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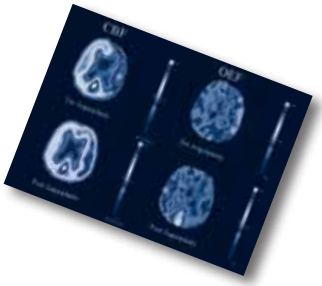
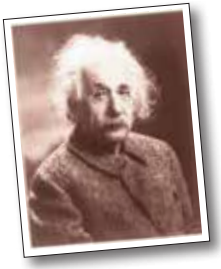
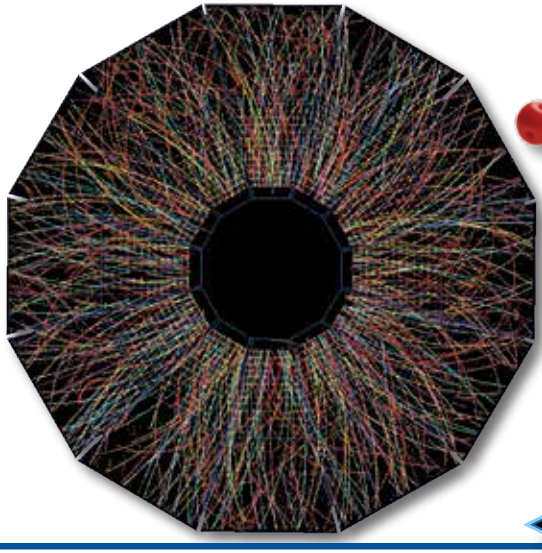
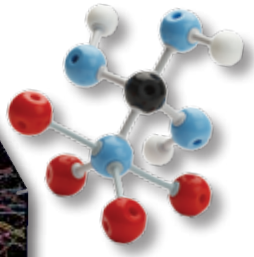


NUCLEAR SCIENCE







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Requirements

1. Do the following:
   a. Tell what radiation is.
   b. Describe the hazards of radiation to humans, the environment, and wildlife. Explain the difference between radiation exposure and contamination. In your explanation, discuss the nature and magnitude of radiation risks to humans from nuclear power, medical radiation, and background radiation including radon. Explain the ALARA principle and measures required by law to minimize these risks.
   c. Describe the radiation hazard symbol and explain where it should be used. Tell why and how people must use radiation or radioactive materials carefully.

2. Do the following:
   a. Tell the meaning of the following: atom, nucleus, proton, neutron, electron, quark, isotope; alpha particle, beta particle, gamma ray, X-ray; ionization, radioactivity, and radioisotope.
   b. Choose an element from the periodic table. Construct 3-D models for the atoms of three isotopes of this element, showing neutrons, protons, and electrons. Use the three models to explain the difference between atomic number and mass number and the difference between the quark structure of a neutron and a proton.

3. Do ONE of the following; then discuss modern particle physics with your counselor:
   a. Visit an accelerator (research lab) or university where people study the properties of the nucleus or nucleons.

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b. Name three particle accelerators and describe several experiments that each accelerator performs.

4. Do TWO of the following; then discuss with your counselor the different kinds of radiation and how they can be used:
   a. Build an electroscope. Show how it works. Place a radiation source inside and explain the effect it causes.
   b. Make a cloud chamber. Show how it can be used to see the tracks caused by radiation. Explain what is happening.
   c. Obtain a sample of irradiated and non-irradiated foods. Prepare the two foods and compare their taste and texture. Store the leftovers in separate containers and under the same conditions. For a period of 14 days, observe their rate of decomposition or spoilage, and describe the differences you see on days 5, 10, and 14.
   d. Visit a place where radioisotopes are being used. Using a drawing, explain how and why they are used.

5. Do ONE of the following; then discuss with your counselor the principles of radiation safety:
   a. Using a radiation survey meter and a radioactive source, show how the counts per minute change as the source gets closer to or farther from the radiation detector. Place three different materials between the source and the detector, then explain any differences in the measurements per minute. Explain how time, distance, and shielding can reduce an individual's radiation dose.
   b. Describe how radon is detected in homes. Discuss the steps taken for the long-term and short-term test methods, tell how to interpret the results, and explain when each type of test should be used. Explain the health concern related to radon gas and tell what steps can be taken to reduce radon in buildings.
   c. Visit a place where X-rays are used. Draw a floor plan of this room. Show where the unit, the unit operator, and the patient would be when the X-ray unit is operated. Explain the precautions taken and the importance of those precautions.

6. Do ONE of the following; then discuss with your counselor how nuclear energy is used to produce electricity:
    a. Make a drawing showing how nuclear fission happens, labeling all details. Draw another picture showing how a chain reaction could be started and how it could be stopped. Explain what is meant by a "critical mass."
    b. Build a model of a nuclear reactor. Show the fuel, control rods, shielding, moderator, and cooling material. Explain how a reactor could be used to change nuclear energy into electrical energy or make things radioactive.
    c. Find out how many nuclear power plants exist in the United States. Locate the one nearest your home. Find out what percentage of electricity in the United States is generated by nuclear power plants, by coal, and by gas.
7. Give an example of each of the following in relation to how energy from an atom can be used: nuclear medicine, environmental applications, industrial applications, space exploration, and radiation therapy. For each example, explain the application and its significance to nuclear science.
8. Find out about three career opportunities in nuclear science that interest you. Pick one and find out the education, training, and experience required for this profession and discuss this with your counselor. Tell why this profession interests you.

Nuclear Science Resources

Scouting Materials

Archaeology, Astronomy, Chemistry, Dentistry, Electricity, Energy, Engineering, Environmental Science, Geology, Medicine, Plant Science, and *Space Exploration* merit badge pamphlets

For more information about or to order Scouting-related resources, see http://www.scoutstuff.org—with your parent's permission, of course.

Books

Contemporary Physics Education Project. *Nuclear Science—A Guide to the Nuclear Science Wall Chart,* 3rd ed. CPEP, 2003.

Fox, Karen. *The Chain Reaction: Pioneers of Nuclear Science*. Scholastic Library Publishing, 1998.

Gallant, Roy A. *The Ever-Changing Atom*. Marshall Cavendish, 2000.

Goldstein, Natalie. *How Do We Know the Nature of the Atom?* Rosen Publishing Group, 2001.

Halpern, Paul. Collider: *The Search for the World's Smallest Particles*. John Wiley & Sons, 2009.

Hamilton, Janet. *Lise Meitner: Pioneer of Nuclear Fission*. Enslow Publishers, 1997.

Heilbron, J. L. *Ernest Rutherford and the Atoms*. Oxford University Press, 2003.

Kirkland, Kyle. *Atoms and Materials*. Facts on File, 2007.

Mander, Lelia, ed. *Nuclear Energy*. Gareth Stevens, 2003.

Oxlade, Chris. *Atoms*. Heinemann, 2007.

Pasachoff, Naomi E. *Niels Bohr: Physicist and Humanitarian*. Enslow Publishers, 2003.

Richardson, Hazel. *How to Split the Atom*. Scholastic Library Publishing, 2001.

Stux, Erica. *Enrico Fermi: Trailblazer in Nuclear Physics*. Enslow, 2004.

Townsend, John. *Using Nuclear Energy*. Heinemann-Raintree, 2009.

DVDs

The Atom Smashers. PBS Home Video, 2009.

e2 Energy. PBS Home Video, 2007.

Organizations and Websites

ABCs of Nuclear Science

Lawrence Berkley National Laboratory
Website: http://www.lbl.gov/abc

American Nuclear Society
555 N. Kensington Ave.
La Grange Park, IL 60526
Toll-free telephone: 800-323-3044
Website: http://www.ans.org

American Physical Society
1 Physics Ellipse
College Park, MD 20740
Telephone: 301-209-3100
Website: http://www.aps.org

EPA Radiation Protection Students' and Teachers' Pages

Website: http://www.epa.gov/radiation/students.html

Health Physics Society
1313 Dolley Madison Blvd., Suite 402
McLean, VA 22101
Telephone: 703-790-1745
Website: http://hps.org

International Atomic Energy Agency
United Nations Liaison Office
1 United Nations Plaza,
Room DC-1-1155
New York, NY 10017
Telephone: 212-963-6010
Website: http://www.iaea.org

Nuclear Energy Institute
1776 I Street NW, Suite 400
Washington, DC 20006-3708
Telephone: 202-739-8000
Website: http://www.nei.org

Office of Nuclear Energy
U.S. Department of Energy
1000 Independence Ave. SW
Washington, DC 20585
Toll-free telephone: 800-342-5363
Website: http://www.ne.doe.gov

The Particle Adventure
Website: http://particleadventure.org

U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001
Toll-free telephone: 800-368-5642
Website: http://www.nrc.gov

Acknowledgments

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