Objective
The student will be able to describe a nuclear chain reaction.

Curriculum Focus
Science

Materials
Two crumpled pieces of paper per student and one for you

Clear cup

Rubbing alcohol

Vegetable oil- colored oil is best

Key Terms
Chain reaction

Control rods

Critical mass

Fission

Activity 1: Chain Reaction

Introduction

In this large group activity, students will enact a nuclear chain reaction. The extension activity can be used as a demonstration to introduce the concept of fission, so you may want to perform it first, or let students try it in groups.

Procedure

1. Have students crumple two pieces of paper and move to stand around the room.
2. Explain to students that they will be representing uranium nuclei, and that the paper represents two of their neutrons. If a uranium nucleus is hit with a neutron, it can fission or split, releasing more neutrons that can then strike other nuclei. Tell students that if they feel a neutron hit them, they should toss their neutrons out to the sides of them—they have fissioned.
3. Begin the fission process by throwing your paper wad toward the students. Have the class observe what happens. Did all the students get hit? Was the chain reaction successful?
4. Try the demonstration several times with students standing in different orientations—perhaps in a loose clump, a tight clump, a circle, a line, etc. Have students diagram their positions and record how many nuclei fissioned in each orientation.
5. Ask students which orientations were able to sustain a chain reaction, and why they think this is. What was the effect of moving the uranium nuclei closer together? What would happen if there were more students in the classroom?
6. Explain that fission chain reactions can be limited, like those used in a nuclear reactor, or expanding, like those in a nuclear weapon. Uncontrolled reactions keep expanding, fissioning more and more nuclei at a time. Controlled reactions are limited so the same amount of energy is released continuously. This energy can then be used to heat water for a power plant. See *Activity 4* in *Section 2—Energy Basics* for an overview of how electricity is generated.
7. Ask students how they think a chain reaction could be controlled. Explain the concept of critical mass—to maintain a chain reaction there must be enough neutrons striking uranium atoms to keep the chain going. If there are not enough

uranium atoms being struck by neutrons, the reaction dies out. If there are many uranium atoms packed closely together in a critical mass, the reaction can become uncontrolled. Which configurations of students had a critical mass?

8. Demonstrate controlling a chain reaction with control rods. Place students back into one of the configurations that demonstrated an expanding chain reaction, but this time place obstacles between students. Obstacles may be classroom furniture, pieces of poster board, laundry baskets, etc. Start the chain reaction just as before and compare your results.

9. Explain that control rods work to slow or stop a chain reaction by absorbing neutrons so that they cannot hit uranium nuclei. The more control rods are in place, the slower the reaction proceeds.

Extension Activity

Perform the following demonstration for students or allow them to do it in pairs or small groups. The materials needed are a clear container such as a cup or beaker, oil, rubbing alcohol, water, a spoon and butter knife.

Fill a clear cup or small beaker half full of rubbing alcohol. Add water so that the container is about 2/3 full and stir. Then carefully slide a spoonful of cooking oil into the alcohol-water mixture. The oil should float in the center of the glass. If it is floating, add a bit more alcohol, if it sinks, a bit more water. Once the oil blob is hovering in the center of the container, carefully "fission" the oil by cutting it in two with the butter knife. See if you can perform fusion by getting the drops to rejoin into one larger blob of oil.