

Nuclear Science

Merit Badge Workbook



Merit badges are earned by doing: reading the pamphlet, practicing the skills, and showing your counselor what you have learned.
This workbook gives you a place to organize your notes and track your progress along the way.
Merit badge counselors may not require the use of this or any similar workbook.
You still must satisfy your counselor that you can demonstrate each skill and have learned the information.
Use the space under each requirement to note what you have done and what you want to talk about, not to write out full answers.
When a requirement says discuss, show, tell, explain, or demonstrate, that is what you must do.
No one may add to or subtract from the official requirements found on scouting.org (Guide to Advancement 7.0.4.8).
Scouting America last updated this badge's requirements page on February 19, 2026.
Requirements change from time to time. Double-check scouting.org before you start.

Scout's name: _____ Unit: _____ Date started: _____

Counselor's name: _____ Phone no.: _____ Email: _____

Links marked "Scouting America resources" are the ones Scouting America shares on its official badge page.
This workbook is unofficial and not endorsed by Scouting America.

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1. Radiation. Do the following:

(a) Explain radiation and the difference between ionizing and nonionizing radiation.
Scouting America resources: Radiation & You (video) · IDTIMWYTIM: Radiation (video)

What radiation is, in my own words

The two kinds of radiation

Kind	What it is, and how it differs from the other
Ionizing radiation	
Nonionizing radiation	

(b) Explain the ALARA principle. Explain what process you would go through to ensure your dose is kept ALARA when performing the requirements in this merit badge.
Scouting America resources: The ALARA Principle (website)

The ALARA principle

The process I would go through to keep my dose ALARA during this badge

(c) Describe the radiation hazard symbol and explain where it should be used.
Scouting America resources: Radiation Hazard Symbol (video)
How Are Universal Ionizing Radiation Symbols Used Around the World? (website)

What the radiation hazard symbol looks like

Where it should be used

(d) Explain how we are exposed to ionizing radiation from outside the earth as well as on earth every day. List four examples of Naturally Occurring Radioactive Materials (NORM) that are in your house or grocery store and explain why they are radioactive.

Scouting America resources: Five Radioactive Products We Use Every Day (video)
Your Grocery Store is Radioactive (and So Is Everything Else) (video) · The Mystery of High-Energy Cosmic Rays (video)

How we are exposed to ionizing radiation every day

Source	How we are exposed
From outside the earth	
On earth	

Four Naturally Occurring Radioactive Materials (NORM) in my house or grocery store

Item	Where I found it	Why it is radioactive

(e) Explain the difference between radiation exposure and contamination. Describe the hazards of radiation to humans, the environment, and wildlife. Calculate your approximate annual radiation dose and compare it to a typical expected dose of someone who works in a nuclear power plant.

Scouting America resources: What Do Radiation Contamination and Exposure Mean? (video) · Biological Effects of Radiation (video)
Radiation Dose Calculator (website)

Exposure and contamination

Term	What it means
Radiation exposure	
Contamination	

Hazards of radiation

To	The hazards
Humans	
The environment	
Wildlife	

My approximate annual dose | Typical nuclear plant worker's dose

How I calculated my dose, and how the two compare

Requirement 1 completed on | counselor initials

2. Basic Nuclear Science. Do the following:

(a) Explain the following terms: atom, nucleus, proton, neutron, electron, quark, isotope; alpha particle, beta particle, gamma ray, X-ray; ionization, radioactivity, radioisotope, and stability.

Scouting America resources: Glossary of Nuclear Science Terms (website) · What Are Isotopes? (video) · Quarks Explained (video)

Nuclear science terms

Term	What it means, in my own words
Atom	
Nucleus	
Proton	
Neutron	
Electron	
Quark	
Isotope	
Alpha particle	
Beta particle	
Gamma ray	
X-ray	
Ionization	
Radioactivity	
Radioisotope	
Stability	

(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. Write down the isotope notation for each model including the atomic and mass numbers. In a separate model or diagram, explain or show how quarks make up protons and neutrons.

Scouting America resources: Make a Model of an Isotope (PDF) · Interactive Isotopes (website)

Element I chose _____ Date _____

My three isotope models

Isotope	Isotope notation (atomic and mass numbers)	Protons	Neutrons	Electrons

My model or diagram of how quarks make up protons and neutrons (draw here or attach)

Requirement 2 completed on _____ counselor initials _____

3. Modern Particle Physics. Do the following:

(a) Explain how a particle accelerator works.

Scouting America resources: Particle Accelerators: What Are They, How Do They Work and Why Are They Important To Us? (video)

How a particle accelerator works

(b) Do ONE of the following:

Scouting America resources: Lawrence Berkeley National Laboratory Nuclear Science Division (video)
Inside the World's Largest Science Experiment (video)

☐ **(1)** Visit an accelerator, research lab, or university and discuss with a scientist how they study the properties of the nucleus or nucleons.

Place I visited _____ Scientist I talked with _____ Date _____

How they study the properties of the nucleus or nucleons

☐ **(2)** List three particle accelerators and describe several experiments conducted and their associated basic science and practical applications.

Three particle accelerators

Accelerator	Experiments conducted	Basic science and practical applications

Requirement 3 completed on _____ counselor initials _____

4. Classic Experiments. Do TWO of the following:

Scouting America resources: Detecting and Measuring Ionizing Radiation - A Short History (PDF)

☐ **(a)** Build an electroscope. Show how it works. Place a radiation source near the electroscope ball and explain the effect it causes. Adults must handle radioactive materials.

Scouting America resources: DIY Electroscope (video)

Date _____ Adult who handled the radiation source _____

How my electroscope works

The effect of the radiation source near the ball, and why

☐ **(b)** Make a cloud chamber. Show how it can be used to see the tracks caused by radiation. Adults must handle radioactive materials and dry ice. Explain what is happening.

Scouting America resources: How To Build a Cloud Chamber! (video) · Working Cloud Chamber | Exploratorium (video) Visualize Radioactive Decay in a Cloud Chamber (PDF)

Date _____ Adult who handled the source and dry ice _____

The tracks I saw, and what is happening in the chamber

☐ **(c)** Perform an experiment demonstrating half-life using nonradioactive materials such as candy, coins, or other small items. Discuss decay chains.

Scouting America resources: How Radioactive Decay Works | Decay Chains (video) Skittles Half Life Lab | Radioactive Isotope Decay | Half Life Graph (video)

Date _____ Items I used _____

My half-life experiment

Round	Items left	Items removed

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Decay chains: my notes for the discussion

Requirement 4 completed on _____ counselor initials _____

5. Radiation Safety. Do ONE of the following:

☐ **(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. Adults must handle radioactive materials. 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.

Scouting America resources: How Materials Shield Radiation (PDF) · Time, Distance and Shielding (video) Measuring Radiation (video) · Using a Survey Meter: CPM vs Distance (video)

Date _____ Adult who handled the radioactive source _____

Counts per minute as the source moves

Distance from the detector	Counts per minute

Three materials between the source and the detector

Material	Counts per minute	Why the measurement differs

Reducing a person's radiation dose

Factor	How it reduces the dose
Time	
Distance	
Shielding	

☐ **(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 concerns related to radon gas and tell what steps can be taken to reduce radon in buildings.

Scouting America resources: What is Radon, Anyway? (video) · How Dangerous Is Radon to Your Health? (video)

How radon is detected in homes

Radon test methods

Method	Steps taken	When to use it
Short-term test		
Long-term test		

How to interpret the results

Health concerns related to radon gas

Steps 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 for the safety of the operator.

Scouting America resources: X-Ray Room Tour || Ask the Rad Tech (video)

Place I visited _____ Date _____

Floor plan showing the X-ray unit, the operator, and the patient (draw here or attach)

Precautions taken, and why they matter for the operator's safety

Requirement 5 completed on _____ counselor initials _____

6. Nuclear Energy. Do ONE of the following; then discuss with your counselor how nuclear energy is used to produce electricity:

Scouting America resources: Nuclear Energy (website)

How nuclear energy is used to produce electricity (notes for my counselor discussion)

☐ **(a)** Make a drawing showing how nuclear fission happens. Observe a mousetrap reactor (setup by an adult) and use it to explain how a chain reaction could be started. Explain how a chain reaction could be stopped or controlled in a nuclear reactor. Explain what is meant by a "critical mass."

Scouting America resources: What Really Happened the First Time We Split a Heavy Atom in Half (video)
What is Critical Mass | Nuclear Chain Reaction| Fission Chain Reaction| Critical Mass Of Uranium (video) · Mousetrap Fission (video)

My drawing of how nuclear fission happens (draw here or attach)

Date I observed the mousetrap reactor _____ Adult who set it up _____

Chain reactions

Topic	My explanation
How a chain reaction could be started	
How it could be stopped or controlled in a reactor	
What "critical mass" means	

☐ **(b)** Visit a local nuclear power plant or nuclear reactor either in person or online (with your parent or guardian's permission). Learn how a reactor works and how the plant generates electricity. Find out what percentage of electricity in the United States and in your state is generated by nuclear power plants and by other methods. Make a graph of the information you find.

Scouting America resources: What Is Nuclear Energy? Shrink Down to an Atom and Find Out (video)
Energy Consumption & Efficiency Data | Energy Information Agency (website)

Plant or reactor I visited (in person or online) _____ Date _____

How a reactor works and how the plant generates electricity

Where our electricity comes from

Method	Percent in the United States	Percent in my state

My graph (draw here or attach)

Requirement 6 completed on _____ counselor initials _____

7. Beneficial Applications of Nuclear Science. Give an example of each of the following and explain how nuclear science is used in these applications: nuclear medicine, environmental applications, industrial applications, space exploration, and radiation therapy. For each example, explain the application and its significance to nuclear science.

Scouting America resources: Radiation Technologies in Daily Life (video) · Ways Nuclear Science Helps Cancer Patients (video) Ways Nuclear Techniques Combat Malnutrition (video) · Ways Nuclear Science Helps Ocean Health (video)

Beneficial applications of nuclear science

Application	My example	How nuclear science is used, and its significance
Nuclear medicine		
Environmental applications		
Industrial applications		
Space exploration		
Radiation therapy		

Requirement 7 completed on _____ counselor initials _____

8. Careers. Explore careers related to nuclear science. Research one career to learn about the training and education needed, costs, job prospects, salary, job duties, and career advancement. Your research methods may include—with your parent or guardian's permission—an internet or library search, an interview with a professional in the field, or a visit to a location where people in this career work. Discuss with your counselor both your findings and what about this profession might make it an interesting career.

Scouting America resources: What do Nuclear Scientists Do? (video) · Nuclear Engineering (video) · Nuclear Medicine (video) Navy Nuclear (video) · 7 Nuclear Careers that Don't Require an Engineering Degree (webpage)

Careers related to nuclear science

Career	What people in it do

Career I researched _____ How I researched it _____

What I found

Topic	My findings
Training and education needed	
Costs	
Job prospects	
Salary	
Job duties	
Career advancement	

What might make it an interesting career

Requirement 8 completed on _____ counselor initials _____

Counselor sign-off

Your counselor signs your blue card or approves the badge in Scoutbook, and your unit records it. This line is for your own records.

Counselor's signature _____ Date completed _____

Official Scouting America resources

Scouting America resources: Nuclear Science merit badge page (requirements and resources)
Nuclear Science merit badge pamphlet (free PDF) · All merit badges

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