Period 17 Review Questions

1. **What does the moderator do in a nuclear reactor?**

   The neutrons released by uranium fission move at high speeds. The moderator slows these neutrons so that they have a better chance of being captured by a U-235 nucleus and, thus, causing another fission. Materials commonly used as the moderator are water and graphite (carbon).

2. **What do the control rods do in a nuclear reactor?**

   The control rods absorb neutrons. The rods are moved into the reactor core to decrease the rate of the reaction or moved out of the core to increase the reaction rate. Control rods are made of boron or cadmium.

3. **Why are the used fuel rods from a nuclear reactor so radioactive?**

   To produce neutrons, a fuel rod must have the proper ratio of enriched Uranium-235 to Uranium-238. When a fuel rod has reached the end of its useful lifetime, the amount of U-235 has decreased only

slightly. There is still radioactive U-235 and U-238 present.

4. **Could a Chernobyl-type accident happen in the U.S.? Why or why not?**

   No. The Chernobyl reactor was graphite moderated and water cooled. U.S. reactors are water moderated and water cooled. If the coolant was lost from a U.S. reactor, a meltdown could occur, but not an uncontrolled fission reaction.

5. **What is the 'China Syndrome'?**

   As depicted in the movie by the same name, the 'China Syndrome' refers to a reactor core meltdown that melts through the Earth to the opposite side of the globe. Of course, this is fiction. While a reactor core meltdown is possible, the heat could never melt through the core of the Earth.

6. **Does a breeder reactor produce more energy than it uses? If not, what does it breed?**

   Conservation of energy makes it impossible for any process to produce more energy than it uses. A breeder reactor converts

some U-238 into plutonium. Therefore, it "breeds" plutonium.

7. Why is it so difficult to build a working fusion reactor?

   The fusion of two protons requires very high temperatures of a million degrees Celsius or more to overcome the electric repulsive force between the positively charged protons. This temperature is much too hot for any material to hold the reactants.

8. How much energy is stored in 0.5 kg of antiprotons and 0.5 kg of protons?

   Electrons, protons, and neutrons all have antiparticles, or antimatter twins. When a particle and its antiparticle meet, they annihilate each other in a burst of energy. All of their matter is converted into energy.

   $E = M c^2 = (0.5\ kg + 0.5\ kg) \times (3 \times 10^8\ m/s)^2$

   $= 1\ kg \times (9 \times 10^{16}\ m^2/s^2) = 9 \times 10^{16}\ J$