**EDUCATOR VERSION**

U.S. DEPARTMENT OF ENERGY

ATOMIC LEGACY CABIN

The U.S. Department of Energy Office of Legacy Management Atomic Legacy Cabin presents:

# NUCLEAR SCIENCE WEEK

**OCTOBER 19-23, 2020**

**THINK CLEAN. THINK SOLUTIONS. THINK NUCLEAR.**

# Introduction Letter

Dear educators,

Thank you for your virtual participation in **Nuclear Science Week 2020** with the U.S. Department of Energy Office of Legacy Management (LM).

**Nuclear Science Week** (NSW) is an international, weeklong celebration of the local, regional, and international innovations and careers in nuclear science. Communities from across the nation are encouraged to get involved and host local events during the third week of October. This year, NSW goes virtual as it explores the five pillars of nuclear science: carbon-free energy, global leadership, transformative health care, innovation and technology, and space exploration.

In 2019, LM staff participated in NSW by hosting events at local high schools that promoted careers in science, technology, engineering, and math. LM also provided tours for local educators at the Atomic Legacy Cabin (ALC), an interpretive center, which opened in June 2019, that presents the history of uranium mining and processing on the Colorado Plateau, as well as Grand Junction's unique contribution to the Manhattan Project and the Cold War.

This year, LM encourages students and educators to "Get to Know Nuclear" through its online Radiation — Energy in Motion program. Radiation is an emission of energy that is everywhere and serves as the foundation of nuclear science.

To use this program in the classroom, visit the ALC website (energy.gov/lm/atomic-legacy-cabin, under the "Explore" tab) and watch the Radiation — Energy in Motion video (featuring a radiation expert) with your students. While viewing the video, your students can answer the questions on page 3 of the packet. In addition to the video and Q&A, students may complete the Nuclear Science & Radiation activity sheet independently or with small groups (pages 4-7). A sample NSW lesson plan, titled Perception of Risk (pages 8-10), is also included and may be used in addition to the LM material provided. LM encourages you to also explore the NSW website where you can find other lesson plans, free virtual content, and resources for the week's national events.

LM can also connect educators with subject matter experts in a wide range of academic fields, including chemistry, ecology, geology, engineering, and history. These experts are available for classroom support as guest speakers or student resources. For more information, contact the Atomic Legacy Cabin at atomiclegacycabin@lm.doe.gov

We are looking forward to building community partnerships in the future.

Shawn Montgomery
U.S. Department of Energy
Office of Legacy Management

For more information and to explore 2020 virtual events, visit: nuclearscienceweek.org.
For more information about ALC, visit: energy.gov/lm/atomic-legacy-cabin.

ALC remains closed to the public. During the COVID-19 pandemic, the health and safety of our employees and communities are our highest concern. To assure social and physical distancing and compliance with regulatory guidance that limits nonessential activities, the indoor areas of our centers will remain closed until further notice. We will update our webpage if this current status changes. We look forward to the time when we can safely welcome our visitors back inside.

# Nuclear Science Week 2020

## Virtual Event Schedule, October 19-23

NUCLEAR SCIENCE WEEK

To learn more about how nuclear technologies positively impact American lives, visit nuclearscienceweek.org/watch and explore free virtual content during this year's Nuclear Science Week. Each day of the week, a new 30-minute episode will feature a unique aspect of nuclear technology, kid interviews, and science shorts with STEM professionals.

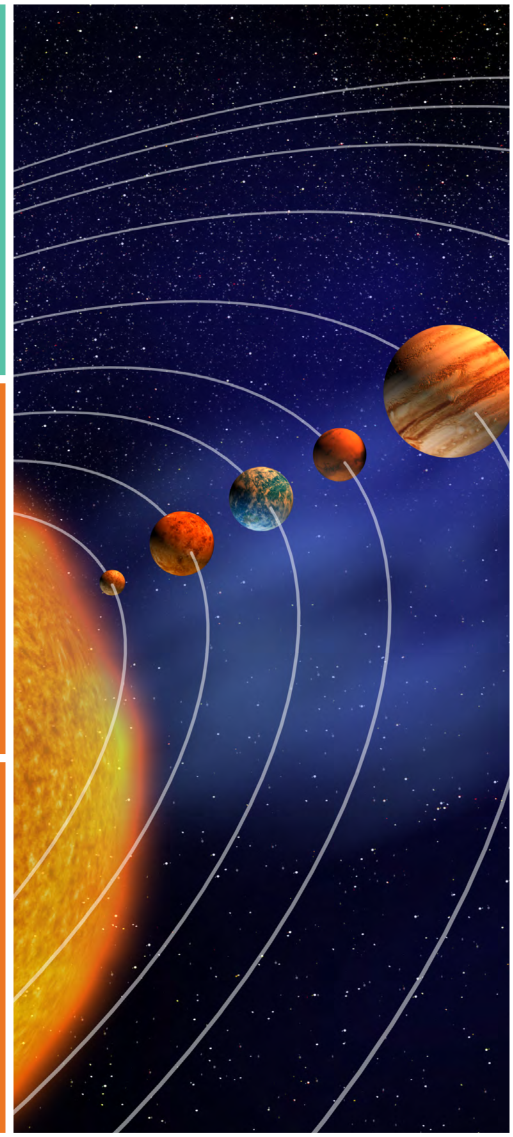
**MONDAY**
OCTOBER 19

**INTRODUCTION**

**TUESDAY**
OCTOBER 20

**WEDNESDAY**
OCTOBER 21

**SPACE EXPLORATION + GLOBAL LEADERSHIP**



**CARBON-FREE ENERGY + TRANSFORMATIVE HEALTH CARE**

**THURSDAY**
OCTOBER 22

**INNOVATION AND TECHNOLOGY + NUCLEAR SCIENCE MUSEUM**

# RADIATION — Energy in Motion

Visit the Atomic Legacy Cabin (ALC) website (energy.gov/lm/atomic-legacy-cabin) to watch and learn about radiation control from an expert. After watching the video, answer the following questions about radiation.


### 1. What is radiation?

Used to describe energy on the electromagnetic spectrum. Referred to as energy in motion.

### 2. What role does radiation play in nuclear science?

Nuclear power involves nuclear material, which gives off radiation.
Example: nuclear power plants make energy and reactors give off radiation.
Example #2: nuclear medicine uses radiation for diagnosis and/or treatment of patients.

### 3. How is radiation detected?

The human body cannot detect radiation with its own senses. Radiation is detected with special instruments, like Radiation Friskers. The detector clicks fasters when it is close to a source of radiation.

### 4. How is radiation controlled?

We use shielding to keep our radiation doses low and maximize distance between the source of radiation. Example: shielding with lead aprons.

### 5. What things release radiation?

X-ray machines, the Earth, the sun, uranium glaze, cell phones (not nuclear radiation), uranium rocks, bananas, Brazil nuts, and smoke detectors.

### BONUS QUESTION: What does ALARA stand for?

ALARA: as low as reasonably achievable.

# Nuclear Science & Radiation Activity Sheet

## All About Atoms

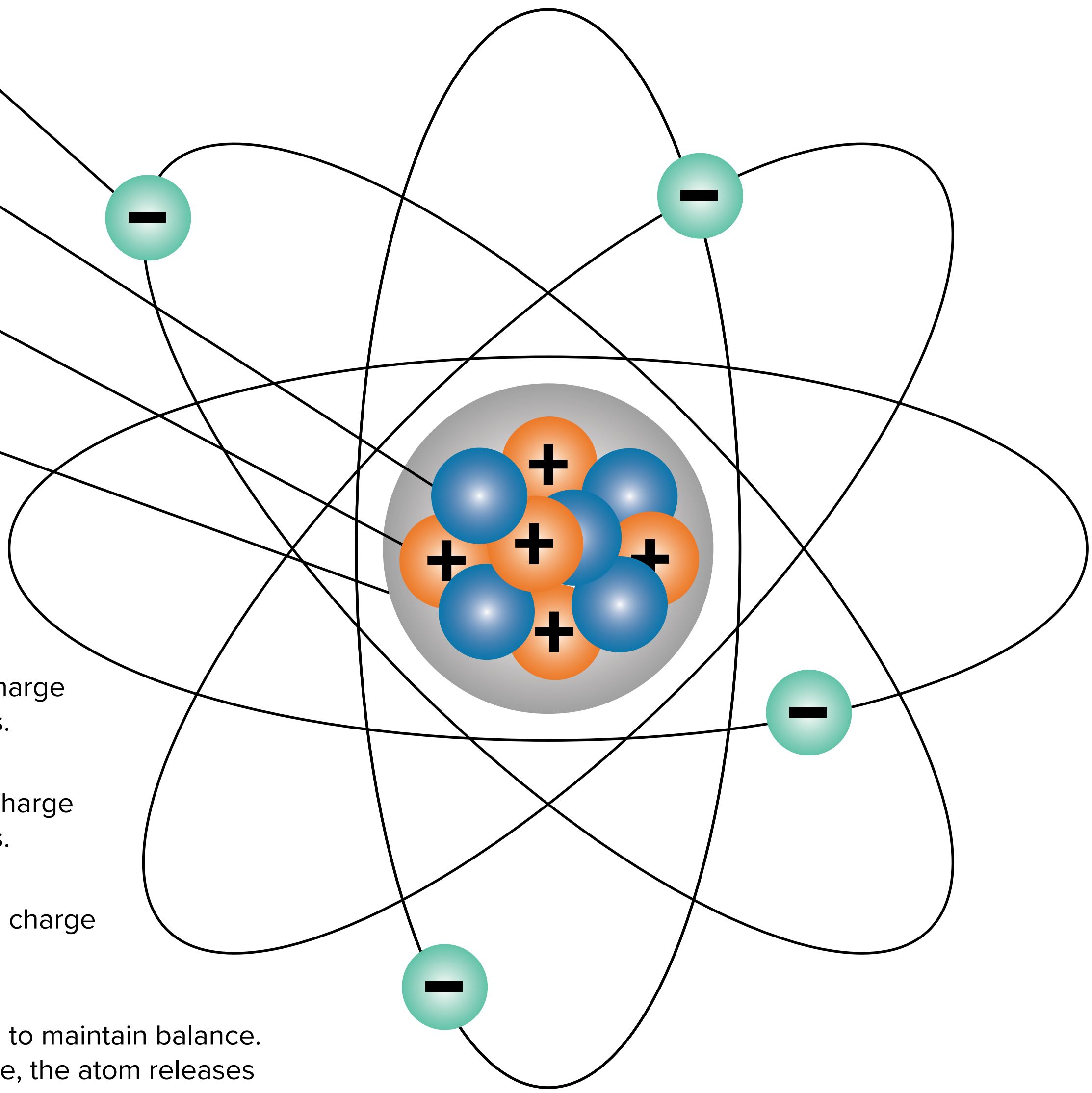
**Age Level:** 11-14 (middle school).

**Key Definitions:** atom, protons, neutrons, electrons, radiation, alpha, beta, gamma, radiation frisker.

**Objective:** to understand the basics of radioactive science and radiation control.

In order to understand radiation, you must first know the basics of atoms. Atoms are the building blocks of all matter. Just like blocks, atoms fit together to make up everything we see — even us! However, atoms are extremely tiny, so much so that we can't see them, even with a microscope.

There are three basic parts to an atom: protons, neutrons, and electrons. Identify the parts of an atom on the illustration below.




**Atomic Structure:**

- **Protons** have a positive charge and are inside the nucleus.
- **Neutrons** have a neutral charge and are inside the nucleus.
- **Electrons** have a negative charge and surround the nucleus.
- **Nucleus** of an atom works to maintain balance. When a nucleus is unstable, the atom releases energy in the form of radiation to achieve stability.

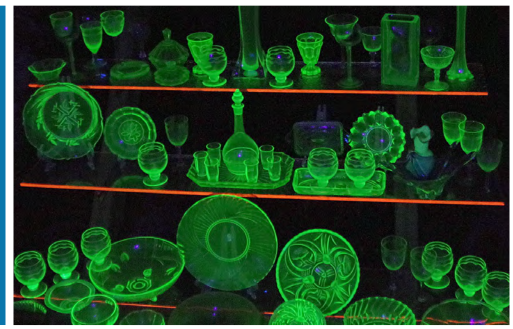
# Nuclear Science & Radiation Activity Sheet

## What is Radiation?

Radiation is the emission of energy from a substance. There are two main categories used to classify the source of radiation: naturally occurring (also known as background radiation) and human-made. Naturally occurring radiation comes from natural sources, which can range from the soil, water, and vegetation that we find on Earth to a wide variety of events taking place throughout the universe, like a supernova. Human-made radiation, as its name plainly states, comes from human activity, such as mining and milling of uranium.

Determine whether the following items produce naturally occurring or human-made radiation.
For naturally occurring, circle 🍃 and for human-made, circle 🚻.

**SUN**



**X-RAYS**

**URANIUM GLASS**

**URANIUM ORE**

**BANANAS**

**BUILDING MATERIALS**

# Nuclear Science & Radiation Activity Sheet

## Three Main Types of Radiation

It might surprise you that we are surrounded by naturally occurring radiation. For instance, bananas, the sun, and even you are radioactive.

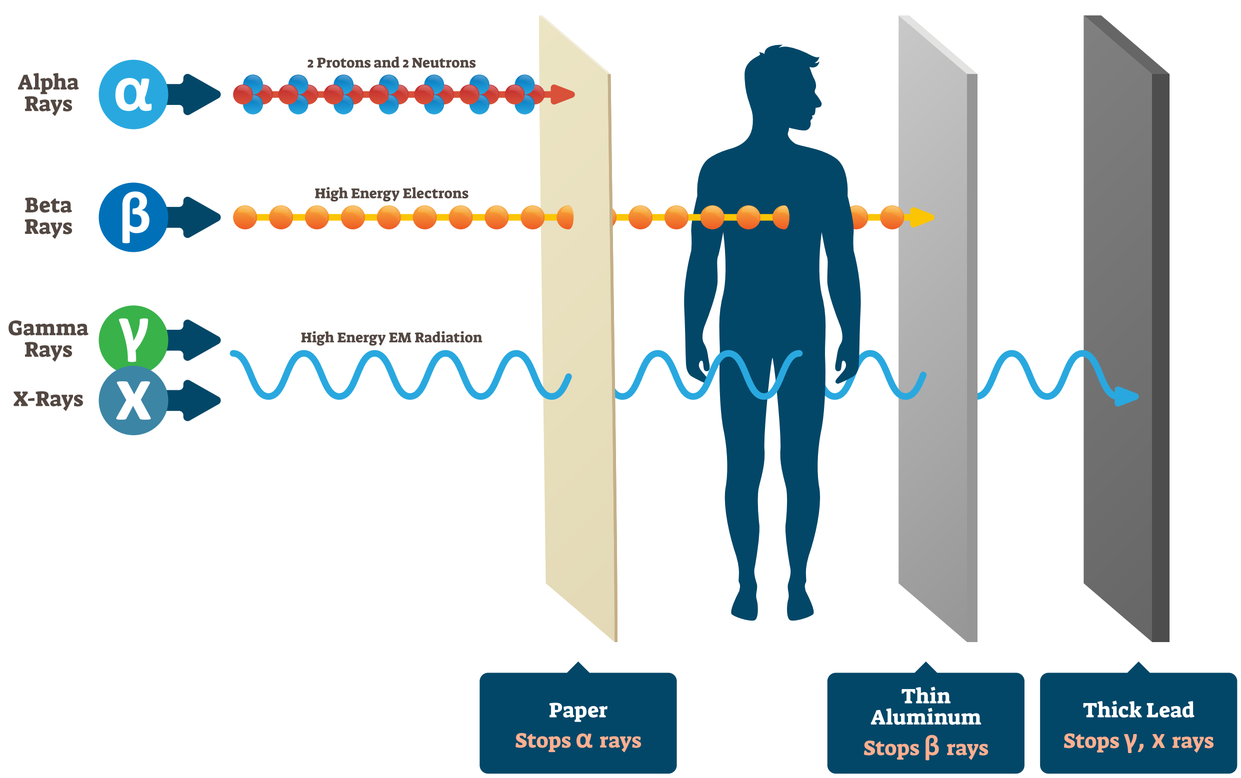
On average, we receive very low levels of radiation that are not harmful to us. However, too much radiation — like too much of anything — can be harmful. Therefore, it is important to know the basics of radiation safety like time, distance, and shielding. Time simply means limiting the exposure time to a source of radiation. Distance means making sure you keep a safe distance from a source of radiation. Shielding refers to the proper materials that can stop the emission of the three types of radiation.

1. **Alpha radiation** occurs when an atomic nucleus releases two protons and two neutrons. These particles are heavy and slow moving, making them easy to stop with a piece of paper.

2. **Beta radiation** occurs when an atomic nucleus releases an electron. These light, fast-moving particles can be stopped by thin plates of material like aluminum.

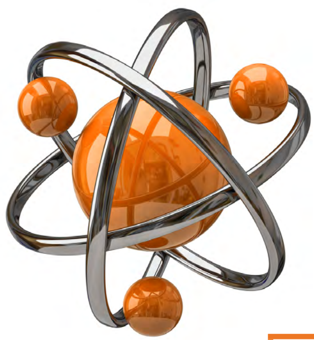
3. **Gamma radiation** involves a high energy photon escaping the nucleus and damaging surrounding material. These particles are fast moving with no electrical charge. Though harder to stop, they can be captured with thick, dense material, like lead.

***X-rays emit a form of gamma radiation, which is why we wear lead aprons when receiving a x-ray.**



# Nuclear Science & Radiation Activity Sheet

## Key Terms Crossword Puzzle Key



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### ACROSS

2. A type of radiation that can be stopped by aluminum.
4. The part of an atom that has a neutral charge.
5. The emission of energy from a substance.
8. A tool used to measure radiation contamination.
9. A type of radiation that can damage surrounding material.

### DOWN

1. A type of radiation that releases two protons and two neutrons.
3. The part of an atom that has a negative charge.
6. The building blocks of all matter.
7. The part of an atom that has a positive charge.

Radiation cannot be detected using our five senses, which is why we use tools like the Radiation Frisker to locate and measure radiation contamination.

# Perception of Risk

This content is published and available on the Nuclear Science Week website. It is included as an optional addition to your lesson plan. Find more curriculum at nuclearscienceweek.org/for-educators/overview-for-educators.

**OBJECTIVE:** *To explore the fears and the perception of risk associated with different activities.*

**GRADE:** 6-12

**INTENDED LEARNING OUTCOME:**

- Make predictions.
- Collect and record data.
- Create tables and graphs to describe and summarize data.

**SUBJECTS:** Math, Science, Statistics, Social Studies

**MATERIALS:** Risk Ranking Table Sheet (attached)

**TEACHING TIME:** 20-30 minutes

**NUMBER OF PLAYERS/STUDENTS:** Suitable for all size groups

**TEACHER INFORMATION:**

Everything we do in life, each decision we make carries a certain amount of risk with it. However, if we decide on a course of action, then we have decided, either consciously or unconsciously, that the benefits of the action outweigh the risks. Different individuals often perceive risks of varying types differently. In this activity, students have the opportunity to identify their perception of the risk associated with an activity, the opportunity to compare their ideas with their classmates, and then with actual accident data on these activities. This activity helps the students understand some of the factors (e.g., emotion, knowledge) that go into their perception of risk.

**PROCEDURE:**

- Each student will be asked to rate the activities and technologies in terms of perceived risk. A ranking of 1 indicates the highest risk, while a ranking of 10 is the lowest risk.
- Before comparing the students ratings with actual statistical causes of death, have the students provide their ratings and determine a class average.

**ANALYSIS AND RESULTS:**

- How do individual rankings match with the class averages?
- Were the rankings for any activity widely scattered?
- Have the students discuss their rationale for ranking each activity.
- Were the rankings affected by the emotional reaction to the activity? In other words, if the person liked the activity did it get a lower risk ranking?

**ASSESSMENT:** Have the students write a paragraph on how easily they think it would be to change a person's perception of risk through education. That is, if a person believes an activity to have a high risk factor, how easily could that perception be reduced by educating the person about the actual risks and benefits of the activity?

# Perception of Risk

This content has been recreated from the Nuclear Science Week website as additional material to expand your lesson plan. Find more curriculum at nuclearscienceweek.org/for-educators/overview-for-educators.

## Risk Ranking Table

| RISK | RANKING | | |
|---|---|---|---|
| | YOU | CLASS AVERAGE | ACTUAL |
| Aviation | | | |
| Motor Vehicle | | | |
| Motorcycle | | | |
| Firearm Discharge | | | |
| Firearm Assault | | | |
| Fireworks | | | |
| Hornets, Wasps, Bees | | | |
| Lightning | | | |
| Nuclear Power/Radiation | | | |
| Skiing | | | |
| Smoking | | | |
| Surgery | | | |
| Bicycle | | | |
| Swimming | | | |
| Asteroid Impact | | | |

# Perception of Risk

This content has been recreated from the Nuclear Science Week website as additional material to expand your lesson plan. Find more curriculum at nuclearscienceweek.org/for-educators/overview-for-educators.

## Risk Ranking Table - Results

| RISK RANKING | RISK | ACTUAL RANKING | SOURCE |
|---|---|---|---|
| 11 | Aviation | 1 in 2,067,000 | U.S. Department of Transportation |
| 2 | Motor Vehicle | 1 in 7,700 | U.S. Department of Transportation |
| 5 | Motorcycle | 1 in 91,500 | U.S. Department of Transportation |
| 8 | Firearm Discharge | 1 in 514,147 | The Economist |
| 3 | Firearm Assault | 1 in 24,974 | The Economist |
| 14 | Fireworks | 1 in 50,729,141 | The Economist |
| 13 | Hornets, Wasps, Bees | 1 in 25,364,571 | The Economist |
| 12 | Lightning | 1 in 10,495,684 | The Economist |
| 9 | Nuclear Power/Radiation | 1 in 1,000,000 | U.S. Nuclear Regulatory Commission |
| 10 | Skiing | 1 in 1,556,757 | Bandolier |
| 1 | Smoking | 1 in 5 | Center for Disease Control & Prevention |
| 6 | Post Surgery Complication | 1 in 117,519 | The Economist |
| 7 | Bicycle | 1 in 410,000 | U.S. Department of Transportation |
| 4 | Swimming | 1 in 56,587 | Risk Communication Institute |
| 15 | Asteroid Impact | 1 in 74,817,414 | The Economist |

***The risk of death from 3 mremradiation exposure (1 in 1,000,000) has approximately the same risk as:**

Spending two days in New York City (due to air quality)

Riding 1 mile on a motorcycle or 300 miles in a car (risk of collision)

Eating 40 tablespoons of peanut butter or 10 charbroiled steaks (due to aflotoxin)

Smoking one cigarette

STEM WITH LM

energy.gov/lm/programs/stem-lm

nuclearscienceweek.org

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To learn more about nuclear science and discover STEM education across the nation, explore these other resources.

nationallabs.org/our-labs/stem-resources

STEM RISING

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energy.gov/science-innovation/stem-rising