



# 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 January 2014.

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 this **workbook** to: [Workbooks@USScouts.Org](mailto:Workbooks@USScouts.Org)  
Comments or suggestions for changes to the **requirements** for the **merit badge** should be sent to: [Merit.Badge@Scouting.Org](mailto:Merit.Badge@Scouting.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.	

Discuss modern particle physics:

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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.

1.	
2.	

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'

Location:



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.

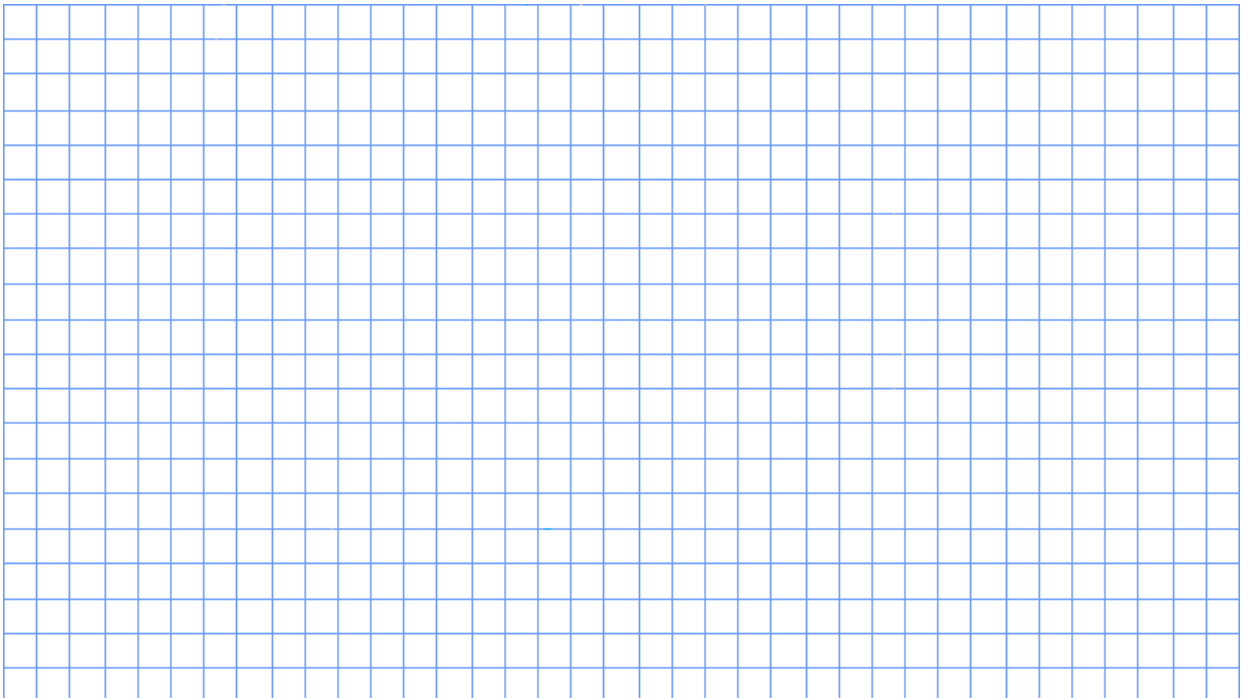

Discuss the steps taken for the long-term and short-term test methods, tell how to interpret the results, and explain when each type of test should be used.


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.

Location: \_\_\_\_\_

- 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.

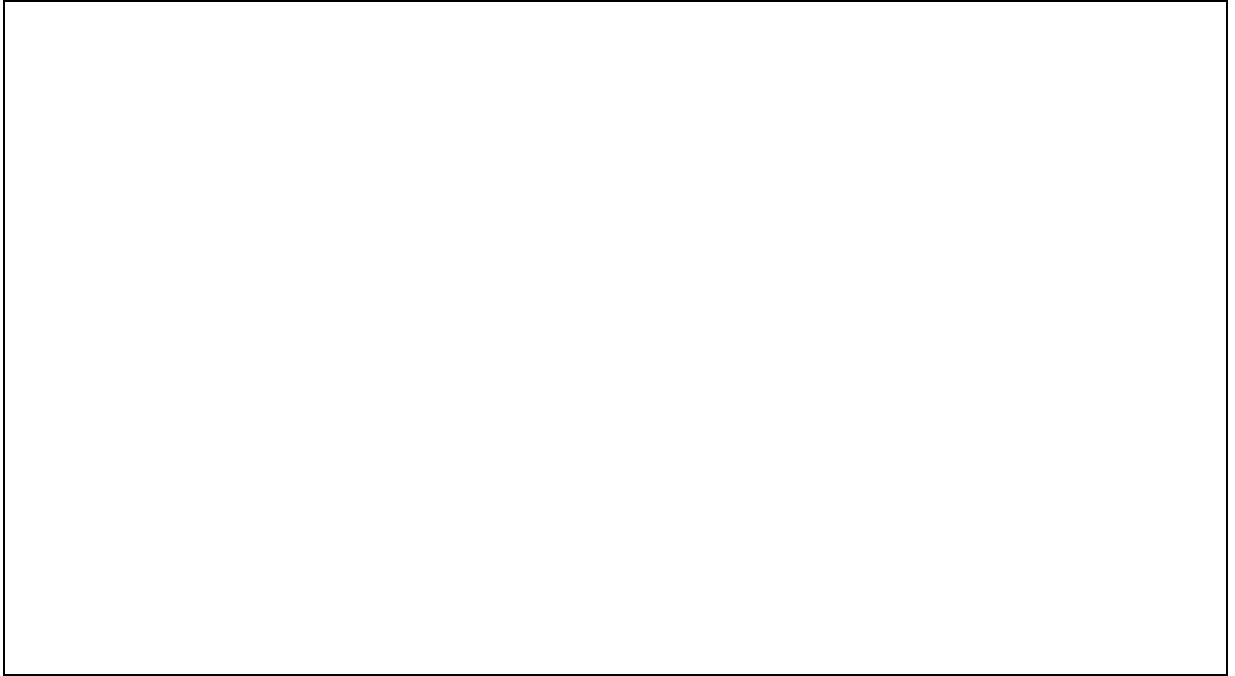

Discuss with your counselor the principles of radiation safety:


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.

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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.

Nuclear power plants	
Coal	
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.


<p><b>Requirement resources can be found here:</b> <a href="http://www.meritbadge.org/wiki/index.php/Nuclear_Science#Requirement_resources">http://www.meritbadge.org/wiki/index.php/Nuclear_Science#Requirement_resources</a></p>
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## Important excerpts from the [Guide To Advancement - 2013](#), No. 33088 (SKU-618673)

### [1.0.0.0] — Introduction

The current edition of the *Guide to Advancement* is the official source for administering advancement in all Boy Scouts of America programs: Cub Scouting, Boy Scouting, Varsity Scouting, Venturing, and Sea Scouts. It replaces any previous BSA advancement manuals, including *Advancement Committee Policies and Procedures*, *Advancement and Recognition Policies and Procedures*, and previous editions of the *Guide to Advancement*.

### [Page 2, and 5.0.1.4] — Policy on 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 special needs. For details see section 10, "Advancement for Members With Special Needs".

### [Page 2] — 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.

### [7.0.3.1] — The Buddy System and Certifying Completion

A youth member must not meet one-on-one with an adult. 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 verification. 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.

Note that from time to time, it may be appropriate for a requirement that has been met for one badge to also count for another. See "Fulfilling More Than One Requirement With a Single Activity," 4.2.3.6.

### [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.

It is sometimes reported that Scouts who have received merit badges through group instructional settings have not fulfilled all the requirements. To offer a quality merit badge program, council and district advancement committees should ensure the following are in place for all group instructional events.

- Merit badge counselors are known to be registered and approved.
- Any guest experts or guest speakers, or others assisting who are not registered and approved as merit badge counselors, do not accept the responsibilities of, or behave as, merit badge counselors, either at a group instructional event or at any other time. Their service is temporary, not ongoing.
- Counselors agree not to assume prerequisites have been completed without some level of evidence that the work has been done. Pictures and letters from other merit badge counselors or unit leaders are the best form of prerequisite documentation when the actual work done cannot be brought to the camp or site of the merit badge event.
- There is a mechanism for unit leaders or others to report concerns to a council advancement committee on summer camp merit badge programs, group instructional events, and any other merit badge counseling issues—especially in instances where it is believed BSA procedures are not followed. See "Reporting Merit Badge Counseling Concerns," 11.1.0.0.
- 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.

### [7.0.3.3] — Partial Completions

A Scout need not pass all the requirements of one merit badge with the same counselor. It may be that due to timing or location issues, etc., he must meet with a different counselor to finish the badge. 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, the counselor does not retain his or her 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 unit leader 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 Scout's 18th birthday. Units, districts, or councils shall not establish other expiration dates for partial merit badges.

### [7.0.4.8] — Unofficial Worksheets and Learning Aids

Worksheets and other materials that may be of assistance in earning merit badges are available from a variety of places including unofficial sources on the Internet and even troop libraries. Use of these aids is permissible as long as the materials can be correlated with the current requirements that Scouts must fulfill. Completing "worksheets" may suffice where a requirement calls for something in writing, but this would not work for a requirement where the Scout must discuss, tell, show, or demonstrate, etc. Note that Scouts shall not be required to use these learning aids in order to complete a merit badge.