TIME SCIENCE AND Society
SCIENCE ISSUES THAT AFFECT YOU!

Reacting to Nuclear Energy

Most people agree that thanks to energy sources, we have many things that make our quality of life better. Energy runs our cars, lights our homes, and powers our appliances. What many people don't agree on is where that energy should come from.

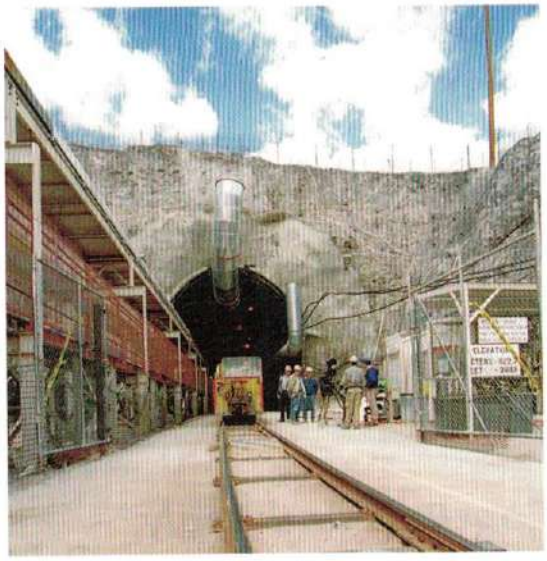
Almost all of the world's electric energy is produced by thermal power plants. Most of these plants burn fossil fuels—such as coal, oil, and natural gas—to produce energy. Nuclear energy is produced by fission, which is the splitting of an atom's nucleus. People in favor of nuclear energy argue that, unlike fossil fuels, nuclear energy is nonpolluting.

Opponents counter, though, that the poisonous radioactive waste created in nuclear reactors qualifies as pollution—and will be lingering in the ground and water for hundreds of thousands of years.

Supporters of nuclear energy also cite the spectacular efficiency of nuclear energy—one metric ton of nuclear fuel produces the same amount of energy as up to 3 million tons of coal. Opponents point out that uranium is in very short supply and, like fossil fuels, is likely to run out in the next 100 years.

Opponents worry that as utilities come under less government regulation, safety standards will be ignored in the interest of profit. This could result in more accidents like the one that occurred at Chernobyl in the Ukraine. There, an explosion in the reactor core released radiation over a wide area.

Supporters counter that it will never be in the best interests of those running nuclear plants to relax safety standards since those safety standards are the best safeguard of workers' health. They cite the overall good safety record of nuclear power plants.



This site at Yucca Mountain, Nevada, is the location of a proposed high-level nuclear waste storage facility. Here radioactive materials would be buried for tens of thousands of years.

Debate Form three teams and have each team defend one of the views presented here. If you need more information, go to the Glencoe Science Web site. "Debrief" after the debate. Did the arguments change your understanding of the issues?

ScienceOnline
For more information, visit gpscience.com/time

chapter 9 Study Guide

Reviewing Main Ideas

Section 1 Fossil Fuels

1. Fossil fuels include oil, natural gas,and coal. They formed from the buried remains of plants and animals.
2. Fossil fuels can be burned to supply energy for generating electricity. Petroleum also is used to make plastics and synthetic fabrics.

3. Fossil fuels are nonrenewable energy resources. They can be replaced, but it takes millions of years.

Section 2 Nuclear Energy

1. A nuclear reactor transforms the energy from a controlled nuclear chain reaction to electrical energy.
2. Nuclear wastes must be contained and disposed of carefully so radiation from nuclear decay will not leak into the environment. These low-level nuclear wastes are buried to protect living organisms.

3. Nuclear fusion releases energy when two nuclei combine. Fusion only occurs at high temperatures that are difficult to produce in a laboratory.

Section 3 Renewable Energy Sources

1. Alternative energy resources can be used to supplement or replace nonrenewable energy resources.
2. Other sources of energy for generating electricity include hydroelectricity and solar, wind, tidal, and geothermal energy. Each source has its advantages and disadvantages. Also, some of these sources can damage the environment.
3. Although some alternative energy sources produce less pollution than fossil fuels do and are renewable, their use often is limited to the regions where the energy source is available. For example, tides can be used to generate electricity in coastal regions only.

4. It may be possible to use hydrogen as a fuel for automobiles and other vehicles. Biomass, such as wood and other renewable organic matter, has been used as fuel for thousands of years.

FOLDABLES™ Use the Foldable that you made at the beginning of the chapter to help you review energy sources.

chapter 9 Review

Using Vocabulary

biomass p. 276
fossil fuel p. 257
geothermal energy p. 275
hydroelectricity p. 273
nonrenewable resource p. 263
nuclear reactor p. 264
nuclear waste p. 268
petroleum p. 259
photovoltaic cell p. 271
renewable resource p. 271

Complete each statement using a term from the vocabulary list above.

1. A(n) _____ uses the Sun to generate electricity.
2. _____ makes use of thermal energy inside the Earth.
3. Energy produced by the rise and fall of ocean levels is a(n) _____.
4. _____ includes the following: oil, natural gas, and coal.
5. Fossil fuels are a(n) _____ because they are being used up faster than they are being made.
6. A special caution should be taken in disposing of _____.

Checking Concepts

Choose the word or phrase that best answers the question.

7. Why are fossil fuels considered to be nonrenewable resources?
   A) They are no longer being produced.
   B) They are in short supply.
   C) They are not being produced as fast as they're being used.
   D) They contain hydrocarbons.
8. To generate electricity, nuclear power plants produce which of the following?
   A) steam **C)** plutonium
   B) carbon dioxide **D)** water
9. What is a major disadvantage of using nuclear fusion reactors?
   A) use of hydrogen as fuel
   B) less radioactivity produced
   C) extremely high temperatures required
   D) use of only small nuclei
10. How are spent nuclear fuel rods usually disposed of?
    A) burying them in a community landfill
    B) storing them in a deep pool of water
    C) burying them at the reactor site
    D) releasing them into the air
11. How much energy in the United States comes from burning petroleum, natural gas, and coal?
    A) 85% **C)** 65%
    B) 35% **D)** 25%
12. Solar cells would be more practical to use if they were which of the following?
    A) pollution free **C)** less expensive
    B) nonrenewable **D)** larger
13. Which energy source uses water that is heated naturally by Earth's internal heat?
    A) hydroelectricity **C)** tidal energy
    B) nuclear fission **D)** geothermal energy
14. What do hydrocarbons react with when fossil fuels are burned?
    A) carbon dioxide **C)** oxygen
    B) carbon monoxide **D)** water
15. Which of the following is NOT a source of nuclear waste?
    A) products of fission reactors
    B) materials with short half-lives
    C) some medical and industrial products
    D) products of coal-burning power plants
16. Which of the following is the source of almost all of Earth's energy resources?
    A) plants **C)** magma
    B) the Sun **D)** fossil fuels

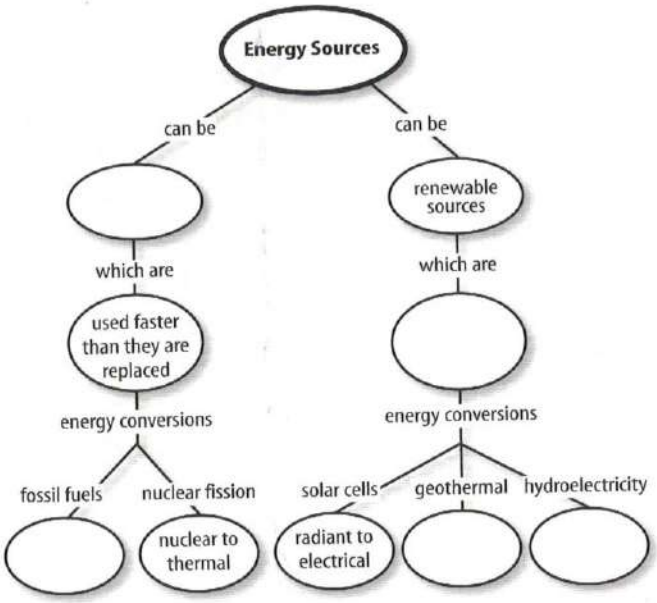
Interpreting Graphics

17. Copy and complete the table below describing possible effects of changes in the normal operation of a nuclear reactor.

Reactor Problems

Cause	Effect
The cooling water is released hot.	Do not write in this book.
The control rods are removed.	
	The reactor core overheats and meltdown occurs.

18. Copy and complete this concept map.



Thinking Critically

19. Infer why alternative energy resources aren't more widely used.

20. Infer whether fossil fuels should be conserved if renewable energy sources are being developed.

21. Infer Suppose new reserves of fossil fuels were found and a way to burn these fuels was developed that did not release pollutants and carbon dioxide into the atmosphere. Should fossil fuels still be conserved? Explain

22. Explain why coal is considered a nonrenewable energy source, but biomass, such as wood, is considered a renewable energy source.

23. Make a table listing two advantages and two disadvantages for each of the following energy sources: fossil fuels, hydroelectricity, wind turbines, nuclear fission, solar cells, and geothermal energy.

Applying Math

24. Convert Units Crude oil is sold on the world market in units called barrels. A barrel of crude oil contains 42 gallons. If 1 gallon is 3.8 liters, how many liters are there in a barrel of crude oil?

Use the table below to answer question 25.

High-Production Coal Mines

Coal Mine	Metric tons/year
North Antelope Rochelle	6.78×10^7
Black Thunder	6.13×10^7

25. Use Percentages Nine of the top coal producing mines are located in Wyoming. Production information on two of the mines is in the table above. A total of about 1.02×10^9 metric tons is produced per year in the United States. What percentage do these two coal mines contribute to the total yearly coal production in the U.S.?

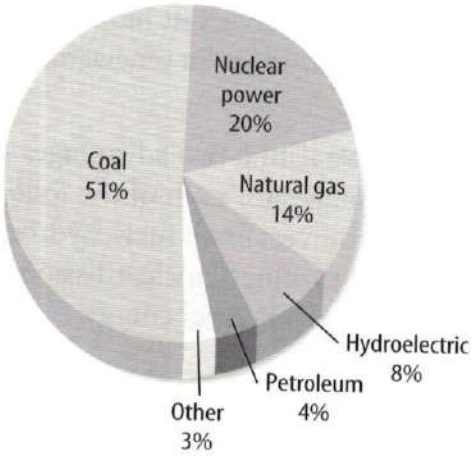
chapter 9 Standardized Test Practice

Part 1 Multiple Choice

Record your answers on the answer sheet provided by your teacher or on a sheet of paper.

Use the graph below to answer questions 1 and 2.

Sources of Electricity



1. The graph above shows the percentage of electricity generated in the United States that comes from various energy sources. According to the graph, about what percentage comes from fossil fuels?
   A. 51% **C.** 65%
   B. 55% **D.** 69%

2. The graph shows that approximately what percentage of electricity comes from nonrenewable energy sources?
   A. 97% **C.** 69%
   B. 89% **D.** 55%

3. Which of the following is a typical efficiency for a solar cell?
   A. 10% **C.** 75%
   B. 50% **D.** 95%

4. Which of the following best describes wind mills used for the production of electricity?
   A. They are quiet.
   B. They can be used anywhere.
   C. They are 90 percent efficient.
   D. They are nonpolluting.

5. Which of the following forms only from ancient plant material, not from ancient animal remains?
   A. coal **C.** natural gas
   B. crude oil **D.** petroleum

Use the table below to answer questions 6 and 7.

Efficiency of Fossil Fuel Conversion

Process	Efficiency (%)
Chemical to thermal energy	60
Conversion of water to steam	90
Steam spins turbine	75
Turbine spins electric generator	95
Transmission through power lines	90

6. The table above shows the efficiency of different steps in the conversion of fossil fuels to electricity at a power plant. According to the table, what is the efficiency for converting chemical energy in the fossil fuels to heat, and then converting water to steam?
   A. 30% **C.** 75%
   B. 54% **D.** 90%

7. What is the overall efficiency shown in the table for converting chemical energy in fossil fuels to electricity?
   A. 35% **C.** 90%
   B. 82% **D.** 95%

Test-Taking Tip

Determine the Information Needed Concentrate on what the question is asking about a table, instead of all the information in the table.

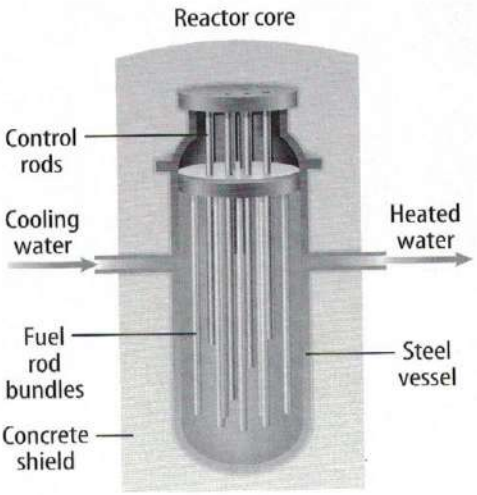
Question 7 Read the question carefully to determine which rows in the table contain the information needed to answer the question.

Part 2 Short Response/Grid In

Record your answers on the answer sheet provided by your teacher or on a sheet of paper.

8. Explain why hydroelectric power plants are almost twice as efficient as fossil fuel or nuclear power plants.
9. About 90 percent of the coal that is used in the United States is used for what purpose?
10. What is the most inefficient stage in the production of electrical energy at a fossil-fuel burning power plant?
11. Describe the typical disposal method for low-level nuclear wastes.

Use the illustration below to answer questions 12 and 13.

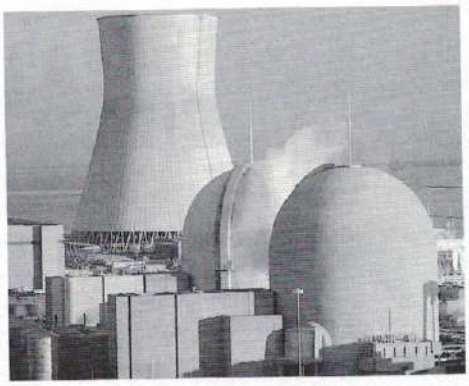


12. The core of a nuclear reactor might contain hundreds of fuel rods. Describe the composition of a fuel rod.
13. Describe the purpose of the control rods and explain how their placement in the reactor affects the nuclear chain reaction.
14. Fusion is the most concentrated energy source known. Why, then, is it not used at nuclear plants to make electricity?

Part 3 Open Ended

Record your answers on a sheet of paper.

Use the photograph below to answer questions 15 and 16.



15. The photograph above shows a nuclear power plant that generates electricity using the energy released in nuclear fission of uranium-235. Draw a sketch showing this fission process. Describe your sketch and explain how the process results in a chain reaction.
16. Explain how a nuclear reactor at a nuclear power plant produces electricity. What is the purpose of the large tower shown in the photograph?
17. Explain how the steam that is used to run turbines is produced at a geothermal power plant.
18. Describe two advantages and three disadvantages of using solar energy to generate electricity.
19. Explain why biomass is considered a renewable energy source.
20. Describe the processes that form oil, natural gas, and coal.
21. What is the difference between low-level and high-level nuclear waste? Describe an example of each type.