



Nuclear Science

Merit Badge Workbook

This workbook can help you but you still need to read the merit badge pamphlet.

The work space provided for each requirement should be used by the Scout to make notes for discussing the item with his counselor, not for providing the full and complete answers. Each Scout must do each requirement.

No one may add or subtract from the official requirements found in **Boy Scout Requirements** (Pub. 33216 – SKU 34765).

The requirements were last issued or revised in 2011 • This workbook was updated in March 2012.

Scout's Name: _____ Unit: _____

Counselor's Name: _____ Counselor's Phone No.: _____

<http://www.USScouts.Org> • <http://www.MeritBadge.Org>

Please submit errors, omissions, comments or suggestions about improving this workbook to: Workbooks@USScouts.org

1. Do the following:

a. Tell what radiation is. _____

b. Describe the hazards of radiation to humans, the environment, and wildlife.

Humans: _____

Environment: _____

Wildlife: _____

Explain the difference between radiation exposure and contamination.

Exposure: _____

Contamination: _____

In your explanation, discuss the nature and magnitude of radiation risks to humans from nuclear power, medical radiation,, and background radiation including radon.

Nuclear power: _____

Medical radiation: _____

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.,

Atom: _____

Nucleus: _____

Proton: _____

Neutron: _____

Electron: _____

Quark: _____

Isotope: _____

Alpha particle: _____

Beta particle: _____

Gamma ray: _____

X-ray: _____

Ionization: _____

Radioactivity: _____

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.

b. Name three particle accelerators and describe several experiments that each accelerator performs. then discuss modern particle physics with your counselor.

1. _____

2. _____

3. _____

Modern particle physics: _____

4. Do TWO of the following; _____

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. _____

5 days _____

10 days _____

14 days _____

- 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. _____

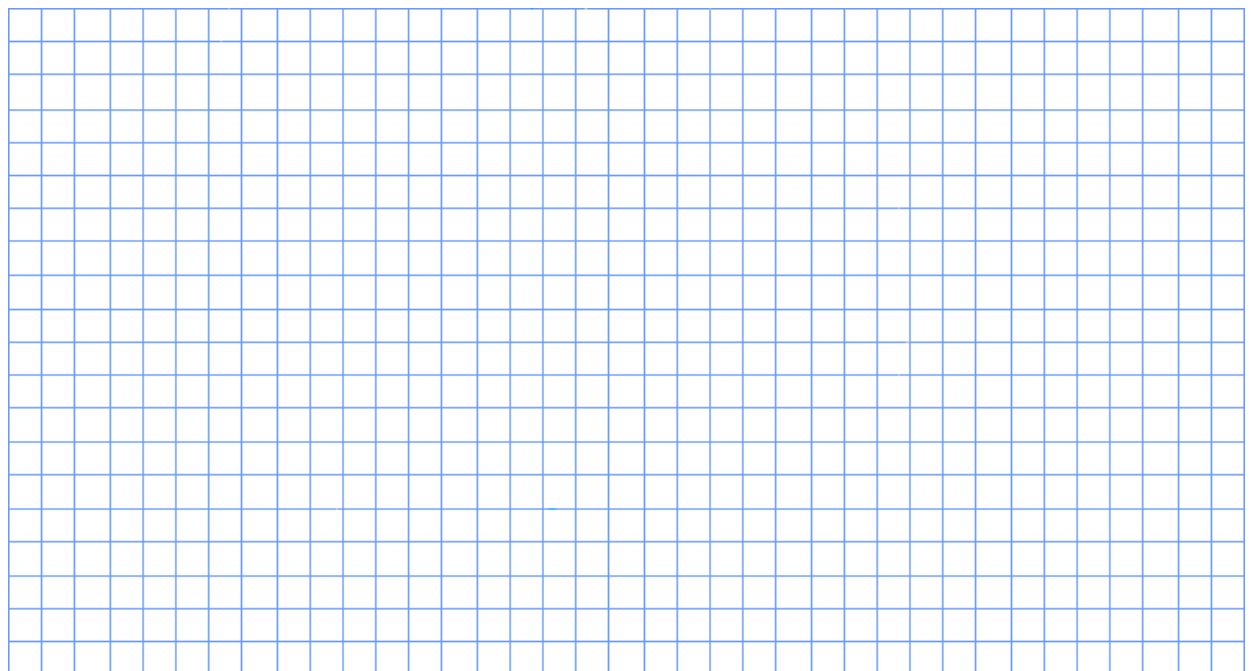
Explain how time, distance, and shielding can reduce an individual's radiation dose. _____

- 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. _____

Discuss with your counselor the principles of radiation safety: _____

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.

Discuss with your counselor how nuclear energy is used to produce electricity: _____

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.

Nuclear medicine, _____

Environmental applications, _____

Industrial applications, _____

Space exploration, _____

Radiation therapy. _____

For each example, explain the application and its significance to nuclear science.

Nuclear medicine, _____

Environmental applications, _____

Industrial applications, _____

Space exploration, _____

Radiation therapy. _____

8. Find out about three career opportunities in nuclear science that interest you. _____
1. _____
 2. _____
 3. _____

Pick one and find out the education, training, and experience required for this profession.

Career: _____

Education: _____

Training: _____

Experience: _____

Discuss this with your counselor, and explain why this profession might interest you. _____

Requirement resources can be found here:
http://www.meritbadge.org/wiki/index.php/Nuclear_Science#Requirement_resources

Important excerpts from the [‘Guide To Advancement’](#), No. 33088:

Effective January 1, 2012, the *‘Guide to Advancement’* (which replaced the publication *‘Advancement Committee Policies and Procedures’*) is now the *official* Boy Scouts of America source on advancement policies and procedures.

- **[Inside front cover, and 5.0.1.4] — Unauthorized Changes to Advancement Program**
No council, committee, district, unit, or individual has the authority to add to, or subtract from, advancement requirements.
(There are limited exceptions relating only to youth members with disabilities. For details see section 10, “Advancement for Members With Special Needs”.)
- **[Inside front cover, and 7.0.1.1] — The [‘Guide to Safe Scouting’](#) Applies**
Policies and procedures outlined in the *‘Guide to Safe Scouting’*, No. 34416, apply to all BSA activities, including those related to advancement and Eagle Scout service projects. [Note: Always reference the online version, which is updated quarterly.]
- **[7.0.3.1] — The Buddy System and Certifying Completion**
Youth members must not meet one-on-one with adults. Sessions with counselors must take place where others can view the interaction, or the Scout must have a buddy: a friend, parent, guardian, brother, sister, or other relative—or better yet, another Scout working on the same badge—along with him attending the session. When the Scout meets with the counselor, he should bring any required projects. If these cannot be transported, he should present evidence, such as photographs or adult certification. His unit leader, for example, might state that a satisfactory bridge or tower has been built for the Pioneering merit badge, or that meals were prepared for Cooking. If there are questions that requirements were met, a counselor may confirm with adults involved. Once satisfied, the counselor signs the blue card using the date upon which the Scout completed the requirements, or in the case of partials, initials the individual requirements passed.
- **[7.0.3.2] — Group Instruction**
It is acceptable—and sometimes desirable—for merit badges to be taught in group settings. This often occurs at camp and merit badge midways or similar events. Interactive group discussions can support learning. The method can also be attractive to “guest experts” assisting registered and approved counselors. Slide shows, skits, demonstrations, panels, and various other techniques can also be employed, but as any teacher can attest, not everyone will learn all the material.

There must be attention to each individual's projects and his fulfillment of *all* requirements. We must know that every Scout—actually and *personally*—completed them. If, for example, a requirement uses words like “show,” “demonstrate,” or “discuss,” then every Scout must do that. It is unacceptable to award badges on the basis of sitting in classrooms *watching* demonstrations, or remaining silent during discussions. Because of the importance of individual attention in the merit badge plan, group instruction should be limited to those scenarios where the benefits are compelling.

- **[7.0.3.3] — Partial Completions**
Scouts need not pass all requirements with one counselor. The Application for Merit Badge has a place to record what has been finished—a “partial.” In the center section on the reverse of the blue card, the counselor initials for each requirement passed. In the case of a partial completion, he or she does not retain the counselor's portion of the card. A subsequent counselor may choose not to accept partial work, but this should be rare. A Scout, if he believes he is being treated unfairly, may work with his Scoutmaster to find another counselor. An example for the use of a signed partial would be to take it to camp as proof of prerequisites. Partials have no expiration except the 18th birthday.