



Nuclear Science

Merit Badge Workbook

This workbook can help you but you still need to read the merit badge pamphlet (book). No one can add or subtract from the Boy Scout Requirements #33216. Merit Badge Workbooks and much more are below: [Online Resources](#).
Send comments to the workbook developer: craig@craiglincoln.com. Requirements revised: 2011, Workbook updated: March, 2011.

Scout's Name: _____ Unit: _____

Counselor's Name: _____ Counselor's Ph #: _____

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. _____

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

then discuss modern particle physics with your counselor: _____

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 149 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.. _____

then discuss with your counselor the different kinds of radiation and how they can be used: _____

5. 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. _____

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, _____

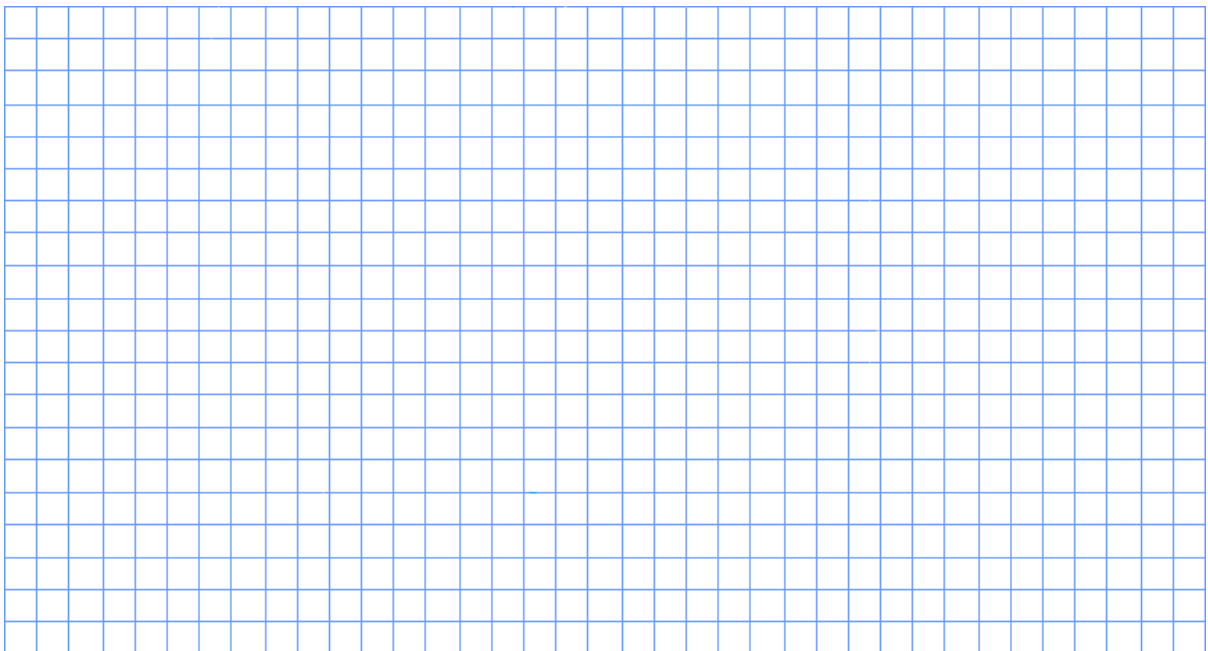
and explain when each type of test should be used. _____

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. _____

then discuss with your counselor the principles of radiation safety: _____

6. Do ONE of the following:

- 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.

then 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. _____

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

nuclear medicine, _____

environmental applications, _____

industrial applications, _____

space exploration, _____

and 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. _____

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

Online Resources: *(Use any Internet resource with caution and only with your parent's or guardian's permission.)*

Boy Scouts of America: ► scouting.org ► [Guide to Safe Scouting](#) ► [Age-Appropriate Guidelines](#) ► [Safe Swim Defense](#)
 ► [Scout](#) ► [Tenderfoot](#) ► [Second Class](#) ► [First Class](#) ► [Rank Videos](#) ► [Safety Afloat](#)

Boy Scout Merit Badge Workbooks: usscouts.org -or- meritbadge.org **Merit Badge Books:** www.scoutstuff.org

Requirement Resources

These resources and much more are at: http://meritbadge.org/wiki/index.php/Nuclear_Science

- 1a. [Radiation Hazards](#) - [Radiation Hazards of X-rays](#) - [Radiation Hazards in the U.S.](#) - [Radiation Information](#) - [Radiation made Easy](#) - [Wikipedia Radiation poisoning](#) - [Deterministic and Stochastic Models](#) - [Deterministic vs Stochastic Estimate your Annual Dose of Radiation](#) - [Radiation Exposure](#) [EPA Radiation Laws](#)
- 1b. [Radiation Symbol](#) - [Radiation Hazard Symbol](#) - [A history of the radiation symbol](#) - [Radiation and Risk](#)
2. [Dictionary of Radiological Terms](#) - [US NRC Glossary of Nuclear Terms](#) - [Nuclear Science Terms](#) - [Term Glossary](#) - [First Course in Nuclear Science](#) - [Glossary of Terms](#)
3. [The Atomic Heritage Foundation](#) - [Biographies of the Nuclear Age](#) - [Famous Figures in Nuclear Science](#)
[Henri Becquerel](#) - [Niels Bohr](#) - [Marie Curie](#) - [Albert Einstein](#) - [Enrico Fermi](#) - [Otto Hahn](#) - [Ernest Lawrence](#) - [Lise Meitner](#) - [Wilhelm Roentgen](#) - [Sir Ernest Rutherford](#)
4. [Periodic Table](#) - [Interactive Periodic Table ANimated Electrons, Atom Diagrams, etc.](#) - [Periodic Table of the Elements](#)
[Atomic Model Suggestions](#) - [Isotopes of Hydrogen](#)
- 4a. [Nuclear Fission](#) - [Nuclear Fission](#) - [Chain Reaction](#)
- 4b. [Critical Mass](#)
- 5a. [Build an Electroscope](#)
- 5b. [Description of how a Nuclear Reactor works](#) - [Inside a Nuclear Reactor](#)
- 5c. [How time, distance and shielding reduce radiation dose](#) - [How to reduce exposure to radiation](#) - [Wikipedia Biological Shielding](#) - [Time, Distance, and Shielding](#) - [How to detect radiation](#)
- 5d. [Food Irradiation](#) - [Food Irradiation from A-Z](#) - [Irradiation How to recognize irradiated foods](#) - [USFDA Food Irradiation](#)
- 5e. [Natural Radioactivity](#) - [Citizen's Guide to Radon](#) - [How radon tests work](#) - [Radon Outreach Program](#)
- 5f. The graph paper you need is in the [Nuclear Science Worksheet](#).
[X-ray info and safety precautions](#) - [X-ray safety](#) - [Dangers of X Rays](#)
- 5g. [How to build a cloud chamber](#) - [How a cloud chamber works](#)
- 5h. [Radioisotopes in medicine](#) - [Uses of Isotopes](#)
- 5i. [Seed Irradiation](#)
- 5j. See 6c below.
- 6a. [Nuclear Medicine](#) - [Environmental](#) - [Nuclear Propulsion](#) - [Radiation Therapy](#)
- 6b. [US Nuclear power](#) - [Locate Nuclear Power Plants in the US](#) - [Energy in the United States](#) - [Nuclear Power Plants and Utilities](#) - [Nuclear Power in the World](#)
- 6c. [Brookhaven Lab](#) - [Fermi Lab](#) - [Stanford Linear Accelerator](#) - [Jefferson Lab](#) - [Argonne Lab](#) - [Advanced Light Source at Berkeley](#)
7. [Nuclear Engineering Career Page](#) - [Nuclear Education and Research](#) - [Careers in Radiology](#) - [Radiation Therapy Careers](#)