STUDENT 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

OCT 18-22, 2021

NAME: ______________________ DATE: ______________

THINK CLEAN. THINK SOLUTIONS. THINK NUCLEAR.

Overview

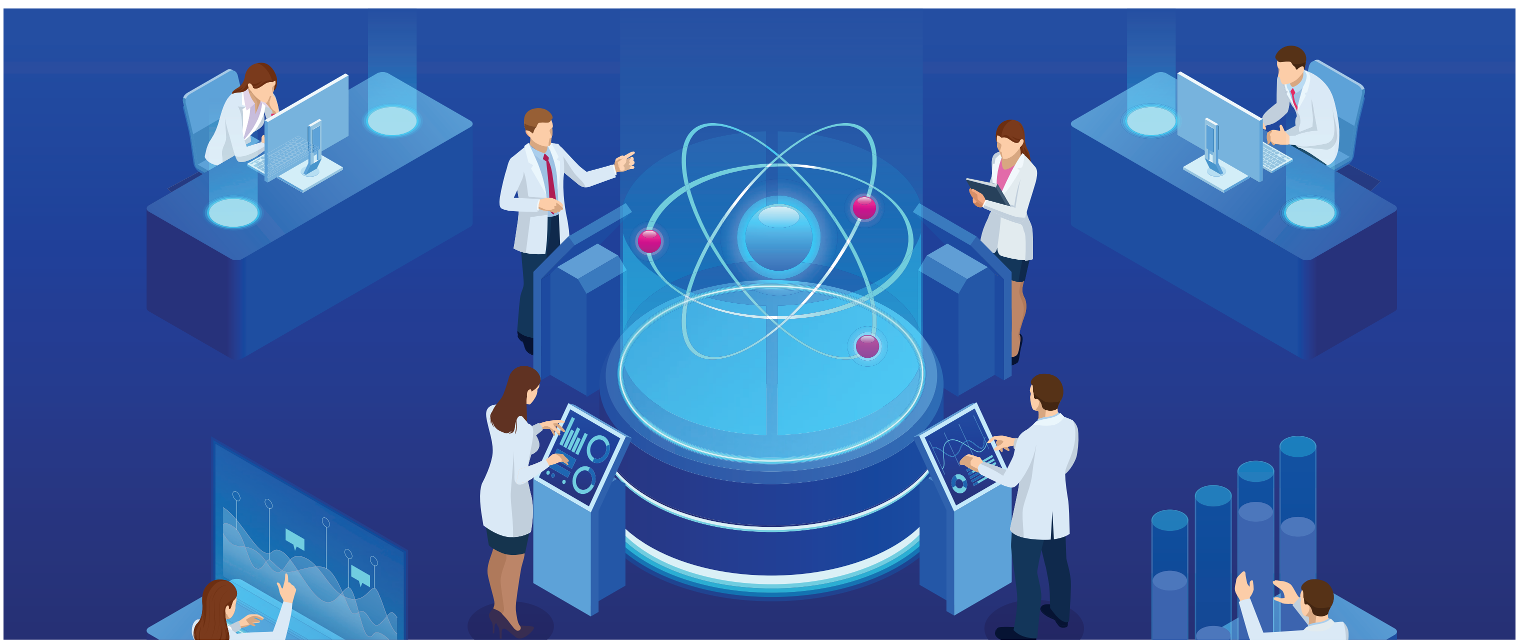
Nuclear Science Week (NSW) is an international, weeklong celebration of the innovations and careers in nuclear science. Communities are encouraged to get involved and host local events during the third week of October. This year, NSW goes virtual as it explores the five pillars of nuclear science: carbon-free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

The U.S. Department of Energy Office of Legacy Management (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. Visit the Atomic Legacy Cabin (ALC) website to learn more about the types of radiation, where it comes from, and how LM protects human health and the environment through radiation control.

In 2019, LM staff participated in NSW by hosting events that promoted careers in science, technology, engineering, and math (STEM). LM also provided tours for educators at the ALC, an interpretive center that opened in June 2019 and 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.

Included in this packet:

- Nuclear Science Week materials and information.
- Radiation — Energy in Motion video Q&A.
- Nuclear Science & Radiation activity sheet.
- Making Atoms Visible - Electroscope lesson.
- Other resources.



For more information, visit: nuclearscienceweek.org.
For more information about ALC, visit: energy.gov/lm/atomic-legacy-cabin.

ALC remains closed. 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 status changes. We look forward to when we can safely welcome our visitors back inside.

Nuclear Science Week 2021

National Event, Oct. 18-22

NUCLEAR SCIENCE WEEK

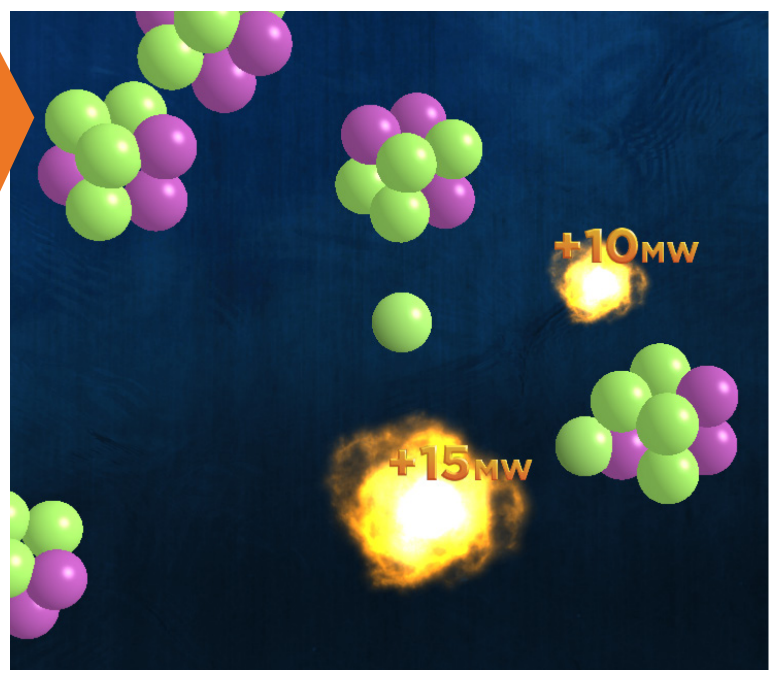
To learn more about how nuclear technologies positively impact American lives, visit nuclearscienceweek.org/watch and explore free content during NSW. New 30-minute episodes feature the unique aspects of nuclear technology, kid interviews, and science shorts with STEM professionals. Also, students can play a fun, interactive video game to learn how fission works.

NUCLEAR SCIENCE NETWORK

WATCH 30-MINUTE EPISODES THAT EXPLORE THE POSITIVE IMPACTS OF NUCLEAR SCIENCE.

LIGHT UP YOUR WORLD VIDEO GAME

TAKE THE "MISSION FISSION CHALLENGE" TO SPLIT AS MANY ATOMS AS FAST AS YOU CAN.



RADIATION — Energy in Motion

Visit the ALC website (https://www.energy.gov/lm/explore-atomic-legacy-cabin) to learn about radiation control from an expert. After watching the video, answer the following questions about radiation.

1. What is radiation?

2. What role does radiation play in nuclear science?

3. How is radiation detected?

4. How is radiation controlled?

5. What releases radiation?

BONUS QUESTION: What does "ALARA" stand for?

Nuclear Science & Radiation Activity Sheet

All About Atoms

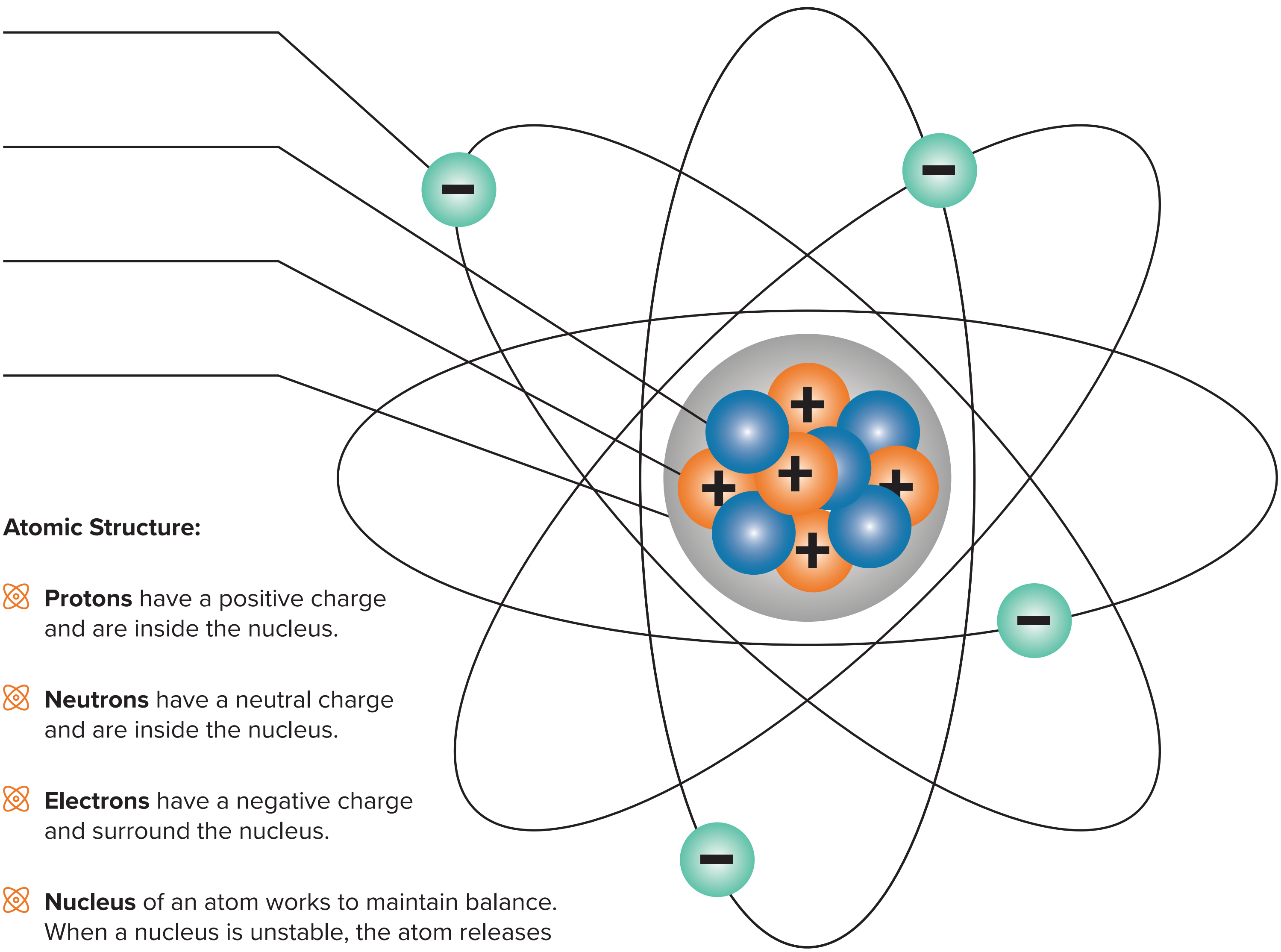
Age Level: 10-11 (elementary school).

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 know the basics of atoms. Atoms are the building blocks of all matter. Just like blocks, atoms fit together to make 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 energy in motion. 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, as well as a wide variety of events occurring in the universe, like a supernova. Human-made radiation, as its name plainly states, comes from human activity, such as medical procedures involving computerized tomography (CT) scans or X-rays.

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

X-RAYS

SUN

URANIUM GLASS

URANIUM ORE

BANANAS

BUILDING MATERIALS

Nuclear Science & Radiation Activity Sheet

Four 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: time, distance, and shielding. First, we should limit our exposure time to a source of radiation. Next, we should also maintain a safe distance from the radioactive material. Finally, we should use the appropriate materials that will shield us from the three types of radioactive emissions:

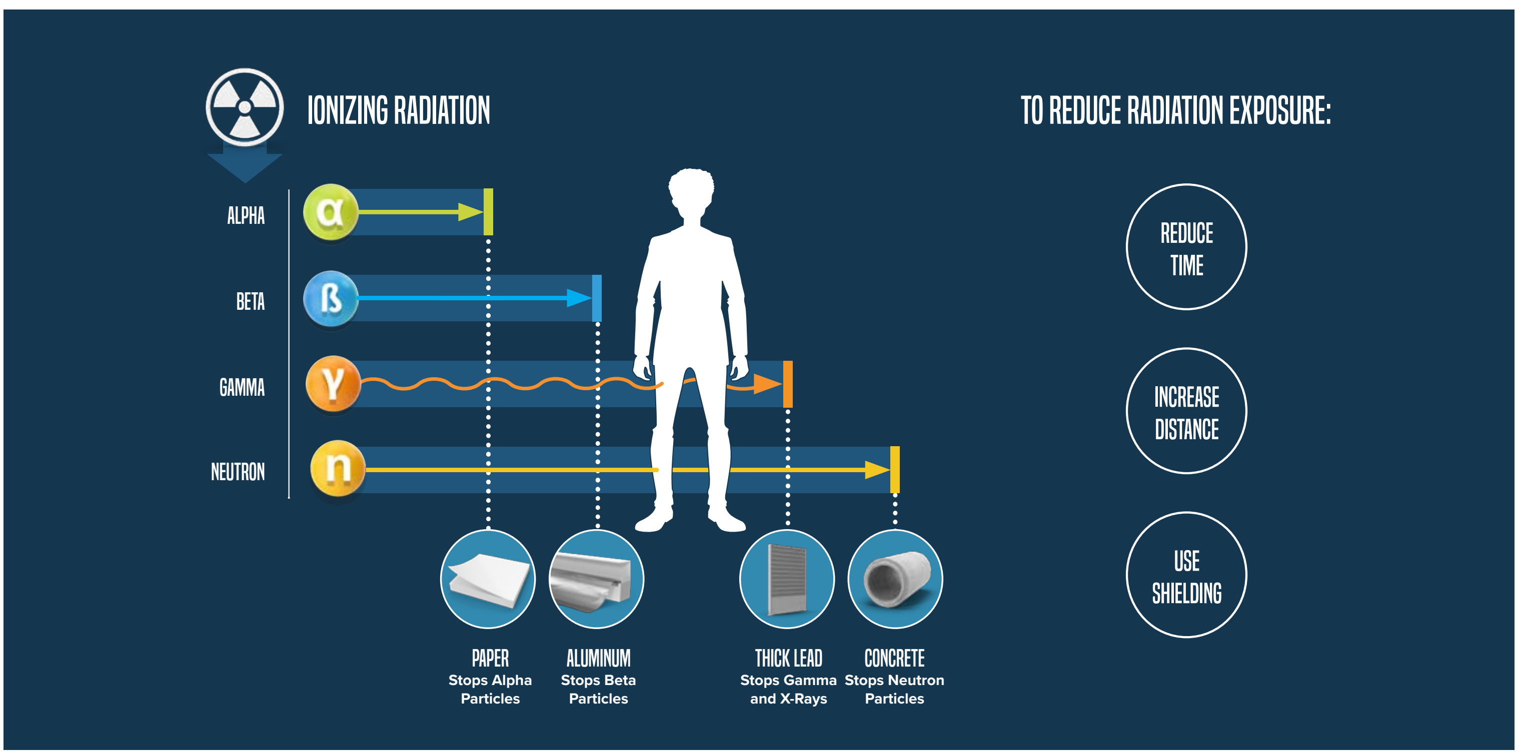
1. **Alpha radiation** occurs when an atomic nucleus releases two protons and two neutrons. Thin plates of material, like aluminum, can stop stop these light, fast-moving particles.

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. Thick material, such as lead, can capture these particles, though they are harder to stop.

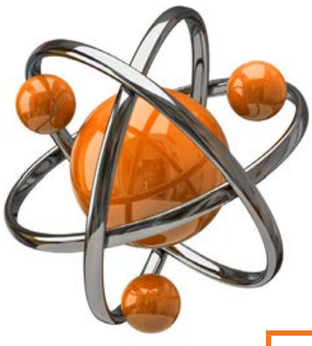
   ***X-rays emit a form of gamma radiation, which is why we wear lead aprons during the procedure.**

4. **Neutron radiation** is created when an uranium or plutonium atom fissions, producing nuclear energy. Since neutrons can travel great distances, thick materials, such as concrete or water, are required to stop them.



Nuclear Science & Radiation Activity Sheet

Key Terms Crossword Puzzle



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.

Making Atoms Visible - Electroscope

This content is published and available on the Nuclear Science Week website, in the Teacher Resource Guide published by the American Nuclear Society. It is included as an optional addition to your lesson plan. Find the guide here: "Making Atoms Visible - Electroscope"

OBJECTIVE: *Make a simple instrument to detect static electricity and radiation.*

GRADE: 5-12

DISCIPLINARY CORE IDEAS (DCI, NGSS):
5-PS1-1, MS-PS1-1, MS-PS1-4, HS-PS1-8, HS-PS4-2, HS-PS4-5

TIME FOR TEACHER PREPARATION:
30-60 minutes (to gather materials and set-up)

ACTIVITY TIME: 30-60 minutes

SAFETY:

- Students should use care when handling aluminum foil.
- Students should use care when handling glue.

SCIENCE AND ENGINEERING PRACTICES (NGSS):

- Ask questions and define problems.
- Use Models.
- Plan and Carry out investigation.
- Analyze and interpret data.
- Using mathematics, information and computers.
- Argue from Evidence.
- Obtain, evaluate and communicate information.

CROSS CUTTING CONCEPTS (NGSS):

- Patterns.
- Cause and Effect.
- Scale, Proportion, and Quantity.
- Systems and System Models.
- Energy and Matter: Flows, Cycles, and Conservation.
- Structure and Function.
- Stability and Change of Systems.

MATERIALS:

- Pen, Marker, or Pencil
- Balloon
- Foam plate
- Foam cup
- Drinking straw
- Glue
- Aluminum pie pan
- Thread
- Aluminum foil
- Masking tape
- Wool fabric
- Comb
- Plastic ruler
- Student Data Collection Sheets

BACKGROUND:

An electroscope is a very simple instrument that is used to detect the presence and magnitude of electric charge on a body such as static electricity. The type of electroscope detailed in this experiment is called a pith-ball electroscope. It was invented in 1754 by John Canton. The ball was originally made out of a spongy plant material called pith. Any lightweight neutrally conductive material, such as aluminum foil, can work as a pith ball. The pith ball is charged by touching it to a charged object. Since the ball is neutrally conductive and the electrons are not free to leave the atoms and move around the ball, when the charged ball is near a positively charged body, or source, the negatively charged electrons are attracted to it and the ball moves towards the source. Conversely, a negatively charged source will repel the electrons, and therefore the ball. Electroscopes can also be used to detect ionizing radiation. In this case, the radiation ionizes the air to be more positively or negatively charged depending on the type of radiation, and the ball will either be attracted or repelled by the source. This is how electroscopes can be used for detecting x-rays, cosmic rays, and radiation from radioactive material.

Making Atoms Visible - Electroscope

Student Data Collection Sheet

OBJECTIVE: *Make a simple instrument to detect static electricity and radiation.*

DIRECTIONS:

1. Make two holes near the bottom of a foam cup on opposite sides.
2. Push a plastic straw through the holes in the cup.
3. Turn the cup upside down and glue it onto the bottom of an aluminum pie pan. Make sure that the cup is right at the edge so that the straw sticks out over it. If you don't want to wait for the glue to dry, tape the cup to the pan.
4. Cut a piece of thread about 8 inches long and tie a few knots in one end of the thread.
5. Cut a one-inch square of aluminum foil. Use it to make a ball around the knots in the thread. The ball should be about the size of a marble. It should be just tight enough so it doesn't fall off the thread.
6. Tape the end of the thread to the straw so that the ball of foil hangs straight down from the straw, right next to the edge of the pan.
7. Tape the straw to the cup so it doesn't move around when you use the electroscope.
8. To test the electroscope, create some static electricity. An easy way to create static is by rubbing a balloon on a foam plate. When you do this, you "charge" the plate, which means you cause a buildup of electrons on one side. Even though the plate is charged, the electrons don't move because foam doesn't conduct electrons.
9. Once you've created some static electricity, place the electroscope on top of the foam plate. Be sure to hold the electroscope by the foam cup and not the aluminum pan, otherwise it won't work. Electrons move easily through metal, so when you put the pie pan onto the foam plate, the electrons travel into the pan and the foil ball. When the electroscope detects static electricity, the foil ball pushes out from the pan.
10. Try charging different objects, like a comb or ruler, with static electricity. Test them on the electroscope and record your results on your data sheet.

Making Atoms Visible - Electroscope

Student Data Collection Sheet

NAME: ______________________________ DATE: ______________

QUESTIONS:

1. Which objects hold an electric charge? Which don't?

2. Why is the ball attracted or repelled by different objects?

3. How is using an electroscope similar to testing the charge of a balloon with your hair?

4. How is the electroscope able to detect radioactivity?

ENRICHMENT QUESTION: Why did John Canton invent the first electroscope and what did he use it for?

U.S. DEPARTMENT OF ENERGY

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CABIN

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

STEM WITH LM

energy.gov/lm/programs/stem-lm

NSW

nuclearscienceweek.org

nationallabs.org/our-labs/stem-resources

STEM RISING
U.S. DEPARTMENT OF ENERGY

energy.gov/science-innovation/stem-rising