MOSI

# Nuclear Science

## Merit Badge Workbook

Thank you for your interest in participating in our upcoming merit badge workshop. We are very excited to be able to offer this workshop to help you complete the necessary requirements to earn your badge while also carrying out the hands-on activities in an enriching and fun way. This workbook describes the workshop's activities and prerequisites. Most of these prerequisites are primarily research and reading activities that will better prepare you for the merit badge workshop.

Activities we will complete in the workshop are colored blue.

Prerequisites are colored red.

BEFORE you attend this merit badge workshop you MUST do the following prerequisites:

Item 1

Item 7

Item 8

Please note: The merit badge counselor will not sign "blue cards" for scouts not demonstrating completed prerequisites on this workbook.

# 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. _____

X 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; _____

X a. Build an electroscope. _____

Show how it works. _____

Place a radiation source inside and explain the effect it causes. _____

_____

_____

X 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 _____

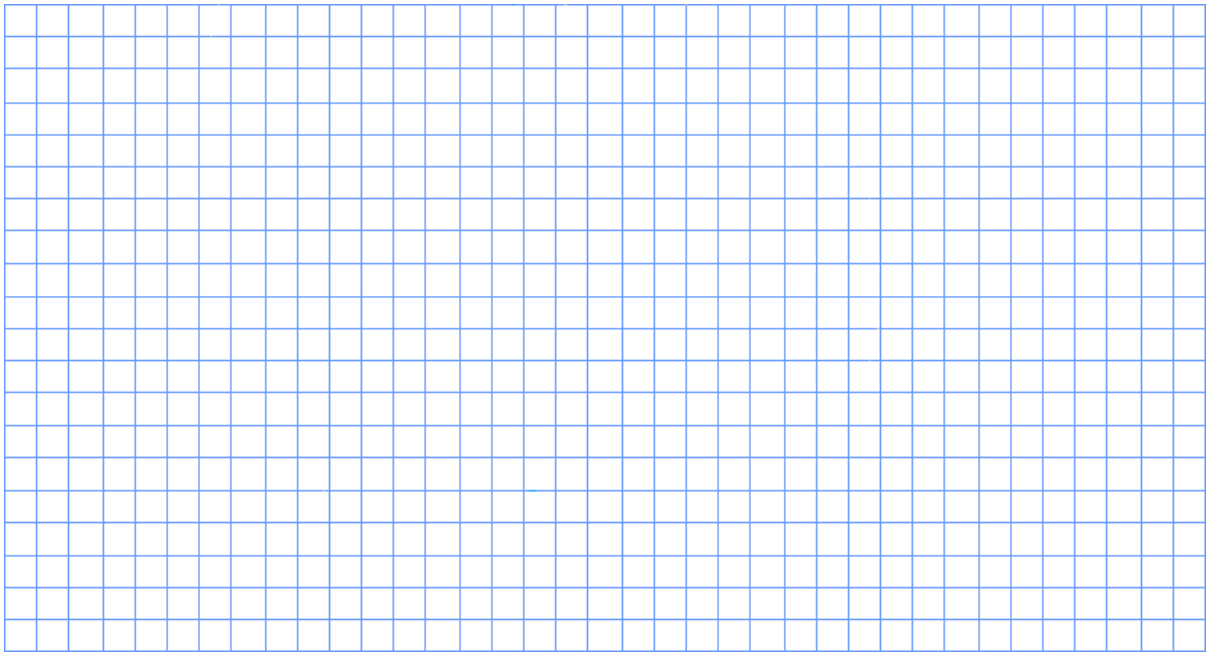
_____

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.” _____

_____

_____

_____

_____

X 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