NUCLEAR EXPLORERS℠

Informal Education Program for Youth

Center for Nuclear Science and Technology Information

An initiative of the American Nuclear Society

NUCLEAR EXPLORERS[SM] is an informal education program from the American Nuclear Society's Center for Nuclear Science and Technology Information.

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NUCLEAR EXPLORERS℠ Informal Education Program for Youth

When you think of education, you probably think of classrooms, teachers, schedules, and tests. Of course, learning doesn't stop when the last bell rings. In fact, a lot of what children learn is discovered outside of school through youth programs at parks, museums, libraries, before and after school activities, and in myriad other settings. Informal education focuses on learning through exploration in engaging, interactive settings where the emphasis is on fun, not grades.

The Nuclear Explorers program is designed to assist American Nuclear Society (ANS) local and student sections to expand their community outreach to youth informal education program providers. This toolkit provides guidance in developing partnerships, promoting, planning, and presenting your own Nuclear Explorers programs. You'll find links to suggested workshop agendas, sample emails to potential partners, promotional flyers, activities, social media posts, and more. And of course, the ANS staff are available to help you succeed.

Informal education is an increasingly popular option for parents looking to provide productive out-of-school experiences for their children, whether during before- or after-school care or simply for educational enrichment. According to the Afterschool Alliance, more than half of parents look for science, technology, engineering and math (STEM) content in an out-of-school program. There is a natural audience that should be interested in your programming!

Nuclear science and technology experiences are ideally suited to informal settings. Without pressure to perform or classroom time constraints, children are free to explore topics that they might not get in school, such as running nuclear experiments, building robots, or learning about new nuclear technologies. This is also an opportunity to interest students in nuclear or related science careers.

For more information or assistance in developing a Nuclear Explorers program in your community, please contact ANS at outreach@ans.org.

All of the materials featured in this brochure are available for download at www.ans.org/members/nucexp

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Finding Partners

Finding organizations to partner with simply involves a little research. A phone call is best, but a letter or email can start the process as well. Some samples are included in the following pages to help you out. Here are some potential partners to consider.

Schools

Inquire about their after-school programs. A great place to start is the school your children or your neighbors' children attend. Ask your child's teacher who to contact. Many schools also maintain websites where you can look up the appropriate contact. Approach both public and private schools. Some after school programs are operated by outside organizations, so be prepared to contact those if needed.

Parent Organizations

Frequently, parent groups organize special programs for students, as well as for parents. Contact the school office for PTA or PTO contact information.

Park Districts

Park district programs for children and teens vary from a one-day activity to multi-day experiences. Unlike schools, they often run year-round. Contact the park program office to learn the process for offering a new activity.

Libraries

Like park districts, libraries offer a wide range of programs that are offered year-round. These programs are most often conducted by community members, not library staff. Even if they don't offer Nuclear Explorers as a library program, they may offer their facilities free or at a reduced cost to community members, so you may still be able to present the program there. Some libraries will even help promote it. Contact your library's Children's and Youth Librarians for information.

Y/YWCA

Ys are famous for their summer camps, but many run programs throughout the year. Some have after-school care services, while some schools contract with a local Y to run their after-school programs. You can look up your local Y through the Y-USA website. The youth program director is a likely first contact, or call to find out who determines youth programming. While the Y serves all children, the YWCA is a likely partner for programs for young women and girls.

Scouts

ANS members frequently participate in nuclear workshops for Girl and Boy Scout troops. ANS worked with the Girl Scouts of Greater Chicago and Northwest Indiana to create the "Get to Know Nuclear" patch, which you can order for your local scouts. We also support local and students sections in assisting Boy Scouts to earn the BSA Nuclear Science Merit Badge. You can find information and activities for conducting scout programs on NuclearConnect.org.

4H, Museums, and Other Private Organizations

Numerous national organizations offer out-of-school STEM programs as well. Teen Science Cafe Network, for instance, is a national organization that supports local Science Cafes for high school students. You can find additional out-of-school STEM opportunities in your area through the National Afterschool Association, The National Summer Learning Association, the Afterschool Alliance and 4H.

Sample Introductory Email

Instructions: Please customize the activities and other information in brackets based on what you are offering locally.

Subject line: Free, Fun Youth Nuclear Explorers Program for [Name of Organization]

Dear_____,

I am writing to offer you a free STEM program organized for your (children/teens/students) by local scientists and engineers. Nuclear Explorers is an informal education program from the American Nuclear Society's Center for Nuclear Science and Technology Information that leads students through an engaging, hands-on exploration of nuclear science and technology appropriate for their age levels. Most of all, it is intended to make science fun outside of school.

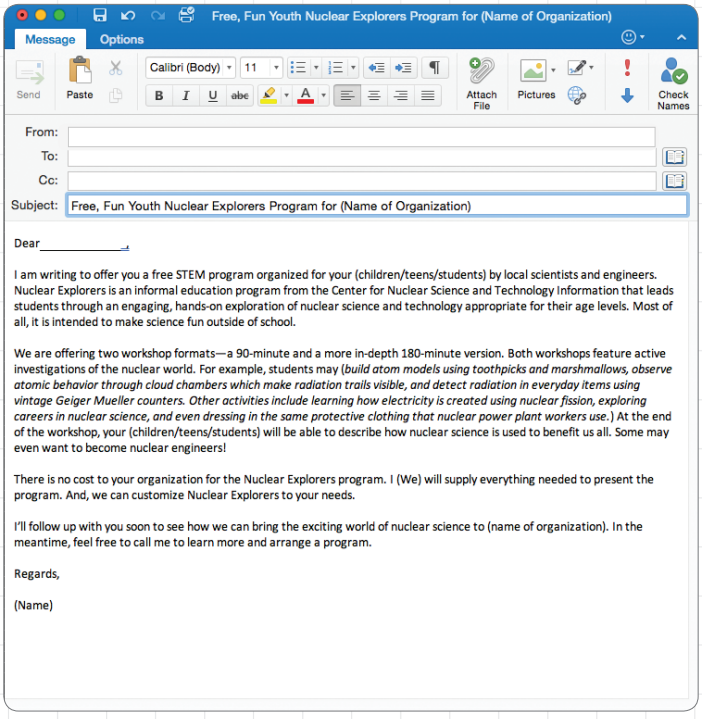
We are offering two workshop formats—a 90-minute and a more in-depth 180-minute version. Both workshops feature active investigations of the nuclear world. For example, students may [*build atom models using toothpicks and marshmallows, observe atomic behavior through cloud chambers which make radiation trails visible, and detect radiation in everyday items using vintage Geiger Mueller counters. Other activities include learning how electricity is created using nuclear fission, exploring careers in nuclear science, and even dressing in the same protective clothing that nuclear power plant workers use.*] At the end of the workshop, your (children/teens/students) will be able to describe how nuclear science is used to benefit us all. Some may even want to become nuclear engineers!

There is no cost to your organization for the Nuclear Explorers program. I (We) will supply everything needed to present the program. And, we can customize Nuclear Explorers to your needs.

I'll follow up with you soon to see how we can bring the exciting world of nuclear science to [name of organization]. In the meantime, feel free to call me to learn more and arrange a program.

Regards,

[Name]



Nuclear Explorers Promotional Flyer

Instructions: Customize this format with information about your program. Work with your presenting partner to produce it. Be sure to include the Nuclear Explorers logo. You and your presenting partner can distribute it to appropriate audiences to promote the program. Download the flyer.

A fun, hands-on exploration of nuclear science and technology for ages [X-XX]

BE A NUCLEAR EXPLORER!

[Date]

[Time]

[Place]

Join nuclear engineers and scientists for a look inside the world of nuclear science and technology!

Activities include: *[insert activities you will be using]*

- Making models of the atom using toothpicks and marshmallows
- Observing atomic behavior through cloud chambers which make radiation trails visible
- Discovering how nuclear fission is used to create nuclear energy
- Detecting radiation in everyday items using vintage Geiger Mueller counters
- And many others

Event details *[sponsor, who is teaching, how to register, etc.]*

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Nuclear Explorers is an informal education program from the American Nuclear Society's Center for Nuclear Science and Technology Information.

Sample Social Media Posts

General Instructions: It is best to include photos with your posts. Take action pictures of your presenters engaged in one of the activities. Include students of the same age as those you want to attend your program in the picture, if possible. (Do not post photos of minor children without parental permission.) Be sure to smile so it looks like fun!

Begin promoting your program at least eight weeks in advance.

Facebook

Instructions: Plan on posting two or three times on Facebook, once when registration opens, then again as the event approaches.

1. Explore the world of nuclear science and technology with Nuclear Explorers from the American Nuclear Society! Join us at [location on date] as we make models of the atom, observe radiation trails, use Geiger Mueller counters to detect radiation in everyday items, and many other hands-on activities. [Insert details for how to register]

2. Get your atom on! You can make models of the atom, observe radiation trails, use Geiger Mueller counters to detect radiation in everyday items, and many other hands-on activities in the Nuclear Explorers[SM] workshop from the American Nuclear Society. [Insert details for how to register]

Twitter

Instructions: Post Tweets continuously, as often as every day, from the time registration begins until you hold your event. For your convenience, you can schedule tweets ahead of time to post as you often as you like.

Get your atom on! Ages X-Y join (@twitter handle of participating organization) as we explore nuclear science, @ans_org Nuclear Explorers program. #STEM #education [link to more details and registration information]

Discover how nuclear science improves your life @ans_org Nuclear Explorers workshop for ages X-Y (@twitter handle). #STEM #education [link to more details and registration information]

Kids X-Y detect radiation with a Geiger counter, explore nuclear science, technology @ans_org's Nuclear Explorers workshop (@twitter handle) #STEM #education [link to more details and registration information]

Sample Workshop Agendas

Through this workshop, students will learn the structure of the nucleus, what causes radiation, how to observe it, how fission is used to create energy, and how a nuclear reactor works. The goal is for students to leave with an objective view of nuclear science and the benefits it brings to society.

You'll find directions for all of the activities in the outlines below in the ANS Teacher Resource Guide, which is downloadable from NuclearConnect.org. ANS has produced a PowerPoint presentation to accompany this agenda (see page 10). You may amend it as necessary.

This is just a suggested format, with notes on how to conduct and explain each segment. The workshop can be presented in a single day, on subsequent days, or edited to a single, shorter workshop. It is based on a successful after-school program presented by an ANS member. Feel free to adjust according to your and your partnering organization's needs.

Agenda - Session 1
(90 minutes)

1. **Introduction**
   (10 minutes)

2. **Making Atoms Visible: Cloud Chamber Activity**
   (40 minutes)
   - Reference: Teacher Resource Guide page 2.1
   - Set up three cloud chambers, each with an alpha, beta, and gamma source, and have student observe.
   - Discuss results.

3. **What is Nuclear Fission?**
   (10 minutes)
   - Reference: Teacher Resource Guide 7.1
   - Fission is the spitting of large atoms (uranium), and it creates heat.
   - The more fission, the more heat
   - Fission demonstration/activity with balloons

4. **How Does a Nuclear Power Plant Work?**
   (20 minutes)
   - Reference: Teacher Resource Guide page 11.1
   - Discuss how the reactor produces heat, to make steam, to turn a turbine, to generate electricity.
   - Energy Equivalents: 1 uranium pellet = 2,000 lbs of coal, 17,000 cubic feet of natural gas
   - Energy production critical mass activity
   - Nuclear Connect reactor function graphics

5. **Wrap up**
   - Review
   - Certificates of Completion
   - Clean up

Agenda - Session 2
(90 minutes)

1 Introduction
(10 minutes)

Every known element is listed on the Periodic Table. Every element is made up of atoms. Atoms are made up of protons, neutrons, and electrons. Protons are positive and electrons are negative and they repel (use magnets to demonstrate). Neutrons have no charge.

- What does nuclear mean?
  - Every answer gets a token (candy or other reward).
  - Answers will vary "nucleus of a cell, solar system, family, atoms" etc.
  - What we will talk about today is the nucleus of an atom. Atoms have protons and neutrons in the nucleus. Electrons surround it.
- What is the first step of science?
  - Every answer gets a token.
  - Answers will vary. "Observe, Ask a question, Purpose"
  - What can we observe?
  - HT2S2 = Hear, Taste, Touch, Smell, See
  - We can't use these senses to observe radiation directly.

2 Radiation/Energy
(10 minutes)

Radiation is energy that travels as particles or waves and can be naturally occurring or man-made. It is all around us in various forms ranging from radio waves to x-rays to cosmic radiation.

3 Energy from the Atom: Reading Comprehension Activity
(10 minutes)

- While students are reading, get activities set up.
- Energy from the Atom: Atoms Worksheet (page 11)
- Read and answer the questions.
- Every answer gets a token.

4 Build Radioactive and Stable Atoms Activity
(30 minutes)

- Reference: Teacher Resource Guide page 9.11
- Preassemble bags of materials to build a nucleus.
- Assign different atoms and have students/groups identify the element or its isotope. Example:
  - 6 protons + 6 neutrons = carbon-12 (build an atom)
  - 6 protons + 8 neutrons = carbon-14 (build an isotope)

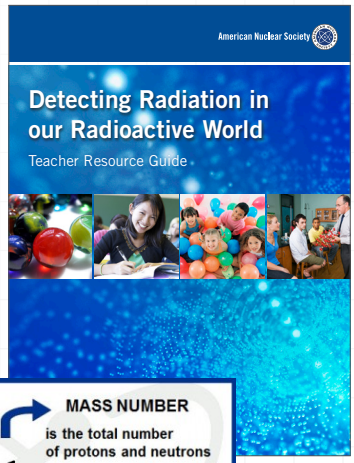
5 Is it Radioactive? Activity
(30 minutes)

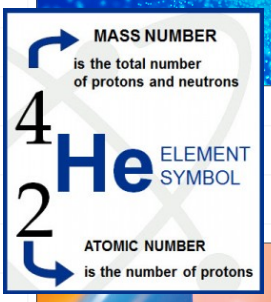
- Reference: Teacher Resource Guide page 6.1
- Provide a variety of radioactive and non-radioactive items for students to test. Place them on a table or around the room.
- Have students use the Geiger counters to identify radioactive items.
- Discuss results:
  - What items did you expect to be radioactive, but were not?
  - What items were you surprised were radioactive?
- Background Radiation
  - Ask students to name other sources of radiation. Reward answers.
  - Possible answers: x-rays, CT scans, radon
  - Have students calculate their annual dose using ANS dose calculator brochure.

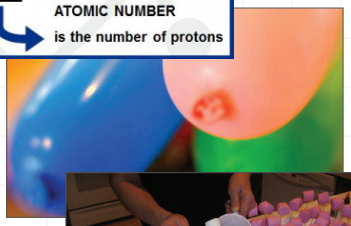
6 Wrap up and clean up

Workshop Materials

- **Nuclear Explorers Power Point presentation**
- **"Detecting Radiation in Our Radioactive World" teacher guide**
- **Rewards for answers** (candy, stickers, science novelties)
- **Energy from the Atom: Atoms worksheet** (page 11)
- **Periodic table**
- **Geiger counter**
- **Variety of radioactive** (NORM) **items** (lantern mantel, radium dial, No-Salt, smoke detector, isotope buttons, vintage orange Fiesta® ware, uranium ore)
- **Variety of non-radioactive items** (lead, green/other color plate, rocks, glow sticks - orange/green)
- **Magnetic marbles, gum drops, or marshmallows** (three colors)
- **Toothpicks**
- **Plastic bags**
- **Cloud chambers** (Petri dish, black construction paper)
- **Rubbing alcohol**
- **Flashlights**
- **Gloves**
- **Styrofoam plates/bowls**
- **Dry ice**
- **Balloons—regular and twistable**
- **Scissors**
- **Permission slip/Registration form**
- **Certificates of Completion** (page 16)

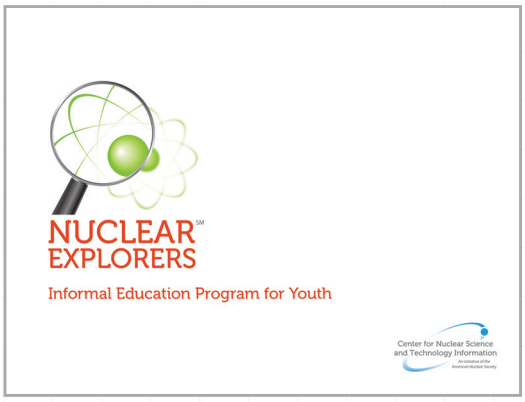


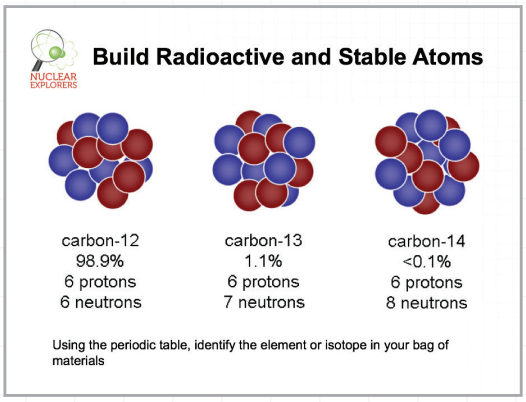


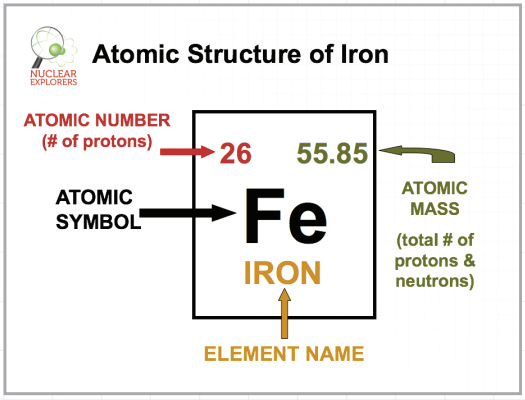


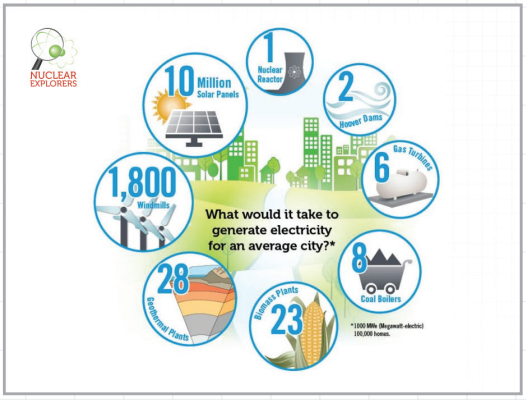
PowerPoint Presentation

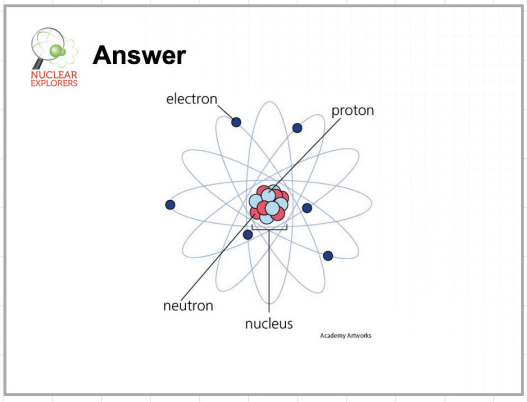
This presentation was prepared to accompany the Sample Workshop on pages 7 & 8. Feel free to edit it to your needs, using the Nuclear Explorers format. Download the presentation.

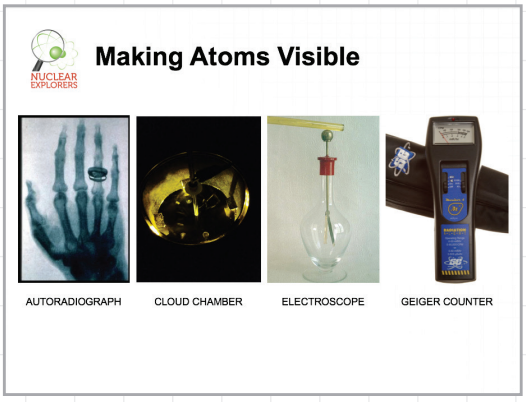












Energy from the Atom Reading Activity

Following is the reading activity included in the sample workshop agenda. Again, this is just an example of possible materials to include in your workshops. You can download the PDF from the ANS Member Center on the website.

ATOMS

American Nuclear Society

An atom is the small unit of which all matter is made. It consists of three types of particles: **NEUTRONS**, **PROTONS**, and **ELECTRONS**. The neutrons and protons are located in the center of the atom in what is called the nucleus. The electrons orbit the nucleus.

All of these particles are, of course, too small for us to see. But if we could see them, we would notice that the protons and neutrons are about the same size and that they are much larger than the electrons. Therefore, almost all the mass of an atom is in its nucleus.

Each proton in an atom's nucleus has a positive electric charge, and each electron circling around the nucleus has a negative charge. The neutrons carry no charge at all – that is, they are electrically neutral. When an atom has the same number of protons and electrons, which is usually the case, the positive and negative charges cancel each other, and the atom itself is electrically neutral.

All atoms of a particular element have the same number of protons in their nuclei. For example: All helium atoms have two protons in their nuclei. All carbon atoms have six protons. The number of protons in the atoms of an element is the **ATOMIC NUMBER** of that element.

While all atoms of a particular element have the same number of protons, they do not always have the same number of neutrons. Atoms of the same element with different number of neutrons are called **ISOTOPES** of the element. It is much like a family. The Smith family has several members. Each of them has a different name, for instance: dad is Bob; mom is Mary; the children are John, Alice, and Ted. Each of them has a different size and weight. They are all still Smiths.

An element could be considered to be a family. In uranium, all family members will have 92 protons, which makes them uranium. One member could have 92 protons and 143 neutrons. Its name would be uranium-235. Another member might have 92 protons and 146 neutrons. Its name would be uranium-238.

Element (Family)	Nucleus		Isotope (Name)
	Protons	Neutrons	
hydrogen	1	1	hydrogen-1
	1	1	hydrogen-2
	1	2	hydrogen-3
carbon	6	6	carbon-12
	6	7	carbon-13
uranium	92	143	uranium-235
	92	146	uranium-238

The sum of the number of neutrons and protons in an isotope is the atomic weight of the isotope.

- The atomic weight of uranium-235 is 235 (92 protons + 143 neutrons = 235)
- The atomic weight of uranium-238 is 238 (92 protons + 146 neutrons = 238)

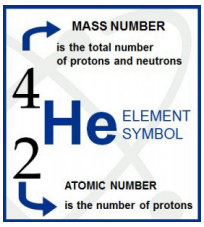
If an atom gains or loses neutrons, it becomes a different isotope of the same element. If it gains or loses protons, it becomes an isotope of a different element.

Name: _____

JUST FOR YOU

Answer the following questions based on the reading passage. Don't forget to go back to the passage whenever necessary to confirm your answers.

1. The three types of particles in atoms are _____, _____, and _____.
2. The atomic number of an element is equal to the number of _____in its nucleus.
3. The atomic weight of an isotope of an element is the total number of _____ and _____ in the nuclei of its atoms.
4. If a uranium isotope has 92 protons and 146 neutrons, its atomic weight would be _____
5. An isotope of an element gets part of its name from the total number of _____ and _____in its nuclei.
6. If the isotope helium-4 has 2 protons and 2 neutrons, the isotope helium-6 would have _____ protons and _____neutrons.
7. One element changes into another element when it gains one or more _____.

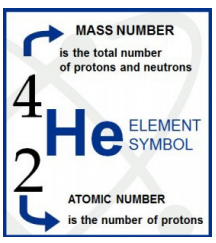


Name: KEY

JUST FOR YOU

Answer the following questions based on the reading passage. Don't forget to go back to the passage whenever necessary to confirm your answers.

1. The three types of particles in atoms are **PROTONS, NEUTRONS, and ELECTRONS**.
2. The atomic number of an element is equal to the number of **PROTONS** in its nucleus.
3. The atomic weight of an isotope of an element is the total number of **PROTONS** and **NEUTRONS** in the nuclei of its atoms.
4. If a uranium isotope has 92 protons and 146 neutrons, its atomic weight would be **238**.
5. An isotope of an element gets part of its name from the total number of **PROTONS** and **NEUTRONS** in its nuclei.
6. If the isotope helium-4 has 2 protons and 2 neutrons, the isotope helium-6 would have **2 (two)** protons and **4 (four)** neutrons.
7. One element changes into another element when it gains one or more **PROTONS**.



Evaluation Form for Student Participants

***Instructions:** For younger students, you may consider asking the questions and having them raise their hands, rather than have them fill out a form.*

NUCLEAR EXPLORERS

Workshop - Student Evaluation

Date of workshop _____

Location _____

Presenter _____

Please help make the NUCLEAR EXPLORERS workshops better by letting us know what you think. *Circle the answer that best says what you think.*

I thought the workshop was	Not very good	Good	Great!
The activities were:	Boring	OK	Great!
I learned:	Nothing new	A little bit	A lot!
The instructor was:	Not so good	Good	Great!
Would you tell your friends to come to this workshop?		Yes	No

The best part of the workshop was: _____

_____

_____

My least favorite part of the workshop was: _____

_____

_____

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555 N. Kensington Ave.
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outreach@ans.org
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Evaluation Form for the Adult Program Host

The following evaluation will help gain valuable information to continuously improve your NUCLEAR EXPLORERS workshops. If presenters offer favorable comments, ask if you can use them in your promotional materials.

NUCLEAR EXPLORERS

Workshop - Adult Evaluation

Date of workshop _____

Location _____

Presenter _____

	STRONGLY AGREE				STRONGLY DISAGREE
1. The workshop was presented as described	1	2	3	4	5
2. The program was well-paced within the allotted time	1	2	3	4	5
3. The presenter held the students' attention	1	2	3	4	5
4. The instructor was knowledgeable on the topic	1	2	3	4	5
5. I will recommend holding the workshop again	1	2	3	4	5
6. I will recommend this workshop to other youth groups	1	2	3	4	5

7. In your opinion, for your students, was this workshop:

☐ Too elementary ☐ Just right ☐ Too advanced

Please rate the following:

	EXCELLENT	VERY GOOD	GOOD	FAIR	POOR
A. The program overall	☐	☐	☐	☐	☐
B. Visuals	☐	☐	☐	☐	☐
C. Demonstrations	☐	☐	☐	☐	☐
D. Activities	☐	☐	☐	☐	☐
E. Handouts	☐	☐	☐	☐	☐

What is the age range of your students? _____

What did you like best about the workshop? _____

How would you improve the workshop? _____

Comments _____

_____

_____

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Outreach Materials Request

Download the form.

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email: outreach@ans.org

2017 NUCLEAR EXPLORERS MATERIALS REQUEST

Must be submitted 30 days prior to the event

1. APPLICANT INFORMATION:

Local/Student Section | **Applicant Name**

Address | **Member ID**

City **State** **Zip** | **Email**

2. DESCRIPTION OF EVENT:

Name of Event | **Contact Person**

Date and Time of Event | **Contact Email**

Location Address | **Event/Registration Website**

City **State** **Zip** | **Expected Attendance (#)**

Cooperating partner holding event

Brief Description: (use separate sheet if needed)

ANS MEMBERS ORGANIZING THIS EVENT

Member Name

Member Name

Member Name

Member Name

SHIPPING

Ship to name

Address (business address preferred; no PO boxes

Address 2

City, state, zip

Outreach Event Report

Download the form.

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Nuclear Explorers
OUTREACH EVENT REPORT

Must be submitted within 30 days after event

Event Name	**Section Name**
Event Date	**Submitted By**
Event Address	**City, ST ZIP**
Total Volunteer Hours (planning and day of)	**Email**

What was the participating organization?

Where was the event held? (For example: a STEM club, an after-school program at a school, a park district program, etc.)

Please describe the event (Use separate sheet if needed. Please email any video, photos, or other documentation you have.)

AUDIENCE DEMOGRAPHICS

Audience Size (#)

Audience Age Group (by grade; check all that apply):

- ☐ K-2
- ☐ 3-5
- ☐ Middle school (11-13)
- ☐ High school (14-18)
- ☐ Other

Certificate of Completion

Download the certificate.

American Nuclear Society

Certificate of Completion

This is to certify that

has successfully completed the NUCLEAR EXPLORERS Program offered by ANS's Center for Nuclear Science and Technology Information.

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Date

Additional Resources

You will find many resources on the Center for Nuclear Science and Technology Information website at NuclearConnect.org, including links to activities for students of all ages.

The following additional websites may be of use:

Nuclear Energy Institute Knowledge Center

The Nuclear Regulatory Commission Student Corner

Department of Energy Office of Nuclear Energy

World Nuclear Association Nuclear Basics

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NuclearConnect.org

Inform. Inspire. Engage.