Nuclear Fusion: The Power of the Sun
Lesson Plan

Grade Level: 9-12 | **Curriculum Focus:** Energy;Forces;Motion | **Lesson Duration:** Two class periods

Student Objectives:

- Differentiate between the three different types of nuclear reactions: fusion, fission, and radioactive decay.
- Examine how the sun's energy is produced during nuclear *fusion*.

Materials

- Discovery School video on *unitedstreaming*: *Savage Sun*
  Search for this video by using the video title (or a portion of it) as the keyword.

  Selected clips that support this lesson plan:

  - Nuclear Fusion: The Energy of the Sun
  - The Star Factory: Harnessing Nuclear Fusion to Create a Star on Earth
  - Neutrinos: Studying the Sun's Core

- Research materials on nuclear reactions
- Computer with Internet access
- Materials to create three-dimensional models of nuclear reactions

Procedures

1. Review with your students what they know about the three types of nuclear reactions—fusion, fission, and radioactive decay. They should understand the following:
   - Most of the sun's energy is produced during nuclear *fusion*, in which the union of atomic nuclei from two lighter atoms (hydrogen) unites to form a new heavier atom with smaller mass (helium). The "extra" mass is converted into energy.
   - Fusion reactions should be distinguished from *fission* reactions, which produce energy in most nuclear power plants.
   - *Radioactive decay* is a third type of nuclear reaction, which involves atoms that undergo radioactive (alpha, beta, and gamma) decay.

2. Have students use the Internet or other sources to investigate the reactions that occur in fusion, fission, and radioactive decay reactions. One place to start is the Web site, ABC's of Nuclear Science: http://www.lbl.gov/abc/.
3. Have your students use these and other resources to complete a three-part Venn diagram comparing and contrasting fusion, fission, and radioactive decay.
4. Divide your class into groups, assigning each group one of the three reactions to investigate more thoroughly.
5. Each group should prepare a presentation that includes a three-dimensional model illustrating how its assigned reaction works.
6. Each presentation should also include an explanation of each reactant and product and the way in which energy is released.
7. Once students have given their presentations, end by asking the class to compare and contrast their models.

Discussion Questions

1. What would happen if the amount of light reaching the Earth from the sun were cut in half? Predict what the climate and life would be like here on Earth. How would humans respond to this change?
2. Most of the sun's energy is produced from fusion reactions, while nuclear power plants use fission reactions to produce their energy. Compare and contrast nuclear fission and nuclear fusion. Name at least three ways they are similar and three ways they are different.
3. The scientific community has spent billions of dollars to create an underground facility for collecting data on the neutrinos that rain down on Earth from the sun. Are the potential benefits of understanding neutrinos worth such a large expense? Why or why not?

Assessment

Use the following three-point rubric to evaluate students' work during this lesson.

- 3 points: Student's diagram effectively compares and contrasts the three types of nuclear reactions; model clearly and accurately illustrates how group's assigned reaction works; presentation clear, well organized, and reflects excellent speaking skills.
- 2 points: Student's diagram adequately compares and contrasts the three types of nuclear reactions; model lacks clarity; presentation clear but speaking skills lacking.
- 1 point: Student's diagram inadequate; model lacks clarity; presentation clear but poorly organized; speaking skills lacking.

Vocabulary

aurora

Definition: A luminous phenomenon that consists of streamers or arches of light appearing in the upper atmosphere of a planet's magnetic polar regions and is caused by the emission of light from atoms excited by electrons accelerated along the planet's magnetic field lines.

Context: The aurora borealis forms a spectacular ribbon of light in the sky.

electromagnetic

Definition: Of, relating to, or produced by magnetism developed by a current of electricity.

Context: You can lose AM radio signals on your car radio when they are interrupted by the strong electromagnetic field that is produced around high-voltage power lines.

fusion

Definition: The union of atomic nuclei to form heavier nuclei resulting in the release of enormous quantities of energy when certain light elements unite.

Context: In the sun, helium is produced by the fusion of hydrogen atoms.

nebula

Definition: Any of numerous clouds of gas or dust in interstellar space.

Context: On a clear night, the Orion Nebula is visible even with the naked eye.

neutrino

Definition: An uncharged elementary particle that is believed to be massless or to have a very small mass, that has any of three forms, and that interacts only rarely with other particles.

Context: Even though we cannot see or feel them, trillions of neutrinos hit the Earth every second.

plasma

Definition: A collection of charged particles containing about equal numbers of positive ions and electrons and exhibiting some properties of a gas but differing from a gas in being a good conductor of electricity and in being affected by a magnetic field.

Context: Millions of tons of electrically charged plasma may be thrown out into space after a solar disturbance.

prominence

Definition: A mass of gas resembling a cloud that arises from the chromospheres of the sun.

Context: A large, looping prominence on the surface of the sun can be detected here on Earth about eight minutes after it occurs.

radiation

Definition: The process of emitting radiant energy in the form of waves or particles.

Context: Exposure to ultraviolet radiation has been linked to skin cancer in humans.

Academic Standards

Mid-continent Research for Education and Learning (McREL)

McREL's Content Knowledge: A Compendium of Standards and Benchmarks for K-12 Education addresses 14 content areas. To view the standards and benchmarks, visit http://www.mcrel.org/compendium/browse.asp.

This lesson plan addresses the following national standards:

- Science—Nature of Science: Understands the nature of scientific inquiry.
- Science—Physical Science: Understands the sources and properties of energy.
- Science—Physical Science: Understands forces and motion.
- Science—Nature of Science: Understands the nature of scientific knowledge.

National Academy of Sciences

The National Academy of Sciences provides guidelines for teaching science in grades K-12 to promote scientific literacy. To view the standards, visit this Web site:
http://books.nap.edu/html/nses/html/overview.html#content.

This lesson plan addresses the following national standards:

- Physical Science: Transfer of energy

Support Materials

Develop custom worksheets, educational puzzles, online quizzes, and more with the free teaching tools offered on the Discoveryschool.com Web site. Create and print support materials, or save them to a Custom Classroom account for future use. To learn more, visit

- http://school.discovery.com/teachingtools/teachingtools.html