Nuclear processes are those in which an atomic nucleus changes, including radioactive decay of naturally occurring and human-made isotopes, nuclear fission, and nuclear fusion.

Student projects should cover all the topics discussed in each of the standards that are part of that project. In addition, certain elements are listed that should appear in each of the videos.

VIDEO PROJECT ONE – NUCLEAR FORCES AND ENERGY

11a. *Students know* protons and neutrons in the nucleus are held together by nuclear forces that overcome the electromagnetic repulsion between the protons.

The nucleus is held together by the strong nuclear force. The strong nuclear force acts between protons, between neutrons, and between protons and neutrons but has a limited range comparable to the size of an atomic nucleus. The nuclear force is able to overcome the mutual electrostatic repulsion of the protons only when the protons and neutrons are near each other as they are in the nucleus of an atom.

11. b. *Students know* the energy release per gram of material is much larger in nuclear fusion or fission reactions than in chemical reactions. The change in mass (calculated by $E = mc2$) is small but significant in nuclear reactions.

Two major types of nuclear reactions are fusion and fission. In *fusion* reactions two nuclei come together and merge to form a heavier nucleus. In *fission* a heavy nucleus splits apart to form two (or more) lighter nuclei. The binding energy of a nucleus depends on the number of neutrons and protons it contains. A general term for a proton or a neutron is a *nucleon*. In both fusion and fission reactions, the total number of nucleons does not change, but large amounts of energy are released as nucleons combine into different arrangements. This energy is one million times more than energies involved in chemical reactions.

16 **Why are enormous amounts of energy required to separate a nucleus into its component protons and neutrons even though the protons in the nucleus repel each other?**

A The force of the protons repelling each other is small compared to the attraction of the neutrons to each other.

B The electrostatic forces acting between other atoms lowers the force of repulsion of the protons.

C The interactions between neutrons and electrons neutralize the repulsive forces between the protons.

D The forces holding the nucleus together are much stronger than the repulsion between the protons.