricultural, industrial;  d. agricultural, domestic, industrial;
   e. industrial, agricultural, domestic.

3. What percentage of the water used in the United States is provided by groundwater?
   a. 50;  b. 40;  c. 30;  d. 20;  e. 10.

4. Groundwater is part of the hydrologic cycle and represents approximately 22% of the world's supply of fresh water.

5. Discuss the role of groundwater in the hydrologic cycle.

6. What percentage of the world's supply of fresh water is represented by groundwater?
   a. 5;  b. 18;  c. 22;  d. 43;  e. 50.

7. Porosity is the percentage of a rock, sediment, or soil consisting of pore space. Permeability is the ability of a rock, sediment, or soil to transmit fluids.

8. How can a rock be porous and yet not be permeable?

9. The capacity of a material to transmit fluids is:
   a. porosity;  b. permeability;  c. solubility;  d. aeration quotient;  e. saturation.

10. A material that transmits groundwater is an aquifer and one that prevents the movement of groundwater is an aquiclude.

11. What types of materials make good aquifers and aquicludes?

12. The water table is the surface that separates the zone of aeration (in which pore spaces are filled with both air and water) from the zone of saturation (in which all pore spaces are filled with water).

13. The water table is a surface separating the: a. zone of porosity from the underlying zone of permeability;  b. capillary fringe from the underlying zone of aeration;  c. capillary fringe from the underlying zone of saturation;  d. zone of aeration from the underlying zone of saturation;  e. zone of saturation from the underlying zone of aeration.

14. Groundwater moves very slowly through the pore spaces of rocks, sediment, or soil (zone of aeration) and moves through the zone of saturation to outlets such as streams, lakes, and swamps.
15. **Why is the water table a subdued replica of the surface topography? What causes the water table level to fluctuate?**

16. **Why does groundwater move so much slower than surface water?**

17. **Groundwater:**
   - moves slowly through the pore spaces of Earth materials;
   - moves fastest through the central area of a material's pore space;
   - can move upward against the force of gravity;
   - moves from areas of high pressure toward areas of low pressure;
   - all of these.

18. A spring occurs wherever the water table intersects the Earth's surface. Some springs are the result of a perched water table, that is, a localized aquiclude within an aquifer and above the regional water table.

19. **Where are springs likely to occur?**

20. **How does a perched water table differ from a regional water table?**

21. A perched water table:
   - occurs wherever there is a localized aquiclude within an aquifer;
   - is frequently the site of springs;
   - lacks a zone of aeration;
   - answers (a) and (b);  e. answers (b) and (c).

22. Water wells are made by digging or drilling into the zone of saturation. When water is pumped out of a well, a cone of depression forms. If water is pumped out faster than it can be recharged, the cone of depression deepens and enlarges and may locally drop to the base of the well, resulting in a dry well.

23. **What is a cone of depression and why is it so important?**

24. Rapid withdrawal of groundwater can result in:
   - a cone of depression;  b. ground subsidence;  c. saltwater incursion;  d. loss of hydrostatic pressure;
   - all of these.

25. Artesian systems are those in which confined groundwater builds up high hydrostatic pressure. Three conditions must generally be met before an artesian system can form: the aquifer must be confined above and below by aquicludes; the aquifer is usually tilted and exposed at the Earth's surface so it can be recharged; and precipitation must be sufficient to keep the aquifer filled.

26. **Why are some artesian wells free-flowing while others must be pumped?**
27. *An artesian system is one in which:*
   a. water is confined;
   b. water can rise above the level of the aquifer when a well is drilled;
   c. water must be pumped;
   d. answers (a) and (c);  e. answers (a) and (b).

28. Karst topography results from groundwater, weathering, and erosion and is characterized by sinkholes, solution valleys, and disappearing streams.

29. **List the surface features of karst topography and explain how they form.**

30. Caves form when groundwater in the zone of saturation weathers and erodes soluble rock such as limestone. Cave deposits, called dripstone, result from the precipitation of calcite.

31. **How does groundwater weather and erode?**

32. **How do caves and their various features form?**

33. *Which of the following is not an example of groundwater erosion?*
   a. karst topography;  b. stalactites;  c. sinkholes;  d. caves;  e. caverns.

34. *Which of the following is not a cave deposit?*
   a. stalagmite;  b. room;  c. dripstone;  d. stalactite;
   e. none of these.

35. Modifications of the groundwater system can cause serious problems. Excessive withdrawal of groundwater can result in dry wells, loss of hydrostatic pressure, saltwater encroachment, and ground subsidence.

36. **Discuss the various effects that excessive groundwater removal may have on a region. Give some examples.**

37. Groundwater contamination is becoming a serious problem and can result from sewage, landfills, toxic waste, and agriculture.

38. **Discuss the various ways that a groundwater system may become contaminated.**

39. Hot springs and geysers may occur where groundwater is heated by hot subsurface volcanic rocks. Geysers are hot springs that intermittently eject hot water and steam.

40. **What is the difference between a thermal spring and a geyser?**
41. In which area are you least likely to find hot springs or geysers?
a. eastern Canada;   b. western United States;   c. Iceland;   d. New Zealand;   
e. none of these.

42. The water in hot springs and geysers:
a. is believed to have curative properties;   
b. is noncorrosive;   
c. contains large quantities of dissolved minerals;   
d. answers (a) and (b);   e. answers (a) and (c).

43. Geothermal energy comes from the steam and hot water trapped within the Earth's crust. It is a relatively nonpolluting form of energy that is used as a source of heat and to generate electricity.

44. **In what ways has geothermal energy been used?**

45. Which of the following is not a geothermal site?
a. Rotarua, New Zealand;   
b. Reykjavik, Iceland;   
c. Yellowstone National Park;   Wyoming;   
d. The Geysers, California;   
e. Omaha, Nebraska.

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