18. In the United States, high-grade geothermal resources are concentrated in the
    a. Pacific Northwest
    b. western states
    c. upper Midwest
    d. Southeast
19. The most important environmental effect of hydroelectric energy is
    a. the visual eyesore of dams
    b. the effect on fish and wildlife habitat
    c. noise
    d. air pollution
20. Ethanol is primarily used as a
    a. gasoline additive
    b. cattle feed
    c. fertilizer
    d. pesticide

## CHAPTER QUESTIONS AND PROBLEMS

1. What are two products of burning fossil fuels?
2. What are diagenesis and catagenesis?
3. What is true about the mass of reactants and the mass of products in all chemical reactions such as combustion?
4. Why is water vapor considered to be a greenhouse gas?
5. What substance has the highest binding energy per nucleon?
6. What is deuterium and where is it found?
7. Why is a potential fusion reactor inherently safer than a fission reactor?
8. What is ITER and where will it be constructed?
9. What is the inertial fusion project?
10. How is the solar spectrum changed as it passes through the atmosphere?
11. Assume a 6-foot by 3-foot solar panel is oriented so that it has a maximum solar insolation of 1,000 $W/m^2$. What is the peak power delivered to the panel ~~(3.048 feet = 1 meter)~~?
12. What is the inverse square law in physics?
13. Show that the solar constant of 1,368 $W/m^2$ is equal to 32.8 $kWh/m^2/day$.
14. Compare the positive and negative environmental impacts of solar and wind energy.
15. What are geothermal heat pumps?
16. What is the purpose of a barrage dam?
17. What are two ways to obtain energy from tides?
18. Summarize the important benefits and negative impacts of large dams.
19. What are the positive and negative environmental impacts of using ethanol as a gasoline supplement?
20. In addition to ethanol, what are other uses for biofuels?

## FOR DISCUSSION

What renewable resources are the best fit for the area you live in?

## ANSWERS TO CHECKUPS

### Section 1-1 Checkup

1. Fossil fuels formed from decaying plant and animal matter that was primarily formed over millions of years.
2. Methane is a primary constituent of natural gas; its chemical formula is $CH_4$.
3. The categories for coal are based on energy content and are anthracite, bituminous, sub-bituminous, and lignite.
4. Oil is used in the manufacture of lubricants, waxes, solvents, asphalt, hydraulic fluid, and vinyl.
5. Greenhouse gases are gases that contribute to global warming by absorbing short wavelength infrared energy and reradiating it at longer wavelengths.
6. Burning fossil fuels puts carbon dioxide, a greenhouse gas, in the air. Depending on the specific fuel, pollutants include sulfur, nitrous oxides, benzene, and others, which contribute to acid rain. Coal also produces a large amount of fly ash that creates a disposal problem. Other concerns include obtaining and transporting fossil fuels and safety issues.
7. Safety hazards exist for workers, particularly in the coal industry, and for the public in the form of air pollution. Transporting fuels can create hazards in the form of spills, such as the infamous oil spill by the *Exxon Valdez*.

### Section 1-2 Checkup

1. A chain reaction is a self-sustaining reaction used in fission reactors to continue the process.
2. Normal uranium will not have a chain reaction. Enrichment separates useable $^{235}U$, which can be used as a fuel from regular uranium.

- Wind is caused by pressure differences in the atmosphere and is also affected by specific conditions such as landmasses, temperature differences, cloud cover, and terrain.
- Wind resources can be shown on maps and calculated in detail for a specific site using computer programs that are checked against actual measurements.
- In the United States, major wind resources are concentrated on the coasts and the Midwest.
- Geothermal energy is available anywhere in the world; however, the best sites are near tectonic plate boundaries.
- In the United States, the western states have the best geothermal sites.
- Moving water has kinetic energy. The potential energy of reservoirs is changed to kinetic energy as the water falls out of reservoirs. Rivers and tides also have kinetic energy that can be exploited for power generation.
- Hydroelectric power is a renewable resource that provides clean energy but has negative impacts on fish and wildlife habitat, and it requires large areas of land for reservoirs. Many dams have positive impacts such as providing flood protection, irrigation water, and recreational opportunities.
- Biomass is currently the largest renewable resource in terms of energy obtained. As an energy source, biomass refers to any organic material used for a fuel.
- Ethanol is a renewable resource made primarily from corn; it has the ability to replace a portion of the gasoline required.
- Biofuel production has negative environmental impacts on land use, food and feedstock supplies, and water requirements.

## KEY TERMS

**biomass** Organic material that is commonly used for fuels for heating, power generation, or making liquid fuels useful in transportation.

**bitumen** A black tarlike hydrocarbon classified as pitch; it can occur naturally or after refining petroleum.

**breeder reactor** A nuclear reactor designed to produce plutonium. It could extend uranium supplies considerably because it can convert the otherwise unusable $^{238}U$ into a fissionable fuel.

**catagenesis** The cracking process that results in the conversion of kerogens into hydrocarbons, including natural gas and oil.

**diagenesis** The process of converting constituents to a different product through application of heat and pressure.

**diffuse horizontal irradiance (DHI)** The portion of global horizontal irradiance that comes in indirectly (scattered radiation) from the sun.

**direct normal irradiance (DNI)** The portion of global horizontal irradiance that comes in a straight line from the sun.

**ethanol** The primary biofuel used as a gasoline additive; it is a type of alcohol.

**fossil fuels** Fuels that formed from decaying plant and animal matter and were primarily formed over millions of years. Fossil fuels include coal, oil (petroleum), and natural gas.

**global horizontal irradiance (GHI)** The total amount of shortwave radiation received on a horizontal surface.

**hydrocarbon** A molecule containing only hydrogen and carbon.

**inverse square law** A physics law that states that the flux from an isotropic point source is reduced by the square of the distance from the source to the receiver.

**kerogen** A mixture of organic chemicals that are part of the organic matter in sedimentary rocks.

**pressurized water reactor (PWR)** A nuclear reactor that includes fuel rods, control rods, and a moderator in a vessel that is filled with high-pressure water to prevent it from boiling. The water in the vessel serves as both a moderator and a means to move hot water to a heat exchanger and eventually a steam-driven turbine.

**solar constant** The power emitted by the sun that falls on 1 $m^2$. It is generally cited as 1,368 $W/m^2$.

**Tokamak** A fusion reactor used by researchers to investigate properties of plasmas; the goal is to create a fusion energy reactor that can be used for electrical power generation.

## CHAPTER TRUE/FALSE QUIZ

*Determine whether each statement is true or false. Answers are at the end of the chapter.*

1. The most common use for coal is home heating.
2. A hydrocarbon molecule contains only hydrogen and carbon atoms.
3. When natural gas burns, carbon dioxide is released.
4. All reactors used for generating power are breeder reactors.
5. Delayed neutrons are not important for controlling reactors.
6. A Tokamak is a type of fusion reactor that attempts to confine the plasma.
7. The ozone in the upper atmosphere is particularly important because it absorbs infrared radiation.
8. The portion of global horizontal irradiance that comes in a straight line from the sun is called direct normal irradiance.
9. The solar constant is not affected by sunspots.
10. The prevailing wind direction in mid-latitudes is from east to west.
11. The wind resource in the United States is mainly in the eastern states.
12. *Transform plates* is the name given when two tectonic plates slide laterally past each other.

## ANSWERS TO TRUE/FALSE QUIZ

**1.** F **2.** T **3.** T **4.** F **5.** F **6.** T **7.** F **8.** T **9.** F **10.** F **11.** F **12.** T **13.** F **14.** F **15.** T **16.** F **17.** T **18.** F **19.** T **20.** F

## ANSWERS TO MULTIPLE-CHOICE QUESTIONS

**1.** d **2.** c **3.** d **4.** c **5.** a **6.** a **7.** c **8.** a **9.** b **10.** a **11.** d **12.** b **13.** c **14.** c **15.** b **16.** d **17.** b **18.** b **19.** b **20.** a