Name Date Class

SECTION 1 Reinforcement

Fossil Fuels

Directions: *Complete the table below by placing a check mark (✓) beneath the headings of the substances that have each characteristic described in the first column.*

Characteristic	Petroleum	Natural gas	Coal
1. is a fossil fuel	X	X	X
2. forms from plants and animals	X		
3. forms only from plants			X
4. is a solid			X
5. is a liquid	X		
6. is a gas		X	
7. is made up of hydrocarbons	X	X	X
8. is a source of energy	X	X	X
9. is a nonrenewable resource	X	X	X
10. is pumped from wells	X	X	
11. is separated using fractional distillation	X		
12. is also called crude oil	X		
13. is transported long distances through pipes	X	X	
14. is mined from Earth			X
15. produces polluting substances when burned	X	X LIME	X
16. produces thermal energy when burned	X	X	X
17. can be used to produce electricity	X	X	X
18. is the least polluting fossil fuel		X	

Meeting Individual Needs

Name Date Class

SECTION 1 Enrichment

Oil from the Arctic

Oil is the leading source of energy in the United States. It supplies about 40 percent of our total energy needs. One of our largest domestic sources of crude oil comes from the icy, frigid area of Alaska called the North Slope. Under the North Slope's frozen ground, called permafrost, lies the Prudhoe Bay Oil Field. It is the largest oil deposit ever discovered on the North American continent. It holds over 22 billion barrels of oil. About half of this oil is expected to be recovered by current methods of production.

The Alaskan Pipeline

The Alaskan Pipeline was built to carry the oil from Prudhoe Bay to the port of Valdez, Alaska. The pipeline was completed in 1977, cost $8 billion, and took three years to build. The 1,300 km pipeline is 1.25 m in diameter. It has 1.25 cm thick walls designed to withstand the extreme Alaskan environment. The pipe is insulated with 10 cm of fiberglass and jacketed with galvanized steel. It carries 1.6 million barrels of oil per day, about 15 percent of the total United States production.

Above Ground Portions

On its way from Prudhoe Bay to Valdez, the pipeline crosses three mountain ranges and hundreds of running rivers and streams. Only half of it is buried. The above-ground portion snakes along on its supports 3 to 4.5 m above the ground. Each support consists of steel posts with a crossbeam between them. The reinforced pipeline rests on the supports with room to sway from side to side in the event of earthquakes or expansions or contractions caused by temperature changes.

The Design of the Pipeline

The pipeline wasn't placed above ground just because it was easier to build that way. The reasons for this related mainly to environmental and safety concerns. Oil travels through the pipeline at about 60°C. In order to prevent the permafrost from thawing, which would make the pipeline unstable, the pipeline was elevated. At points where caribou migration routes would have crossed the elevated pipeline, it has been buried and refrigerated to leave these routes undisturbed. A series of safety valves provides further protection to the environment. These valves close automatically if the oil flow stops or reverses on uphill stretches. It is also possible to shut off whole sections of the line if leaks or spills should occur.

Meeting Individual Needs

1. Look at a map of Alaska. Find Prudhoe Bay and Valdez. What type of terrain does the Alaskan Pipeline travel through?

MOUNTAINS

2. Many people feared that the Alaskan pipeline would damage the environment that it passed through. What precautions have been taken to protect the environment along its route?

ELEVATED PIPELINE
USED VALVES

3. Do you think that all of the planning, work, and cost of building the Alaskan pipeline was worth the final product—domestic oil? Explain your answer.

YES.

Name Date Class

Directed Reading for Content Mastery

Section 1 ▪ Fossil Fuels
Section 2 ▪ Nuclear Energy

Directions: *For each of the following, write the letter of the term or phrase that best completes the sentence.*

_____ **1.** _____ is not a fossil fuel.
a. Coal **b.** Wind

_____ **2.** All fossil fuels are _____.
a. nonrenewable **b.** renewable

_____ **3.** Nuclear fusion converts _____ to _____.
a. oxygen; hydrogen **b.** hydrogen; helium

_____ **4.** About _____ percent of the energy used in the United States comes from burning fossil fuels.
a. 50 **b.** 85

_____ **5.** The many different compounds that are found in _____ are separated in a process called fractional distillation.
a. petroleum **b.** natural gas

Directions: *Determine whether the italicized term makes each statement true or false. If the statement is true, write* **true** *in the blank. If the statement is false, write the term that makes the statement true.*

TRUE **6.** Nuclear wastes must be disposed of carefully so *radiation* will not leak into the environment.

AFFECT PLANTS/ANIMALS **7.** Fossil fuels form from *nuclear chain reactions*.

PETROLEUM **8.** *Coal* has uses other than energy, such as plastics and lubricants.

LESS **9.** When fossil fuels are burned to produce electricity, *more* energy is lost in the process than is delivered to homes, schools, and businesses.

REACTOR CORE **10.** In a nuclear reactor, the actual fission of the radioactive fuel occurs in the part of the reactor called the *control rod*.

Meeting Individual Needs

Name Date Class

SECTION 2 Reinforcement

Nuclear Energy

1. Place the following events describing the production of electrical energy from a nuclear fission reactor in the correct order. Write the numbers **1** (first) through **7** (last) in the spaces provided.

5 **a.** Steam produced by boiling water causes the blades of a turbine to rotate.

1 **b.** A neutron bombards a uranium-235 isotope.

3 **c.** Thermal energy released by the reaction is added to water.

7 **d.** Electricity from the generator is carried to the community through wires.

2 **e.** A uranium-235 atom splits, producing two atoms with smaller nuclei, three neutrons, and thermal energy.

6 **f.** The mechanical energy of the rotating turbine blades is transferred to an electric generator.

4 **g.** Superheated water passes through a heat exchanger, where the thermal energy released boils a separate system of water to produce steam.

Directions: *Answer the following questions on the lines provided.*

2. How does using nuclear energy harm the environment?
They produce nuclear waste that needs to be disposed of

3. How is using nuclear energy less harmful to the environment than using fossil fuels?
Burning fossil fuels pollutes the atmosphere DAILY. Nuclear only pollutes IF there is an accident.

4. How does the half-life of a radioactive waste affect the type of container in which the waste will be stored?
Long Half-life needs to be stored in strung containers.

5. Why is nuclear fusion not currently used as an energy source on Earth?
It is too hard to produce the high temperatures needed for a fusion reaction.

6. How do the products of a fusion reaction differ from the products of a fission reaction?
Fusion produces Helium which is safe for the environment. Fission reactions produce radioactive waste.

Meeting Individual Needs

Name Date Class

SECTION 2 Enrichment

Types of Nuclear Waste

The federal government has classified radioactive wastes as follows:

1. **Spent fuel** consists of fuel exposed to radiation which is removed from a commercial reactor (after three or four years in use) or special fuels from test or research reactors. Spent fuel is highly radioactive and generates a lot of heat. It requires heavy shielding (concrete, water, or lead) and remote handling (no human contact). Most spent fuel is stored in on-site pools at nuclear power plants.
2. **High-level waste** is generated by the reprocessing of either commercial spent fuel or defense production reactor fuel. It is liquid, but can be chemically treated to make a sludge or solid. It is highly radioactive, generates a lot of heat, and requires shielding and remote handling.
3. **Transuranic waste** comes from the reprocessing of spent fuel and from the use of plutonium in making nuclear weapons. The Department of Energy defines it as "waste contaminated with alpha-emitting radio nuclides of atomic number greater than 92 and half-lives of greater than 20 years." It is less radioactive and generates less heat than fission products. It requires long-term isolation, but requires very little or no shielding.
4. **Low-level waste** is short-lived and has low radioactivity. It is generated by hospitals, laboratories, industrial plants, and nuclear reactors. It comes in a variety of forms which include animal carcasses, medical equipment, contaminated wiping rags, paper towels, protective clothing, hand tools, and old equipment. Radiation can be high enough to require shielding for handling and shipment of this waste.
5. **Uranium mill tailings** include earthen residues, usually in the form of fine sand, that remain after mining and extraction of uranium from ores. These mill tailings contain low concentrations of naturally occurring radioactive materials, including thorium-230 and radium-226, which decays to emit the radioactive gas radon-222.
6. **Naturally occurring and accelerator-produced radioactive material** includes radium-226 which is found in smoke detectors and watch dials, polonium-210 which is found in industrial gauges, and cobalt-57 which is produced in linear accelerators for making medical instruments. This type of nuclear waste is not regulated.

Meeting Individual Needs

1. The information on a smoke detector says that it should be returned to the manufacturer and not thrown away in the trash. Why is this so?

So they can dispose of nuclear waste properly.

2. Compare and contrast the sources of and disposal/storage requirements for high-level waste and transuranic waste.

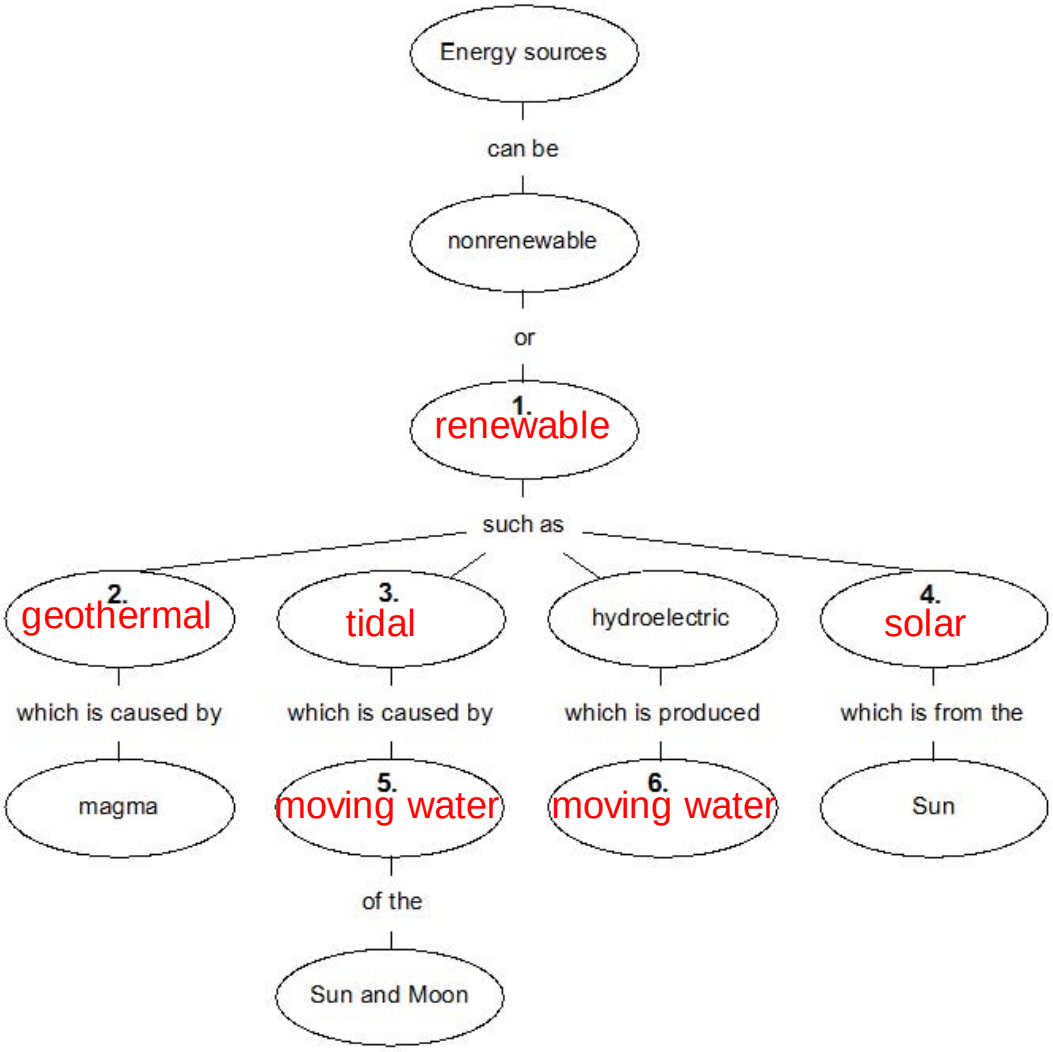
Name Date Class

Directed Reading for Content Mastery

Overview
Energy Sources

Directions: *Complete the concept map using the terms in the list below.*

gravitation **tidal** **renewable**
solar **moving water** **geothermal**



Meeting Individual Needs

Name Date Class

Directed Reading for Content Mastery

Key Terms
Energy Sources

Directions: *Match the term in Column I with the definition in Column II by writing the correct letter in the space provided.*

Column I

j 1. fossil fuels
d 2. petroleum
h 3. nonrenewable resource
a 4. nuclear reactor
e 5. nuclear waste
b 6. renewable resource
i 7. photovoltaic cell
f 8. hydroelectricity
c 9. geothermal energy
g 10. biomass
l 11. radiant energy
k 12. solar cell

Column II

a. uses energy from controlled nuclear reactions to generate electricity
b. resources that are replaced nearly as quickly as they are used
c. thermal energy that is contained in hot magma
d. thick, greenish-brown, highly flammable liquid that contains hydrocarbons
e. any radioactive by-product that results when radioactive materials are used
f. electricity produced from the energy of moving water
g. renewable organic matter that can be used to generate thermal energy
h. resources that cannot be replaced by natural processes as quickly as they are used
i. device that is used to convert solar energy into electricity
j. formed from the decaying remains of ancient plants and animals
k. another name for a photovoltaic cell
l. energy from the Sun that can be used to heat homes and provide hot water

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Directed Reading for Content Mastery

Section 3 ▪ Renewable Energy Sources

Directions: *Complete the following sentences using the terms listed below.*

batteries	geothermal	windmill	solar energy
tidal energy	radiant	hydroelectric	renewable resource
solar cell	pollution	hydrogen gas	potential energy

1. A renewable resource is replaced nearly as quickly as it is used.
2. A photovoltaic cell converts solar energy into electricity.
3. A photovoltaic cell is also called a solar cell.
4. Electricity generated by solar cells must be stored in batteries for use when the Sun is not shining.
5. If water is retained by a high dam, its gravitational potential energy is increased.
6. Dams built to generate energy from water are called hydroelectric dams.
7. Only a few places on Earth have large enough tidal differences for tidal energy to be useful.
8. A windmill generates electricity when wind spins its propeller, which is connected to an electric generator.
9. At a geothermal power plant, water pumped into a well in the ground makes contact with hot rock, and rises as steam and is used to rotate turbines that spin electric generators.
10. An alternative fuel that produces only water vapor when it burns and creates no pollution is hydrogen gas.
11. The radiant energy from the Sun can be used to heat homes and provide hot water.
12. Hydroelectric power plants are an efficient way to produce electricity with almost no pollution.

Meeting Individual Needs

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SECTION 3 Reinforcement

Renewable Energy Sources

Directions: *Provide the information requested for each alternative energy source listed.*

1. Solar energy
   a. What is solar energy?
   energy from the Sun
   b. What is a photovoltaic cell?
   converts solar energy to electricity

2. Hydroelectricity
   a. What is hydroelectricity?
   converting the energy from moving water into electricity
   b. What is one economic advantage to hydroelectricity?
   water flowing downhill is a cheap source of energy

3. Tidal energy
   a. What is tidal energy?
   energy from the moving water in tides converted to electricity
   b. Why is tidal energy a limited source of energy?
   need to be near the coast

4. Wind energy
   a. What device is used to harness the energy in wind and convert it into electricity?
   windmills
   b. Why is the wind an energy source with limited uses?
   wind doesn't always blow

Meeting Individual Needs

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SECTION 3 Enrichment

Wind Energy

U.S. federal tax credits supported the early growth of the wind energy industry. The nation's capacity to produce electricity from wind was only 10,000 kilowatt-hours (kWh) in 1981. That is about enough to provide power for two homes. Despite the 1985 expiration of these tax credits, by 1989 the capacity had increased to more than 2 billion kWh. That is enough to power the residential energy needs of a major city the size of Washington, D.C. or San Francisco.

The majority of the growth in wind energy use occurred in California. Over 14,000 privately owned and operated wind turbines are located there. These turbines are located in three mountain passes and make up about 80 percent of the world's current wind-energy capacity.

Use the library, or sources such as your state's energy department, NASA, or the American Wind Energy Association to answer the following questions.

Meeting Individual Needs

1. Where are the best places to put wind turbines to efficiently produce electricity?

2. What does it cost to produce electricity using wind turbines?

3. What are some of the advantages of using wind turbines to produce electricity?

wind is free

4. What are some of the disadvantages of using wind turbines?

ugly

5. What applications, other than producing electricity, can wind turbines be used for?