2010

NUCLEAR SCIENCE PROGRAM OVERVIEW & WORKBOOK

SAINT FRANCIS MEDICAL CENTER

MERIT BADGE UNIVERSITY

OVERLAND TRAILS COUNCIL

7/31/2010

TABLE OF CONTENTS

FEBRUARY 2010
Information in this booklet was accurate at the time of publishing.

Program Overview & Workbook was reviewed by
MBU Staff/Committee.

NUCLEAR SCIENCE PROGRAM OVERVIEW

COUNSELOR: tba

C/O: Overland Trails Council
PO Box 1361
Grand Island, NE 68802-1361

LOCATION: Saint Francis Medical Center
2620 West Faidley Av
Grand Island, NE 68803

TRANSPORTATION: Transportation is provided

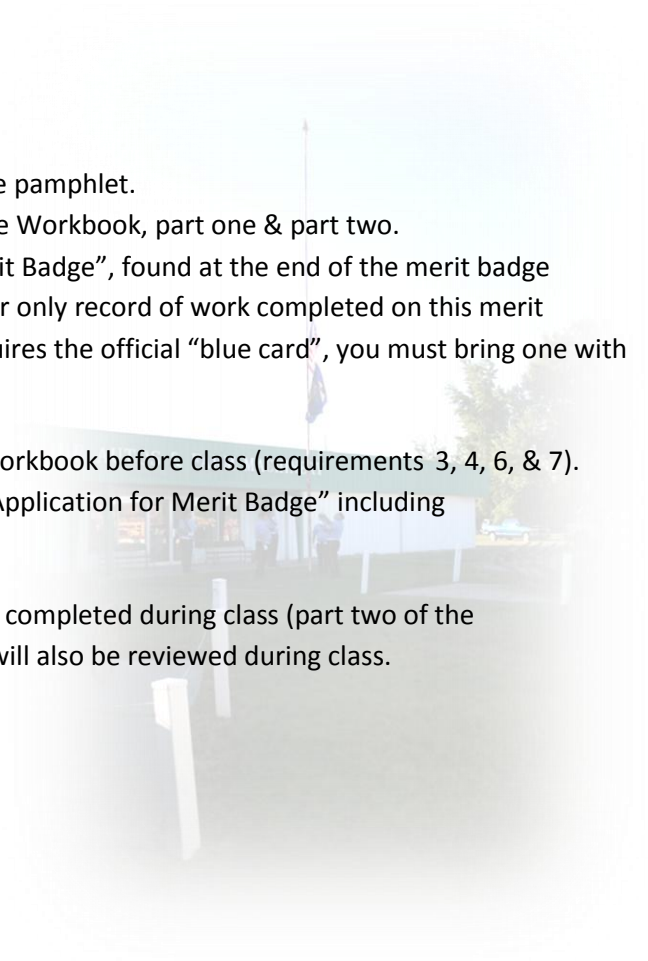
ADDITIONAL COSTS: None

CLASS SIZE: 10

BRING TO CLASS: Nuclear Science merit badge pamphlet.
Nuclear Science Merit Badge Workbook, part one & part two.
Signed "Application for Merit Badge", found at the end of the merit badge workbook. (This will be your only record of work completed on this merit badge.) If your Council requires the official "blue card", you must bring one with you to class.

PRE-REQUISITES: Complete Part One of the workbook before class (requirements 3, 4, 6, & 7).
Complete information on "Application for Merit Badge" including Scoutmasters signature.

CURRICULUM: Requirements 1, 2, 5 will be completed during class (part two of the workbook). Pre-requisites will also be reviewed during class.



NUCLEAR SCIENCE

Boy Scouts Requirements 2010

PRE-REQUISITE REQUIREMENTS ARE PRINTED IN ***BOLD UNDERLINED RED ITALICS*** & MUST BE COMPLETED BEFORE CLASS.

1. Do the following:
    a) Describe the biological effects and hazards of radiation to humankind, the environment, and wildlife. Explain the difference between deterministic and stochastic effects. In your explanation, discuss the nature and magnitude of radiation risks to humans from nuclear power, medical radiation, and background radiation. Explain the measures required by law to minimize these risks.
    b) 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. Tell the meaning of the following: ALARA, alpha particle, atom, background radiation, beta particle, contamination, curie and Becquerel, gamma ray, half-life, ionization, quark, isotope, neutron, nuclear energy, nuclear reactor, particle accelerator, rad and gray, radiation, radioactivity, radon, rem and sievert, and X-ray.
3. ***Choose five individuals important to the field of atomic energy and nuclear science and explain each person's contribution.***
4. ***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. Then do 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.
    b) Explain what is meant by a "critical mass."
5. Do any THREE of the following:
    a) Build an electroscope. Show how it works. Place a radiation source inside and explain any difference seen.
    b) Build a model of a reactor. Show the fuel, control rods, shielding, moderator, and any cooling material. Explain how a reactor could be used to change nuclear energy into electrical energy or make things radioactive.
    c) Using a radiation survey meter and a radioactive source, show how the measurements per minute change as the source gets closer to or farther from the radiation detector. Place three different kinds of materials between the source and the detector, then explain any differences in the measurements per minute. Explain how time, distance, and shielding can reduce the radiation dose.
    d) 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.

e) Describe how radon is detected in homes. Discuss the steps taken for the long-term and short-term test methods, 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.

f) Visit a place where X-ray is used. Draw a floor plan of the room in which it is used. Show where the unit, the unit operator, and the patient would be when X-ray is used. Explain the precautions taken when X-ray is used and the importance of those precautions.

g) Make a cloud chamber. Show how it can be used to see the tracks caused by radiation. Explain what is happening.

h) Visit a place where radioisotopes are being used. Using a drawing, explain how and why they are used.

i) Obtain samples of irradiated seeds. Plant them. Plant a group of non-irradiated seeds of the same kind. Grow both groups. List any differences you observe during a 30-day period. Discuss with your counselor what irradiation does to seeds.

j) Visit an accelerator (research lab) or university where people study the properties of the nucleus. After your visit, discuss what you have learned with your counselor.

6. Do ONE of the following:

a) 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.

b) 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.

c) Name three particle accelerators in the United States and describe the type of experiments each accelerator is designed to perform.

7. Find out about three career opportunities in nuclear science that interest you. Pick one and find out the education, training, and experience required for this profession and discuss this with your counselor. Tell why this profession interests you.

NUCLEAR SCIENCE WORKBOOK
PART ONE, PRE-REQUSITIES

Name _____

Unit # _____ District _____

Council _____

Part One of the workbook must be completed before class.

Bring the entire workbook (part one and part two) with you to class.

Also bring the "Application for Merit Badge" signed by your scoutmaster (included at the end of the workbook).

☐ 3. Choose five individuals important to the field of atomic energy and nuclear science and explain each person's contribution.

Individual one:

Individual two:

Individual three:

Individual four:

Individual five:

Name_____

☐ 4. 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. Then do the following:

Choose an element from the periodic table and construct 3-D models:

Use the three models to explain the difference between atomic number and mass number:

☐ 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.

To help you complete this requirement use "Nuclear Fission Drawing" at the end of this workbook.

☐ b) Explain what is meant by a "critical mass."

Explain what is meant by a "critical mass":

☐ 6. Do ONE of the following:

☐ a) 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.

Give an example of each in relation to how energy from an atom can be used & explain the application

Nuclear medicine	
Environmental applications	
Industrial applications	
Space exploration	
Radiation therapy	

Name_____

6. continued

- ☐ b) 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.

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	
Coal	
Gas	

- ☐ c) Name three particle accelerators in the United States and describe the type of experiments each accelerator is designed to perform.

Name three particle accelerators in the United States:

Particle accelerators	*Type of experiments accelerator is designed to perform*

Name_____

☐ 7. Find out about three career opportunities in nuclear science that interest you. Pick one and find out the education, training, and experience required for this profession and discuss this with your counselor. Tell why this profession interests you.

Career opportunities in aviation:

1.
2.
3.

Pick one career:

Career:
Education:
Training:
Experience:

Why this profession interest's you:

NUCLEAR SCIENCE WORKBOOK
PART TWO, CLASS CURRICULUM

Name _____

Unit # _____ District _____

Council _____

Part Two of the workbook will be completed during class.

- ☐ 1. Do the following:
  - ☐ a) Describe the biological effects and hazards of radiation to humankind, the environment, and wildlife. Explain the difference between deterministic and stochastic effects. In your explanation, discuss the nature and magnitude of radiation risks to humans from nuclear power, medical radiation, and background radiation. Explain the measures required by law to minimize these risks.

Describe the biological effects and hazards of radiation:

Explain the difference between deterministic and stochastic effects:

In your explanation, discuss the nature and magnitude of radiation risks to humans from:

nuclear power:

medical radiation:

background radiation:

Explain the measures required by law to minimize these risks:

Name_____

1. continued

- ☐ b) Describe the radiation hazard symbol and explain where it should be used. Tell why and how people must use radiation or radioactive materials carefully.

Radiation hazard symbol:

Where should it be used:

Why and how people must use materials carefully:

Name_____

□ 2. Tell the meaning of the following: ALARA, alpha particle, atom, background radiation, beta particle, contamination, curie and Becquerel, gamma ray, half-life, ionization, quark, isotope, neutron, nuclear energy, nuclear reactor, particle accelerator, rad and gray, radiation, radioactivity, radon, rem and sievert, and X-ray.

	Definition/meaning
ALARA:	
alpha particle:	
atom:	
background radiation:	
beta particle:	
contamination:	
curie and Becquerel:	
gamma ray:	
half-life:	
ionization:	
quark:	
isotope:	
neutron:	
nuclear energy:	
nuclear reactor:	
particle accelerator:	
rad and gray:	
radiation:	
radioactivity:	
radon:	
rem and sievert:	
X-ray:	

Name_____

☐ 5. Do any THREE of the following:

☐ a) Build an electroscope. Show how it works. Place a radiation source inside and explain any difference seen.

Build an electroscope:

Place a radiation sources inside and explain any difference seen:

☐ b) Build a model of a reactor. Show the fuel, control rods, shielding, moderator, and any cooling material. Explain how a reactor could be used to change nuclear energy into electrical energy or make things radioactive.

Build a model of a reactor:

Explain how a reactor could be used to change nuclear energy into electrical energy:

or make things radioactive:

☐ c) Using a radiation survey meter and a radioactive source, show how the measurements per minute change as the source gets closer to or farther from the radiation detector. Place three different kinds of materials between the source and the detector, then explain any differences in the measurements per minute. Explain how time, distance, and shielding can reduce the radiation dose.

Show how the measurements per minute change as the source gets closer to or farther from:

Explain how time, distance, and shielding can reduce the radiation dose:

Name_____

5. continued

- ☐ d) 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.

Obtain a sample of irradiated and non-irradiated foods:

Prepare the two foods and compare their taste and texture:

Irradiated		*Non-irradiated*	
Taste	*Texture*	*Taste*	*Texture*

For a period of 14 days observe their rate of decomposition or spoilage:

	Irradiated	*Non-irradiated*
Day 5		
Day 10		
Day 14		

Name_____

5. continued

- e) Describe how radon is detected in homes. Discuss the steps taken for the long-term and short-term test methods, 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.

Describe how radon is detected in homes:

Discuss the steps taken for the long-term and short-term test methods,

how to interpret the results:

and explain when each type of test should be used:

Explain the health concern related to radon gas:

Tell what steps can be taken to reduce radon in building:

Name_____

5. continued

- ☐ f) Visit a place where X-ray is used. Draw a floor plan of the room in which it is used. Show where the unit, the unit operator, and the patient would be when X-ray is used. Explain the precautions taken when X-ray is used and the importance of those precautions.

Visit a place where X-ray is used:

Draw a floor plan of the room:

Explain the precautions taken when X-ray is used and the importance of those precautions:

Name_____

5. continued

- ☐ g) Make a cloud chamber. Show how it can be used to see the tracks caused by radiation. Explain what is happening.

Make a cloud chamber:

Show how it can be used to see the tracks caused by radiation:

Explain what is happening:

- ☐ h) Visit a place where radioisotopes are being used. Using a drawing, explain how and why they are used.

Visit a place where radioisotopes are being used:

Using a drawing, explain how and why they are used:

Name_____

5. continued

- ☐ i) Obtain samples of irradiated seeds. Plant them. Plant a group of non-irradiated seeds of the same kind. Grow both groups. List any differences you observe during a 30-day period. Discuss with your counselor what irradiation does to seeds.

Obtain samples of irradiated seeds:

Plant them & Plant a group of non-irradiated seeds of the same kind. Grow both groups:

List any differences you observe during a 30-day period:

Discuss what irradiation does to seeds:

- ☐ j) Visit an accelerator (research lab) or university where people study the properties of the nucleus. After your visit, discuss what you have learned with your counselor.

Visit an accelerator or university where people study the properties of the nucleus:

Discuss what you have learned:

ORGANIZATIONS and WEB SITES

(Whenever you go online, be sure you have your parent's permission first.)

ABCs for Nuclear Science
http://www.lbl.gov/abc
American Nuclear Society
http://www.ans.org
American Physical Society
http://www.aps.org
EPA Radiation Protection Students' and Teachers' Pages
http://www.epa.gov/radiation/students
Health Physics Society
http://hps.org
International Atomic Energy Agency
http://www.iaea.org
Nuclear Energy Institute
http://www.nei.org
Nuclear Energy, Science, and Technology
http://particleadventure.org
U.S. Nuclear Regulatory Commission
http://www.nrc.gov

NUCLEAR SCIENCE WORKBOOK

Notes

APPLICATION FOR MERIT BADGE

Name: _____

Address: _____

City: _____

State: _____

Is a registered _____Boy Scout,

_____Varsity Scout,

_____Venturer,

of _____ No._____

Troop, team, crew, ship

District: _____

Council: _____

MERIT BADGE UNIVERISTY

Merit Badge: **Nuclear Science**

Counselor: _____

Address: Overland Trails Council
PO Box 1361
2808 O'Flannagan
Grand Island, NE 68802-1361

Phone: 308-382-3717

email: mbuotc@yahoo.com

and is qualified to begin working for this merit badge and has completed the following pre-requisite requirements:

SECTION A PRE-REQUISITE REQUIREMENTS

Requirement No. and letter	Date of Approval	Counselor Initial	Requirement No. and letter	Date of Approval	Counselor Initial
3					
4					
6					
7					

The applicant has personally appeared before me and demonstrated to my satisfaction that he has met all pre-requisites requirements for the above stated merit badge and is ready to attend his assigned MBU class.

*Signature of Unit Leader*_____*Date*_____

SECTION B APPLICANTS RECORD

Requirement No. and letter	Date of Approval	Counselor Initial	Requirement No. and letter	Date of Approval	Counselor Initial
1					
2					
5 ( )					
5 ( )					
5 ( )					

The applicant has personally appeared before me and demonstrated to my satisfaction that he has completed all requirements in **SECTION B** above for the

Merit Badge: **Nuclear Science**

Name of Counselor: _____

Signature of Counselor_____Date_____

SCOUT INSTRUCTIONS

- ☐ Complete your name, address, city, unit type & number, district, & council on the Application for Merit Badge.
- ☐ Your unit leader must sign the Application for Merit Badge before attending class.
- ☐ All other information is already printed on the Application for Merit Badge; please make sure all information is correct.
- ☐ The merit badge counselor is registered & approved for this merit badge and is on the MBU Counselor's List.
- ☐ Read the merit badge pamphlet.
- ☐ Attend the merit badge class.
- ☐ Always meet with your counselor along with a buddy (a Scout, friend, or parent)
- ☐ Have your merit badge worksheet with you when you attend class.
- ☐ **If the merit badge pre-requisites are not completed before class, you will not be able to complete the merit badge during this weekend event, you will have to follow up with your Unit's Advancement Chair when you return home**
- ☐ **PLEASE BE AWARE THAT SOME COUNSELORS WILL NOT ALLOW YOU TO ATTEND THEIR CLASS WITHOUT PRE-REQUISITES COMPLETED—CLASS CURRICULUM IS DEPENDENT ON PRE-REQUISITE WORK BEING COMPLETED!**

COUNSELOR INSTRUCTIONS

- ☐ Never meet alone with a Scout.
- ☐ Verify all information & merit badge name on Application for Merit Badge is correct.
- ☐ Sign your name on the line at the bottom of **"SECTION B APPLICANTS RECORD"**.

Drawing showing how nuclear fission happens, labeling all details.

Drawing showing how a chain reaction could be started and how it could be stopped.	
started	*stopped*