

**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.
- \_\_\_\_\_ a. Steam produced by boiling water causes the blades of a turbine to rotate.
  - \_\_\_\_\_ b. A neutron bombards a uranium-235 isotope.
  - \_\_\_\_\_ c. Thermal energy released by the reaction is added to water.
  - \_\_\_\_\_ d. Electricity from the generator is carried to the community through wires.
  - \_\_\_\_\_ e. A uranium-235 atom splits, producing two atoms with smaller nuclei, three neutrons, and thermal energy.
  - \_\_\_\_\_ f. The mechanical energy of the rotating turbine blades is transferred to an electric generator.
  - \_\_\_\_\_ 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?

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3. How is using nuclear energy less harmful to the environment than using fossil fuels?

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4. How does the half-life of a radioactive waste affect the type of container in which the waste will be stored?

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5. Why is nuclear fusion not currently used as an energy source on Earth?

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6. How do the products of a fusion reaction differ from the products of a fission reaction?

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## SECTION 2

### Enrichment

# Types of Nuclear Waste

The federal government has classified radioactive wastes as follows:

- 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.
- 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.
- 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.
- 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.
- 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.
- 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.

- 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?

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

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