NFB STEM2U 2025
Discover the Scientific Method
Explore, Experiment, Excel!

The National Federation of the Blind (NFB) is dedicated to expanding opportunities for blind students in science, technology, engineering, and mathematics (STEM). Through programs designed for students (K-12) nationwide, the NFB equips them with essential nonvisual tools and techniques to pursue higher education and careers in STEM fields. These education initiatives are an important part of our mission.

The National Federation of the Blind advances the lives of its members and all blind people in the United States. We know that blindness is not the characteristic that defines you or your future. Every day we raise the expectations of blind people, because low expectations create obstacles between blind people and our dreams. Our collective power, determination, and diversity achieve the aspirations of all blind people.

This year, we're diving into the exciting world of the scientific method! Participate in hands-on, accessible experiments where you'll use observation, prediction, and testing to tackle real-world problems.

Exciting Experiments Await!

Fun with Physics:

Experiment with different ingredient combinations to see which ones make a plastic bag explode the fastest and discover which chemicals can inflate a balloon!

Chemical Curiosity:

Explore the fascinating science behind chemical reactions! Learn about the difference between exothermic (heat-producing) and endothermic (cooling) reactions.

Build and Innovate:

Get creative by constructing a battery-operated mini fan or designing a rubber band-powered mini car. Unleash your inner inventor!

Engineering Challenges:

Test your skills in buoyancy and material science. Discover which materials keep objects floating while diving into problem-solving and design.

These are just a few of the exciting experiments you'll explore as we elevate our STEM learning together. STEM is for everyone—let us show you how accessible and engaging it can be!

Access the electronic version of this booklet online at www.nfb.org/stem2u2025.

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Nonvisual Skills

Before you begin, it's helpful to learn some nonvisual practical tips for safely and effectively pouring, using scissors and hot glue. Understanding how to set up your workspace and handle these tools properly will help you conduct your experiments with confidence.

Scissors

Cutting with scissors can be simple and safe with the right techniques for blind people. Here’s how to do it confidently:

1. **Finding Where to Cut:** Knowing where to make your cuts is important for accuracy. You can make cutting lines easier to feel by creasing or folding the paper, tracing the lines on a tactile drawing board, or using plastic templates to guide your cuts.
2. **Understanding the Scissors:** It’s important to know how scissor blades work. Scissor blades are sharp, but they only cut when you apply pressure by closing the handles. This means it’s safe for a blind person to use their non-cutting hand to feel where the blades are and check the position of the object being cut.
3. **Cutting Safely:** Once you’re sure the object is in the right position, move your non-cutting hand away and close the handles to make the cut. While cutting, you can use your non-cutting hand to check the blade position again as needed. To make accurate cuts, pause as needed to check and adjust the blade position by touch.

Hot Glue

With a little practice and some simple tips, blind people can safely use hot glue. Planning ahead helps make the experience easier and safer. Here’s how:

1. **Protect Your Workspace:** Place poster boards under your project to catch any drips. Keep an empty coffee can nearby for safely storing the glue gun when not in use. Putting the gun in the can with the hot tip down helps prevent burns when you’re feeling for it.
2. **Know Your Glue Gun:** First, explore a cold glue gun to understand its parts. Find the tip (where the glue comes out), the trigger (to

release glue), and the spot where new glue sticks go in. This helps you know which parts get hot and which parts stay safe to touch.

3. **Using the Hot Glue:** Since touching the hot glue can cause burns, don’t feel it directly. Instead, use a craft stick as a guide to sense and spread the glue. Practice on scrap paper to learn how much glue comes out with different pressure on the trigger. After the glue cools, which takes a few seconds, you can safely touch it.
4. **Handling Glue on Skin:** It’s normal to get a bit of hot glue on your skin. To avoid burns, quickly roll your fingers together to peel it off or dip your fingers in a small cup of water to cool the glue.

Pouring

Pouring liquids accurately can be achieved through several techniques. Dipping a finger slightly into the cup helps monitor the liquid level by touch, while positioning the cup over a sink catches any spills. A liquid level indicator that beeps or vibrates offers added precision, and high-contrast cups make it easier to visually detect the liquid level. Listening to the changing sound of the liquid as it fills the container provides another effective way to gauge fullness.

Specific techniques:

- **Finger method:** Gently place a finger slightly inside the cup near the rim, as the liquid reaches your finger, you know to stop pouring.
- **Pour over the sink or a large bowl/bucket:** This minimizes mess if you accidentally overpour.
- **Liquid level indicator:** A small device with prongs that sit on the cup's edge and beep when the liquid reaches the desired level.
- **Contrast colors**: Use a brightly colored cup with a contrasting liquid color to visually perceive the level even with low vision.
- **Sound cues:** Listen closely to the sound of the liquid filling the container, the sound will change as it gets closer to full.
- **Funnels:** Use a funnel to guide the liquid flow into the container, especially for narrow openings.
- **Tactile markings:** Consider adding raised bumps or Braille labels to containers to identify different liquids.

Important considerations:

- Be familiar with the size and shape of your pouring container to avoid spills.
- Try to pour from the same height and angle each time to maintain a consistent flow.
- Always be mindful of hot liquids and use caution when pouring.

The Scientific Method: A Fun Way to Explore

The scientific method is a step-by-step way to learn about the world. It helps you ask questions, make guesses (hypotheses), test your ideas with experiments, and find out what happens. By using the scientific method, you can discover new things and understand how everything works. We will use the scientific method to conduct our experiments. Here are the steps we will follow.

Steps of the Scientific Method

1. **Ask Questions:** Formulate your questions based on why or how something occurs.
2. **Hypothesis:** Make an educated guess about the cause of an observed phenomenon, drawing on your prior experiences.
3. **Prediction:** State what you believe will happen based on your hypothesis.
4. **Experiment:** This is the testing phase, where you'll devise a way to answer your questions and prove or disprove your hypothesis through observations.
5. **Conclusion:** Analyze your experimental results to determine whether they support or refute your hypothesis and predictions.
6. **Share:** Often overlooked, sharing your results is a crucial part of science. It allows us to learn from each other's research.

Activities

In our activities, we will combine steps two and three using an "if/then" statement. Here's an example to guide you:

Question

Will watering a plant with different liquids help it grow? From my experience, I know that plants thrive with water, soil, and sunlight. I hypothesize that using milk, which contains water and nutrients, might help the plant grow even larger.

Example Hypothesis:

If I water my plant with milk, then it will grow larger than if I water it with plain water. I can then create experiments to test my hypothesis, make observations, and draw a conclusion.

Try It Out!

What questions and hypotheses will you come up with for the activities?

Did You Know?

The scientific method encourages curiosity and creativity. Many famous discoveries were made by scientists who asked unusual questions or thoughts outside the box. For example, Alexander Fleming discovered penicillin by accident when he noticed that mold had killed bacteria in one of his petri dishes. His curiosity about what caused this effect led to the development of antibiotics, which have saved countless lives. So, the scientific method isn't just about strict rules, it's also about being curious and open to new ideas.

Activity 1A: Balloon Blast

Now that we've discussed the scientific method, let's put it into practice! In this activity, you'll mix household products in two different experiments. You'll start by asking questions and making educated guesses, then set up your experiments, observe the results, and draw conclusions.

Question

Can we blow up a balloon without using air to fill it?

Materials

- 1L bottle or similar – 2 **empty*
- Antacid tablets - 2 tabs **finely crushed*
- Baking soda – 2 tablespoons
- Balloons - 2 * *If you have a latex allergy, try completing the "Watch Out, It's Going to Blow!" activity as an alternative.*
- Funnel - 2
- Generic soda (cola, club soda, etc.) - ½ cup
- Goggles
- Learning shades
- Measuring cups
- Plastic cup
- Rubber bands - 2
- Vinegar - ½ cup
- Water - ¼ cup **warm*

Hypothesis and Prediction

Before beginning, review the list of materials and use any prior knowledge to form a hypothesis about the experiment's outcome. Write down your hypothesis or share it with others for discussion.

Experiment 1

1. Practice your nonvisual skills by putting on your learning shades and your goggles for safety.
2. Use measuring cups to measure out ½ cup of vinegar and ¼ cup of warm water, then pour both into an empty plastic cup. Next, pour your combined liquid into an empty plastic bottle. A funnel may be helpful for this part. Gently swirl the bottle to mix.

3. Next, measure two tablespoons of baking soda and use a dry funnel to fill a balloon with it.
4. Carefully stretch the open end of the balloon over the bottle's opening, ensuring it fits snugly without letting the baking soda fall in just yet. You might want to hold the balloon in place with your hand, have a partner help or use a rubber band for added support.
5. Now for the fun part! Hold the balloon around the neck and lift the heavy part, allowing the baking soda to drop into the vinegar at the bottom of the bottle.

Observations with Experiment 1

What happened? What do you hear? What do you notice about the balloon? Why is this happening?

Experiment 2

1. Measure ½ cup of generic soda and pour it into a second empty bottle, using a funnel if needed.
2. Take two antacid tablets and crush them until they fit into the opening of a balloon. A dry funnel can help with this.
3. Carefully stretch the open end of the balloon over the bottle's opening, ensuring it fits snugly without letting the tablets fall in just yet. You might want to hold the balloon in place with your hand or secure it with a rubber band.
4. Now, hold the balloon around the neck and lift the heavy part, allowing the antacid tablets to drop into the soda at the bottom of the bottle.

Observations with Experiment 2

What happened? What do you hear? What do you notice about the balloon? Why is this happening? How does this experiment compare to the first one with baking soda and vinegar?

Conclusion

1. Can you use your observations to answer the initial question?
2. Were you able to prove or disprove your hypothesis?
3. Did one experiment work better than the other? Why?
4. Discuss your conclusions with others or write them down.

Did You Know?

The chemical reaction between baking soda and vinegar produces carbon dioxide gas, which creates the fizzing and bubbling you see and hear! This reaction is actually a type of acid-base reaction: baking soda (a base) reacts with vinegar (an acid) to form sodium acetate, water, and carbon dioxide. The carbon dioxide gas is what causes the impressive fizz and can even propel a small container when the gases build up enough pressure!

Activity 1B: Watch Out, It’s Going to Blow!

Note: Alternative activity to Balloon Blast for those with latex allergies.

Now that we’ve discussed the scientific method, let’s apply it! In this activity, you’ll conduct two experiments by mixing common household products. You’ll start by asking questions and making educated guesses, then set up the experiments, observe the results, and draw conclusions.

Question

What happens when you mix baking soda and vinegar in a confined container? What happens when you mix soda and antacid tablets in a confined container?

Materials

- Antacid tablets - 2 tablets
- Baking soda - 3 tablespoons
- Generic soda (cola, club soda, etc.) - ½ cup
- Goggles
- Large container or box (for catching any spillage) **Optional*
- Learning shades
- Measuring cup
- Measuring spoons
- Sandwich baggie – 2 **sealable*
- Tissue **like Kleenex®*
- Vinegar - ½ cup
- Water – ¼ cup **warm*

Hypothesis and Prediction

Before beginning, review the list of materials and use any prior knowledge to form a hypothesis about the experiment’s outcome. Write down your hypothesis or share it with classmates if you'd like.

Experiment 1

1. Practice your nonvisual skills by putting on your learning shades and your goggles for safety.

2. Measure ½ cup of vinegar and ¼ cup of warm water using measuring cups, and pour both into an empty, sealable plastic bag. Seal the bag and gently shake to mix.
3. Next, measure 3 tablespoons of baking soda using a measuring spoon. Place the baking soda in the center of a piece of tissue and gently fold it to create a small packet.
4. Things might get messy, so be prepared to take your materials outside or place them in a large container to manage any spills. Open the plastic bag just enough to insert the baking soda packet, then quickly seal the bag and place it onto the ground or into a container.

Observations with Experiment 1

What happened? What do you hear? What do you notice about the bag? Why is this happening?

Experiment 2

1. Practice your nonvisual skills by putting on your learning shades and your goggles for safety.
2. Measure ½ cup of generic soda using a measuring cup and pour it into an empty plastic bag.
3. Crush two antacid tablets, using the bottom of your measuring cup for convenience, and place them in the center of a piece of tissue. Wrap the tissue around the crushed tablets to form a small packet.
4. To manage potential spills, take your materials outside or place them in a large container. Open the plastic bag just enough to insert the antacid packet, seal the bag quickly, and place it on the ground or inside the container.

Observations with Experiment 2

What happened? What do you hear? What do you notice about the bag? Why is this happening? How does this experiment compare to the first one with baking soda and vinegar?

Conclusion

1. Can you use your observations to answer the initial question?
2. Were you able to prove or disprove your hypothesis?
3. Did one experiment work better than the other? Why?

4. Discuss your conclusions with others or write them down.

Did You Know?

Mixing soda with an antacid tablet creates a fizzy reaction because of the release of carbon dioxide gas. Soda contains dissolved carbon dioxide, which makes it bubbly. When an antacid tablet, usually made of baking soda or other carbonate compounds, is added, it reacts with the acid in the soda. This reaction produces additional carbon dioxide gas, leading to a rapid, foamy bubbling effect. This fun experiment shows how carbon dioxide can be generated and released through a simple chemical reaction.

Unlocking Experimentation: Navigating the Scientific Method

Now that you've gained some experience with the scientific method, let's make things a bit more complex! Scientists can use the steps we've learned to answer questions, but there's more to it than that. They must establish careful guidelines in their experimental process to ensure their results are accurate and reliable. Here are some key components to consider when working through the scientific method and seeking answers to your questions:

Control

A control is a part of your experiment that remains unchanged so it can be compared to other components after testing. For example, remember our hypothesis from the introduction to the scientific method?

Example Hypothesis:

If I water my plant with milk, then it will grow larger than if I water it with plain water. In this case, watering one plant with plain water, another with milk, and a third with soda would form my experimental setup from the handout discussed previously *The Scientific Method: A Fun Way to Explore.* All three liquids are similar, but plain water is the typical choice for watering plants, making it the control.

Data

Data includes the numbers and measurements you track during your experiments. For instance, to yield the most accurate results, we should water each plant with the same amount of each liquid. We could measure exactly one cup of water, one cup of milk, and one cup of soda for our plants. Additionally, we could measure each plant's growth by counting the number of leaves and tracking how that number increases or decreases over time. All of these examples represent data.

Variables

Variables are the parts of your experiment that can change. Changes may come from your experimental setup (like the liquid used) or from the results of your experiment (like a plant growing more leaves than others).

Independent Variable

This is the component of your experimental setup that you change yourself. In our example, changing the liquids from plain water to milk to soda represents the independent variables in the experiment. It's essential to change only one independent variable at a time to accurately measure the outcome. For example, it wouldn't be helpful to water one plant with both milk and soda, as the results would not be conclusive.

Dependent Variable

This component of the experiment changes as a result of the independent variable. In our example, the number of leaves changing due to the type of liquid for each plant represents the dependent variable.

Controlled Variables

These are the components of the experiment that remain unchanged. Note that this is not necessarily the same as the "control" mentioned above. Controlled variables ensure the consistency of your experiment.

In our example, always using one cup of each liquid would be a controlled variable. Another example would be using the exact same type of plant for each liquid test. Can you think of more controlled variables?

Take a Moment to Process!

There's a lot of information here, so make sure to refer back to this handout while working on your activities for the day. Now, let's get back to experimenting!

Did You Know?

The scientific method has been used for centuries, and many of its principles can be traced back to ancient civilizations! For example, the ancient Greeks, particularly Aristotle, were among the first to use systematic observation and logic to explore the natural world. Aristotle's approach laid the groundwork for modern scientific thinking, emphasizing the importance of observation, reasoning, and evidence in understanding how things work. This legacy continues to shape how scientists conduct experiments and draw conclusions today.

Activity 2: Thermo Thrills

Congratulations on completing Activity 1 and exploring the scientific method! Now, let's move on to a more advanced science experiment.

In this activity, you will mix water with different chemical salts and make observations. You'll also identify the control and variables in your experiment. Chemistry happens when substances interact and create reactions, breaking and forming bonds between mixed chemicals. For instance, think about what happens when you mix table salt (sodium chloride) with water. Let's take a closer look at what water and salt molecules look like and what happens when they mix.

Salty Science

What happens when you mix table salt with water? Water is called the "universal solvent" because it can dissolve many different things. It can dissolve substances that have charged particles (ions) or areas with a slight electric charge (polarity). This happens because water molecules are a bit like tiny magnets, with positive and negative ends. When you add salt to water, these water molecules surround the salt particles and pull them apart (creating hydration shells). The water molecules break the bonds holding the salt together, causing it to dissolve and spread out in the water.

Want to explore creating molecules? Check out the lesson *Edible Science: The Candy Molecule Challenge*.

Safety Information!

1. Remember to always wear gloves and use goggles when working with chemicals.
2. Never smell or breathe in chemicals.
3. In this experiment liquids may suddenly become hot or cold, remember to use caution when touching the beakers.

Materials

- 250 mL beaker – 2 **or glass containers that can hold at least 1 cup of liquid*
- 3 oz paper cup – 2
- Ammonium nitrate - 10g

- Calcium chloride – 20g **may need to break/crush up if mixture is clumped*
- Gloves
- Goggles
- Learning shades
- Measuring cups
- Measuring spoons
- Spoon (plastic) - 2
- Talking kitchen scale
- Talking thermometer
- Water – 200 mL **approximately 1 cup*

Question 1

What happens when you mix ammonium nitrate salt and water in an exothermic reaction?

Hypothesis and Predictions 1

Use what you learned at the beginning of this activity to formulate a hypothesis and make predictions about the chemical reaction occurring in this experiment. Take a moment to write down your guess and share it with others.

Experiment 1

1. Safety first! Grab your gloves and goggles, and don't forget to practice your nonvisual skills by putting on your learning shades.
2. Carefully measure 50 mL of water (approximately ¼ cup) and add it to a clean, empty 250 mL beaker.

Observations with Experiment 1

1. Use a thermometer to record the temperature of the water in the beaker. Make sure someone on your team writes down the temperature. Be sure to note if the temperatures are Fahrenheit or Celsius.

Take a Pause with Experiment 1

1. Can you identify a control and/or a variable in this experiment? Take a moment to discuss it with your team and write it down.

2. Now, use a kitchen scale and a small paper cup to measure five grams of ammonium nitrate salt. Place the empty paper cup on the scale and zero it out (or “tare” the scale) before measuring the salt. Use small measuring spoons to add salt into the cup until you reach five grams.
3. Next, add the five grams of ammonium nitrate salt to the beaker of water and use a plastic spoon to gently stir the mixture.

More Observations with Experiment 1

1. Use the thermometer to record the temperature. Did it change?
2. Try adding an additional five grams of ammonium nitrate and checking the temperature again. Was there a change?
3. Carefully dump the mixture outside onto soil. Ammonium nitrate is not drain safe and should not be dumped down a sink.

Question 2

What happens when you mix calcium choloride salt and water in an endothermic reaction?

Hypothesis and Predictions 2

Apply what you learned at the beginning of this activity to formulate a hypothesis and make predictions about the chemical reaction occurring in this experiment. Take a moment to write down your guess and discuss it with others.

Experiment 2

1. Put on your gloves, learning shades and goggles.
2. Carefully measure 100 mL of water (about ½ cup) and add it to a clean, empty 250 mL beaker.
3. Next, use a thermometer to record the initial temperature of the water in the beaker.
4. Using a kitchen scale and a small paper cup, measure ten grams of calcium chloride salt. Place the empty cup on the scale, then zero out (or "tare") the scale before adding the salt. Use small measuring spoons to scoop salt into the cup until you reach ten grams.
5. Add the ten grams of calcium chloride salt to the beaker of water and gently stir the mixture with a plastic spoon.

6. Record the temperature again. Did it change?
7. Try adding an additional five grams of calcium choloride and check the temperature once more. Was there a change? It may be helpful to have a partner hold/measure with a thermometer while someone else pours/stirs the chemical into the water.
8. Finally, carefully pour the mixture down the sink and wash and dry all materials.

Conclusion

1. Which of these reactions was an exothermic reaction? Which was an endothermic reaction? What form of energy was absorbed or released?
2. Was there a drastic change in temperature? A small change? Why do you think that is?
3. What do you think would happen if you added more of each chemical to the water? Less? Why?

Did You Know?

Although reactions may seem to occur on their own, they actually require energy. Reactions can be classified as exothermic or endothermic. Whoa, those are big words—what do they mean? Exothermic reactions release energy when bonds break and form, while endothermic reactions absorb energy during these processes.

Edible Science: The Candy Molecule Challenge

Have you ever wondered about how molecules are made? What makes the atoms in a molecule stick together? How are different molecules created? Let's explore how atoms and chemical bonds create molecules, and how different combinations of atoms create unique molecules.

Using different colored gumdrops as atoms and toothpicks as molecular chains, you can practice building different molecules.

Materials

- Gumdrops
- Gummy bears
- Learning shades
- Mini marshmallows
- Paper plate
- Scissors
- Toothpicks
- Twizzlers™ **cut into smaller pieces*

Note, if you prefer not to use candy, use small items that are different in texture like fuzzy pom poms, playdough/clay, cooked pasta/beans, buttons, beads, cork, mini-Styrofoam™ balls, etc. Items that can be easily pierced with a toothpick.

Experiment

1. Practice your nonvisual skills by putting on your learning shades.
2. Make each of these molecules below by following the table below.
    a. O_2 (Oxygen)
    b. H_2O (Water)
    c. CO_2 (Carbon dioxide)
    d. NH_3 (Ammonia)
    e. CH_4 (Methane)
    f. C_2H_6 (Ethane)
3. Use a paper plate to keep things together.
4. Attach the candies by poking the end of the toothpick into each other.

Element	Number of Atoms (candies)	Assigned Candy	Number of Bonding Sites (toothpicks)
Carbon	3	Gumdrops	4
Hydrogen	10	Mini Marshmallows	1
Nitrogen	2	Gummy Bears	3
Oxygen	2	Twizzlers	2

Explore the Periodic Table of Elements and practice creating a variety of molecules. For example, to create sodium chloride (table salt), you combine sodium (Na), a highly reactive metal, with chlorine (Cl), a toxic gas. When these two elements react, they form a stable compound known as salt.

Did You Know?

The Periodic Table is like a big chart that organizes all the different kinds of atoms, which are the tiny building blocks of everything around us. Each atom is called an element, and every element has its own spot on the table.

Here's how it works:

- **Rows**: These go left to right and are called periods. The elements in each row have a similar number of layers, or "shells," where their tiny particles, called electrons, are found.
- **Columns**: These go up and down and are called groups. Elements in the same group are like a family—they have similar "personalities" and can act alike in chemical reactions.
- **Colors or sections**: The table is often divided into parts that group metals, nonmetals, and other special kinds of elements.

Each box in the table tells you:

- The element's name (like oxygen or gold),
- Its symbol (a short nickname like O for oxygen or Au for gold),
- And a number called the atomic number, which is how many protons (tiny particles) are in the element.

The Periodic Table helps scientists understand how different elements work and how they combine to make things—like water, air, or even the stars!

Activity 3A: Can You Feel the Breeze?

Have you ever used a small battery-powered fan to cool down? Have you wondered how it works? Mini fans typically have a small motor that uses battery power to spin a rotor, creating airflow.

The motor uses alternating current (AC) to create a rotating magnetic field, which induces a current in the rotor's wire loop, generating a second magnetic field. The interaction between these two magnetic fields causes the rotor to spin.

In this activity, you'll build your own mini fan and have a fun way to measure its airflow. However, you'll need to make some design decisions: What will you build your fan on? What material will you use for the blades? Will you modify the original electrical setup?

Question

Can you use a battery-powered motor and self-designed blades to create a mini fan with improved airflow compared to the sample mini-fan?

Parameters

- Your fan must be no larger than twenty-five centimeters in any direction.
- Check with your program staff about the time limit for this activity.
- Program staff will provide a sample electric mini fan.

Materials

Please note only the materials listed may be used.

- 3"x5" index cards – 20
- 8"x11" plastic sheets – 2
- 9V batteries – 2
- AA batteries – 4
- Aluminum foil (14"x10.5") - 2 sheets
- Battery holders – 4
- Black wires – 2
- Copy paper – 5 sheets
- Craft sticks – 10
- AC motor – 2
- Electric mini fan
- Floss threader
- Hot glue gun
- Hot glue sticks

- School glue
- Motor switch – 2
- Paper clips – 10
- Paper plates – 2
- Plastic cup, 16oz – 4
- Red wires – 2
- Ruler
- Scissors
- Scotch™ tape
- Spoons (plastic) – 10
- Straws – 10
- Tissue paper
- Wooden blocks – 2
- Yarn

Hypothesis and Prediction

Work with your partner or team to make a hypothesis. Use an educated guess to come up with ideas of what types of fan blade will produce the most air. Should you use multiple motors? Does size make a difference? Why?

Experiment

Caution! Do not insert the batteries while connecting or adjusting wires. Handle wires only when the batteries are removed. Battery packs can become very hot, so ensure batteries are inserted last, or insert only one battery at a time when the motor is not running.

1. Practice your nonvisual skills by putting on your learning shades.
2. To power the motor, connect a battery pack to the correct motor terminals using two wires: connect the red wire to the red (positive) terminal and the black wire to the black (negative) terminal. Note, you may need an adult to strip some of the wire.
3. If you opt to use a motor switch, begin by connecting the red positive wire from the battery pack to the switch. Next, use a second red wire to connect the switch to one of the motor's terminals. The rotor's direction is determined by the placement of the black and red wires, rather than by a specific "correct" terminal position. To orient yourself with the battery holder, place it face-up on the table, ensuring the open area for inserting batteries is facing upward and the flat, smooth side is resting on the surface. Rotate the holder so that the two wires stick out from the top (at 12 o'clock). In this position: The black wire is on the left, closest to the spring

terminal. The red wire is on the right. The spare wires are pre-stripped with caps on both ends for easy threading through terminals and prongs. Only remove the caps after threading. However, the wires on the battery holder are not pre-stripped, so you'll need wire strippers to expose the ends. For these, and for any finer wires, the included floss threader can simplify the process.

4. That's it! The rest is up to you. Use the materials provided to design your fan, utilizing as much or as little as you like.

Test

Your program staff will assist in setting up the measuring station for your experiment. Begin by selecting a clear area on the floor and using a strip of duct tape to create a "starting line." Place several balls of tissue paper on the starting line. Position a sample fan on a marked spot in front of the starting line, using duct tape to mark the placement if needed. Turn on the fan and measure the distance reached by the furthest tissue paper ball. Repeat the process using your specially designed mini fan.

Remember to consider the controls, variables, and data collection throughout your experiment.

Observations

What did you observe in your experiment? Did you try more than one experiment?

Conclusions

What did you learn? Did you prove or disprove your hypothesis? Why?

Did You Know?

The efficiency of a motor can vary depending on how much load or resistance it's working against. In this experiment, your fan blades play a big role in this. The shape, angle, and material of the blades can impact how much air resistance the motor encounters. If the blades are too heavy or angled inefficiently, the motor has to work harder, draining the battery faster. Finding the right balance can make your mini fan run more smoothly and improve airflow—just like optimizing real motors in fans, cars, and even planes!

Activity 3B: On Your Mark, Get Set, Go!

What is a rubber band car? It's a simple vehicle constructed from common household items, with many variations made from different materials.

A basic design typically includes a square or rectangular frame, two spinning axles, circular wheels, and a rubber band that wraps tightly around the axle, providing the energy needed to propel the car forward.

For example, a craft stick frame supports two straws glued to it. Toothpicks are threaded through the straws, with plastic bottle caps glued to the ends to serve as wheels. One of the axles—represented by a toothpick in this case—is wound up with a rubber band tightly wrapped around it. When the rubber band is released, the car propels forward. Ask your program staff to show you a sample rubber band car for reference.

Question

How can you enhance the design of a basic rubber band car to increase its distance? What methods will you use to test your improvements?

Parameters

- Your car must be no larger than twenty-five centimeters in any direction.
- Check with your program staff about the time limit for this activity.

Materials

Please note only the materials listed may be used.

- 3"x5" index cards – 20
- Axles – 4
- Balloons – 5 **Avoid if you have a latex allergy.*
- Copy paper – 5 sheets
- Craft sticks – 10
- Duct tape
- Hobby wheels – 8
- Hot glue gun **Tip, use a coffee can to store your glue gun while in use*
- Hot glue sticks
- Paper clips – 10
- Pipe cleaners (Chenille Stems) – 6
- Rubber bands – 10 **assortment*
- Ruler

- School glue
- Scissors
- Straws – 10
- Yarn

Collaborate with your partner or team to formulate a hypothesis. Make an educated guess about which materials will contribute to building the fastest car and explain your reasoning.

Experiment

1. Practice your nonvisual skills by putting on your learning shades.
2. Use the remaining supplies to design your car.

Test

How will you test your hypothesis? Don't forget to think of controls, variables, and data.

Observations

What did you observe in your experiment? Did you try more than one experiment?

Conclusions

What did you learn? Did you prove or disprove your hypothesis? Why?

Did You Know?

Energy stored in a rubber band when it is stretched is a form of potential energy, specifically elastic potential energy. When you wind up the rubber band around the axle, you are storing energy. When you release the rubber band, this potential energy transforms into kinetic energy, which is the energy of motion. This conversion of energy is similar to how a bowstring releases energy to propel an arrow forward!

Activity 3C: Sink or Swim?

Scientists and engineers frequently develop solutions to real-world challenges, leading to new inventions that are constantly refined. For example, engineers in landlocked cities have designed ferries to safely transport cars across bodies of water. They had to create a ferry that could support the weight of multiple cars without sinking. Now, it’s your turn to tackle a design challenge!

Question

Can you use the materials provided to build a raft that will keep a toy car afloat on the water?

Parameters

- Your raft must be no larger than twenty-five centimeters in any direction.
- Check with your program staff about the time limit for this activity.

Materials

Please note only the materials listed may be used.

- 3”x5” index cards – 20
- Balloons – 5 **avoid if you have a latex allergy.*
- Copy paper – 5 sheets
- Craft sticks – 10
- Duct tape
- Hot glue gun **Tip, use a coffee can to store your glue gun while in use*
- Hot glue sticks
- Mini toy car **or another small object to place on top of your raft*
- Paper clips – 10
- Paper cups, 3 oz – 6
- Ruler
- School glue – 1 bottle
- Straws – 10
- Yarn

Collaborate with your partner or team to formulate a hypothesis. Use your educated guesses to brainstorm which materials would make the best raft and explain your reasoning.

Experiment

1. Practice your nonvisual skills by putting on your learning shades.
2. Use the remaining supplies to design your raft.
3. Test your raft by placing it in a sink, large bowl, or container filled with water. Place your mini toy car on top and observe whether the raft floats.

Test

How will you test your hypothesis? Don’t forget about controls, variables, and data.

Observations

What did you observe in your experiment? Did you try more than one experiment?

Conclusions

What did you learn? Did you prove or disprove your hypothesis? Why?

Did You Know?

Buoyancy is the reason why objects float or sink in water. According to Archimedes' principle, an object will float if the weight of the water it displaces is greater than or equal to its own weight. When you build a raft for a toy car, you're essentially designing a structure that displaces enough water to support the weight of the car. The materials used in the raft, their shape, and how well they displace water all play a crucial role in whether the raft will float or sink!

Activity 4: STEM2U Spotlight

The "share" step in the scientific method is a crucial part of the process where the findings of an experiment or study are communicated to others. This step not only helps in spreading knowledge but also has several important benefits for both the person conducting the experiment and the broader community. Here's why sharing your findings is essential:

Verification and Challenges: When you share your findings, others can verify the results or offer alternative perspectives. This allows the scientific community to challenge ideas, helping to refine and improve the conclusions drawn from your experiment. This process of peer review ensures that the results are credible and that any errors or biases are identified and addressed.

Building upon Findings: Sharing your results provides an opportunity for others to build upon your work. Someone might come up with new ways to explore the same question or use your findings to support their own research. This collaboration and expansion of ideas are vital for scientific progress and innovation.

Improving Communication Skills: Effectively communicating your findings, whether through writing, presenting, or creating visuals, helps you improve your ability to explain complex ideas clearly and concisely. Strong communication skills are essential for sharing knowledge, especially in science, where clarity is key to understanding and application.

Celebrating Discoveries: Sharing your results is a way to celebrate the hard work and discoveries made during your experiment. It's an opportunity to acknowledge the effort that went into the research and recognize the learning process, regardless of whether the outcome was as expected or not.

Inspiring Curiosity in Others: By sharing your experiment, you not only provide new knowledge but also inspire others to be curious, ask questions, and conduct their own experiments. This fosters a community of learning and discovery, encouraging others to engage with science and explore their own ideas.

Activity Extension

After completing your experiments, it’s time to share your findings with others! Capture photos or videos of your experiment, setup, and results, and think about creative ways to present your work. Could you create a presentation? Write a song? Start a blog? Produce a fun video? Sharing your findings not only showcases your work but also invites valuable feedback, encouragement, and recognition from others.

We’d love to see what you’ve created! Share your media with the National Federation of the Blind by emailing us at **STEM@nfb.org**, tagging us on Facebook (**@nationalfederationoftheblind**), or TikTok **(@nations_blind**).

Don’t forget to use the hashtag **#NFBSTEM2U** on all social media platforms.

By sharing your work with a wider audience, you can connect with others who share your interests and inspire more people to dive into science and conduct their own experiments.

Note: *By submitting any photos, videos, testimonials, or other content to the National Federation of the Blind (NFB), you grant the NFB the right to use, publish, display, and distribute such content in any form or medium, including but not limited to print, online, and social media platforms, for promotional, marketing, educational, or other organizational purposes.*

Science Unlocked

Get inspired by amazing science stories! Discover how scientists make exciting discoveries using the scientific method. From solving big mysteries to creating cool inventions, these stories show how asking questions, testing ideas, and learning from experiments help us understand the world around us. Whether it's exploring space or finding new medicines, science is full of fun surprises!

Louis Braille

Louis Braille was blinded by an accident when he was a young child. At the time, there were very few ways for blind people to read or write, so they often had to rely on others to read to them. Louis wanted to change this, so he began working on a system that would allow blind people to read and write independently.

Here's how Louis Braille used the scientific method in his invention:

Observation: Louis Braille noticed that blind people, including himself, had no way to read and write on their own. They often had to depend on others to read printed materials.

Hypothesis: He hypothesized that if there was a way to represent letters and words through tactile patterns, blind people could read and write using their fingers.

Experimentation: Louis Braille experimented with different combinations of raised dots on paper to represent letters, numbers, and punctuation. He tested his system with his friends and teachers, making improvements over time.

Analysis: After lots of testing and refining, Louis found that a system of six dots arranged in a grid could represent all the letters of the alphabet and numbers.

Conclusion: The Braille system, which he created at just fifteen years old, became widely adopted and is still used today by millions of blind people around the world for reading and writing.

Louis Braille's invention allowed blind people to gain independence, access education, and improve their quality of life. His story is a great example of how determination, creativity, and the scientific method can lead to life-changing discoveries that make the world more accessible to everyone.

Dr. Jacob Bolotin

Dr. Jacob Bolotin, an American physician who was blind from birth and became a pioneering doctor, helped to make advancements in medical technology and the treatment of people with disabilities. Dr. Bolotin's most notable contribution was his development of a stethoscope that allowed doctors to better diagnose patients, even when they couldn't be seen or were too far away to physically examine. At the time, doctors relied on simple tools that limited their ability to understand what was happening inside a patient's body.

Here's how Dr. Jacob Bolotin used the scientific method:

Observation: As a young man, Dr. Bolotin observed that there were many limitations in diagnosing patients with just the visual clues available to doctors. He saw that some patients needed more precise diagnostics, especially those with invisible conditions.

Hypothesis: He hypothesized that using a tool to better listen to the sounds of a patient's heart and lungs could help diagnose illnesses more accurately, even if the doctor couldn't see the patient's symptoms clearly.

Experimentation: As he began practicing medicine, Dr. Bolotin experimented with different ways to improve stethoscopes and other tools, even making modifications to existing ones to improve their sensitivity.

Analysis: By testing these improved devices on his own patients, he was able to better hear things like irregular heartbeats and breathing patterns that could point to serious medical issues.

Conclusion: His efforts led to better diagnostic techniques and improved medical practices. Though his work wasn't fully recognized until after his death, Dr. Bolotin helped make significant strides in improving medical tools for doctors worldwide.

Dr. Jacob Bolotin's work shows that despite being blind, his ability to innovate and use the scientific method helped change medical history and made healthcare more effective for everyone. His story is a powerful reminder of how perseverance, curiosity, and creativity can lead to groundbreaking discoveries, regardless of challenges.

Frank Epperson

Frank Epperson was just eleven years old when he accidentally invented the popsicle. One winter night, he left a cup of soda mix and a stirring stick on his porch, forgetting about it overnight. The temperature dropped that night, and the soda froze around the stick, creating a frozen treat!

Here’s how Frank’s scientific method went:

Observation: The next morning, Frank noticed that his soda had turned into a frozen treat on a stick!

Hypothesis: He wondered what would happen if he froze other drinks using the same method.

Experimentation: Frank tried freezing different drinks and treats on sticks to see what worked.

Analysis: After several attempts, he found that fruit juices and flavored drinks froze best, making a fun, tasty treat.

Conclusion: Frank had invented what we now call the popsicle! He started selling them, and they became super popular.

Frank didn’t mean to create a new snack, but by experimenting and noticing how the soda froze, he made a fun discovery that millions of people enjoy today. His story shows how a simple observation and a little curiosity can lead to a cool invention.

General Motors

General Motors (GM) has used the scientific method in several ways to innovate, particularly in areas like vehicle safety, fuel efficiency, and the development of electric and autonomous vehicles. Here's an example of how the scientific method applies:

Observation: GM observed increasing environmental concerns, rising fuel costs, and regulatory pressure for lower emissions. They also noted a growing demand for electric and autonomous vehicles.

Question: How can GM create a vehicle that reduces emissions, improves fuel efficiency, and meets consumer demands for sustainability?

Hypothesis: Developing electric vehicles (EVs) and enhancing battery technology can reduce emissions and improve efficiency while offering a superior driving experience.

Experimentation: GM has invested heavily in research and development to test this hypothesis:

- **Battery technology testing:** GM experimented with different battery chemistries, such as nickel-metal hydride and lithium-ion, to improve range, charging time, and durability.
- **Prototypes and modeling:** The Chevy Bolt and the Ultium battery platform were developed and tested in controlled environments, using computer simulations and real-world driving tests.
- **Safety testing:** Extensive crash testing and durability experiments ensured the vehicles met safety standards.

Analysis: Data from tests and consumer feedback were analyzed. GM identified strengths, such as improved battery range, and areas needing improvement, such as charging infrastructure.

Conclusion: The hypothesis that EVs could meet environmental and consumer demands was validated. GM released vehicles like the Chevy Bolt EV and continues to refine their Ultium battery system.

GM iteratively improves its technologies, aiming for innovations like solid-state batteries and more efficient electric motors. This process not only aligns with the scientific method but also demonstrates how GM uses systematic inquiry to drive innovation.

Share Your STEM2U Experience

As part of our commitment to expanding opportunities in science, technology, engineering, and mathematics, we hope that the NFB STEM2U program has equipped you with valuable nonvisual tools and techniques, inspired a deeper exploration of STEM education and careers, and helped you connect with a supportive network of blind mentors and peers.

If you participated in an in-person program. We'd greatly appreciate your feedback to help us strengthen this program.

Please take a moment to complete our survey by scanning the QR code below.

As a thank-you for sharing your feedback, you'll have the opportunity to enter a raffle for a $25 gift card after completing the survey.

About National Federation of the Blind

The National Federation of the Blind knows that blindness does not define the future of blind and low-vision youth. Through our extensive education programs like NFB STEM2U, we introduce blind children to new possibilities, inspire teachers and families with our positive philosophy on blindness, and empower blind youth to achieve their full potential. Beyond our education initiatives, we offer more opportunities to advance the life of your child:

We are a transformative membership and advocacy organization with a network of successful blind adults and families. You can be part of the organized blind movement.

- Join a local chapter in your state affiliate of the National Federation of the Blind
- Connect with the National Organization of Parents of Blind Children, a proud division of the National Federation of the Blind
- Access more of our positive philosophy from blind adults, teachers of blind students, and parents of blind children in the publication, *Future Reflections*, that is published quarterly.

To learn more about the National Federation of the Blind and our education programs, visit https://nfb.org/our-community/parents-blind-children, email us at education@nfb.org, or call us at 410-659-9314, extension 2418.