45. At some instant of time, the activity of a sample of radioactive material is 5.0 μCi. If the sample contains 1.0×10^9 radioactive nuclei, what is the half-life of the material?

46. It has been estimated that Earth has 9.1×10^{11} kg of natural uranium that can be economically mined. Of this total, 0.70 percent is ^{235}U. If all the world's energy needs (7.0×10^{12} J/s) were supplied by ^{235}U fission, how long would this supply last? Assume that 208 MeV of energy is released per fission event and that the mass of ^{235}U is about 3.9×10^{-25} kg.

47. If the average energy released in a fission event is 208 MeV, find the total number of fission events required to provide enough energy to keep a 100.0 W light bulb burning for 1.0 h.

48. How many atoms of ^{235}U must undergo fission to operate a 1.0×10^3 MW power plant for one day if the conversion efficiency is 30.0 percent? Assume 208 MeV released per fission event.

Alternative Assessment

1. You are designing a nuclear power plant for a space station to be established on Mars. Material A is radioactive and has a half-life of two years. Material B is also radioactive and has a half-life of one year. Atoms of material B have one half the mass of atoms of material A. Discuss the benefits and drawbacks involved with each of these fuels.

2. Design a questionnaire to investigate what people in your community know about nuclear power and how they feel about it. Give the questionnaire to your classmates for their comments, and if your teacher approves, conduct a study with people in your community. Present your results in the form of a class presentation and discussion.

3. Investigate careers in nuclear medicine. Interview people who work with radiation or with isotopic tracers in a hospital. Find out what kind of patients they treat or test and the technology they use. What training is necessary for this type of career?

4. Research the lives and careers of female nuclear physicists such as Marie Curie, Lise Meitner, Ida Tacke Noddack, and Maria Goeppert-Mayer. Create a presentation about one of these scientists. The presentation can be in the form of a report, poster, short video, or computer presentation.

5. Research how radioactive decay is used to date archaeological remains and fossils. What nuclear reactions are involved in the carbon-14 dating technique? What assumptions are made when the carbon-14 dating technique is used? What time scale is the carbon-14 technique suitable for? Is the carbon-14 technique appropriate to determine the age of a painting suspected to be 375 years old? Summarize your findings in a brochure or poster for visitors to a science museum.

6. Research the problem of nuclear waste in the United States. How much is there? What kinds of radioactive waste are there? Where are they produced? What are the costs and hazards associated with different techniques for disposal of radioactive waste? How do other countries deal with the problem? Choose the disposal option you think is most appropriate, and write a position paper. Include information about all options and the reasons for your choice.

7. Some modern physicists have developed *string theory* in an attempt to unify the four fundamental forces. Conduct research to learn about this theory. What are the main principles of string theory? Why do some scientists oppose it? Share your results with the class in a short lecture presentation.