Section 7.3.
Nuclear Reactions.

Textbook pages 312 to 325.

Before You Read.

Nuclear reactors supply energy to many parts of Canada. What do you already know about nuclear reactions?

What is nuclear fission?

Nuclear fission is a nuclear reaction in which a nucleus breaks apart, producing two or more smaller nuclei, subatomic particles, and energy.

Heavy nuclei tend to be unstable because of the repulsive forces between their many protons. In order to increase their stability, atoms with heavy nuclei may split into atoms with lighter nuclei. The fission of a nucleus is accompanied by a very large release of energy. Fission is the source of energy for all nuclear power generation used today; however, the radioactive daughter products are a significant waste disposal problem.

How do nuclear reactions work?

In typical chemical reactions, the energy produced or used is so small that there is very little change in mass. There are no changes in the nuclei of the reactants, so the identities of the atoms do not change. Chemical reactions involve electrons and rearrangements in the way atoms and ions are connected to each other.

Next page.

A **nuclear reaction** is a process in which an atom's nucleus changes by gaining or releasing particles or energy. A nuclear reaction can release protons, neutrons, and electrons, as well as gamma rays. In nuclear reactions, a small change in mass results in a very large change in energy.

Scientists can *induce,* or cause, a nuclear reaction by making a nucleus unstable, causing it to undergo a reaction immediately. Bombarding a nucleus with alpha particles, beta particles, or gamma rays induces a nuclear reaction. An example of an induced reaction is given below. Nitrogen-fourteen is bombarded with alpha particles, producing oxygen and protons.

When some nuclei undergo fission, they release subatomic particles that trigger more fission reactions. This ongoing process in which one reaction initiates the next reaction is called a **chain reaction**. The number of fissions and the amount of energy released can increase rapidly and lead to a violent nuclear explosion. Uranium-two hundred and thirty

five, which is used in Canadian nuclear reactors, undergoes such a reaction. Keeping the chain reaction going in a nuclear power plant, while preventing it from racing out of control, requires precise monitoring and continual adjusting.

What are the rules for writing nuclear equations?

A **nuclear equation** is a set of symbols that indicates changes in the nuclei of atoms during a nuclear reaction. The following rules can be used when you write a nuclear equation.

1. The sum of the mass numbers on each side of the equation stays the same.
2. The sum of the charges (represented by atomic numbers) on each side of the equation stays the same.

Next page.

What is nuclear fusion?

Nuclear fusion is a nuclear reaction in which small nuclei combine to produce a larger nucleus. Other subatomic particles as well as energy are released in this process. Fusion occurs at the core of the Sun and other stars where sufficient pressure and high temperatures cause isotopes of hydrogen to collide with great force. This forces two nuclei of hydrogen to merge into a single nucleus, releasing an enormous amount of energy.

We do not currently have the technology to extract energy from fusion reactions. One of the difficulties is achieving and containing the high temperatures and pressures required to bring about fusion.