SENSING FOR SCIENCE

Instructional modules for early learners

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SENSING FOR SCIENCE

What is Sensing for Science?

Sensors are all around us! From cross-walk signals, to cell phone alarm clocks, to street lights that turn on at night, our world is full of devices that take information in and produce a response. The human body is a collection of sensors that responds to the environment. This series of learning activities will help students explore how scientists use sensors!

Activity Summaries

ACTIVITY NUMBER	TITLE	ACTIVITY GOALS	MATERIALS PROVIDED BY LEADER
1	Snack Time Senses	Explore the sensors of the human body	At least 2 snacks per student
2	Sensor Scavenger Hunt	Identify signals for specific body sensors	*Optional snack*
3	Sensor Memory Game	Match signals and sensors	
4	Sensing Light	Explore how scientists detect light	
5	Sensing Heat and Temperature	Explore how scientists detect heat and temperature	Ice water or hot water
6	Sensor Playground	Explore various sensors	
7	Sensory Inquiry	Engage in an inquiry using sensors	

Leader Tips:

We encourage you to read through the entire learning bundle before deciding which activities to begin with your learners. Many of these activities would work well with mixed-age groups, so while we have directed much of the work at younger grade levels, these activities can be brought into upper grades as well.

Kit Materials

(10-20 students)

- Laminated memory card game (5 sets in kit)
- Various sensors (4-5 in kit) - may vary (Water sensing toy, motion sensing toy, light sensing toy, sound sensing toy)
- UV flashlight (10 in kit)
- UV beads (approximately 80)
- UV paper (5 pieces)
- Sunscreen (10 packets)
- Sheet protectors (20)
- String/pipe cleaners (20)
- Thermometer (20)
- Infrared Thermometer (2)

STUDENT DOCUMENTS TO PRINT:

- Snack Time Senses (page 2)
- Sensor Scavenger Hunt
  - (K-1: Sense Cards page 4)
  - (Grades 2-up: Worksheet page 5)
- Sensor/Signal Memory Games (pages 7-10)
- Sensing the Light (pages 13-14)
- Sensing Heat (page 17)
- Sensor Playground (pages 19-20)
- Sensor Inquiry (pages 23-24)

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About Sensing for Science

This learning bundle was supported by the National Science Foundation-funded project called **SMART FIRES** (Sensors, Machine Learning and Artificial Intelligence for Real-Time Fire Science).

ABOUT SMART FIRES

In this project, which spans the entire state of Montana, scientists and engineers use **sensors** to gather information that helps us make better decisions about **prescribed fire**– the process of intentionally setting a fire under specific conditions in order to prevent future wildfires or to help the environment. The team uses sensors to measure weather conditions like temperature, humidity and wind speed to see if it is safe to start a prescribed fire. The researchers also use sensors that indicate how dry or moist the vegetation is. After a fire is started, sensors can tell the fire managers where the hottest parts of the fire are and how the air quality is impacted by smoke.

Many of the sensors are "Smart Optical Sensors." **Optical** means sensing with light, and **Smart** means the device is connected to a computer or microprocessor that allows it to not just collect data but take action.

For instance, a camera is considered an optical sensor. But a standard camera just takes a photo, and a human must then interpret what is in the photo. A "smart optical sensor" camera may take a photo and then also analyze the data in the photo and perform an action and/or communicate information about the image.

Sometimes researchers from SMART FIRES use or modify commercially purchased sensors and sometimes they design their own, including sensors that can (among other tasks) – determine the quantity and type of small particles in a smoke plume or use a photo

SENSING FOR SCIENCE INSTRUCTOR OVERVIEW

This module is designed to introduce young students first to the concept of our bodies as sensors (our five senses) and then on to human-made sensors as tools.

Purpose: This learning bundle introduces students to the concepts of sensors, the functions of various sensors and the use of sensors in real-world scientific contexts to monitor the environment or solve problems. The module includes seven activities. The first three activities build an understanding of the function and key terms related to sensors. The next two activities enable students to explore specific sensors with real-world connections.

The final two activities are more advanced and encourage students to learn to create new projects with sensors, first within an indoor environment, and then in an outdoor exploration. In the culminating activity, students use a sensor in an inquiry-based manner that may be new to them. Each activity has an instructor guide with information on preparation and materials. *No prior experience with or understanding of sensors is required by the instructor!*

The bundle includes seven lessons, each about 1 hour.

SENSING FOR SCIENCE

HELPFUL VOCABULARY (FROM MERRIAM WEBSTER)

TERM	DEFINITION
Sensor	device that responds to a physical stimulus (such as heat, light, sound, pressure, magnetism, or a particular motion) and transmits a resulting impulse (as for measurement or operating a control)
Heat	energy flow that causes substances to rise in temperature
Ultraviolet	situated beyond the visible spectrum at its violet end
Electromagnetic spectrum	the entire range of wavelengths or frequencies of electromagnetic radiation extending from gamma rays to the longest radio waves and including visible light
Stimulus	something that rouses or incites to activity (like touching a sensor, or adding heat or light to a sensor). Similar to the word signal
Signal	an object used to transmit or convey information to a sensor
Temperature	degree of hotness or coldness measured on a definite scale
Wavelength	the distance in the line of advance of a wave from any one point to the next point of corresponding phase
Transmit	to send out a signal

SENSING FOR SCIENCE

Activity 1
Snack Time Senses

Snack Time Senses Instructor Overview

The goal of this introductory activity is to help students understand what the word "sense" means so that we can build to the term "sensor" in future activities. This exploration engages students in several sensory activities so that they can discover that even within the human body we have the ability to sense multiple things at once. Ideally, you will provide students with two different snacks so that they can discuss and compare how each snack affects the human body differently.

Procedure – STEPS, EACH WITH TIME ALLOTMENT

1. **(Grades 2-up)** Hand out worksheets and explain to students that they will be writing or drawing in each box as they eat. **(5 min)**
   (Grades K-1) Display the worksheet on projector or classroom monitor.
2. Hand out snacks. (If you choose to have students compare snacks, it works best to hand out the first snack, have the students fill out the activity, then hand out the second snack.) **(5 min)**
3. **(Grades 2-up)** Allow students to complete the worksheet as they eat. You can guide students to fill out each box by calling out the sense, or to give them 1-2 minutes to write/draw for each sense together as a group.
   (Grades K-1) Use the worksheet to guide a classroom discussion.
   (20 min)
4. **(Grades 2-up)** Ask students to share their writings with each other. **(5 min)**
5. **(All grades)** Guide students through the following questions
   (You may wish to write these on the board.)
   - Were all the senses the same? *(Should be no)*
   - What was the thing that "sensed"?
     (Should be varying, like nose, ears, eyes, fingers, etc.)
     — From these two answers, guide students to realize that we need a general term for "things that sense" and that this term is **"sensor"**
   - Do your sensors respond to everything all the time?
     (For example, if I look at an apple with my eyes do I taste it, or do I have to use my tongue to taste it?).
     — For this question, we want students to realize that sensors respond to specific things in specific situations. (We will add more terms in later activities. Today's focus is the word **"sensor"**.)

Wrap up / Closure / Cleanup

Today we discovered that "sensors" can measure things in the world around us, and that as humans we are all pretty good at sensing!

Materials Needed

- Snacks (1 or 2 per student. Examples would include an apple or orange, which are likely to have associated taste, sound from eating, smell, touch, and sight.)
- Snack Time Senses student handout
  Grades K-1: Project the worksheet or just print one for your own reference.
  Grades 2-up: Print one worksheet per student per snack.
  (2 snacks = 2 worksheets)
- Pencils for students to fill out handout
- Whiteboard to capture student responses
- Guiding questions (either printed or written; find under Procedures at left.)

Educator Preparation

- Print out appropriate number of handouts. Note: for pre-readers, worksheets are not needed. Instead, lead a class discussion.
- Consider how to provide snacks.
  e.g., If you choose to have students compare snacks, hand out the *first snack*, have the students fill out the activity, and then hand out the second snack.
- **NOTE** that if you choose to provide snacks, be sure to **determine if any students have food allergies.** You could also consider allowing students to bring their own snack for this activity, and, **in light of allergy concerns, encourage them not to share.**
- Consider whether you want to write the guiding questions for the students on the board ahead of time or as you ask them.

NAME: _____

DATE: _____

SENSING FOR SCIENCE
Activity 1

SNACK TIME SENSES

Directions:
As you eat your snack, pay close attention to your senses: taste, sight, smell, touch, and hearing. In the boxes, use words or drawings to record your observations of your snack.

Tastes...

Looks...

Smells...

Feels...

Sounds...

SENSING FOR SCIENCE

Activity 2
Sensor Scavenger Hunt

Sensor Scavenger Hunt Instructor Overview

The goal of this introductory activity is to engage students in understanding what the word **"sensor"** means and that **sensors** receive information from specific **signals.** Students will identify the pattern that sensors only respond to specific signals and use this knowledge to predict which sensor is necessary to respond to specific signals.

Procedure – STEPS, EACH WITH TIME ALLOTMENT

1. **Grades K-1:** Instead of a classroom-wide scavenger hunt, lead a group activity. First, hand out Sensor Cards and have students hold up the sensor card for each type of signal: e.g., "What do you *smell* with?" (*...taste, hear, feel/touch, see.*) **(5 min)** Next, display two items at a time from the grab bag/bin. Using the worksheet as a guide, ask, "Which object is red? ...cold? ...shiny?" etc. Ask, "Which sensor did you use?" and have students respond by holding up the card that shows the body part they used to decide their answer. **(15 min)**

   Grades 2-up: Hand out worksheets and explain to students that they will be writing next to each box as they hunt for items using their five senses (sight, smell, taste, hearing and touch). **(5 min)**
   Point out that they will hunt for items using their own **sensors**, which are just body parts that do the sensing (eyes, nose, tongue, ears, hands*).
   Set boundaries of where students can hunt for items.
   **Touch sensors are present all over the body, including nose, mouth, ears and eyes, but for simplicity's sake in these activities, we have used "hand" or "fingers" to signify the touch sensor. If you wish, you can discuss this briefly with students.*
2. *[Optional]* Hand out snacks or place them in the room. **(5 min)**
3. **Grades 2-up:** Enable students to complete the worksheet as they hunt for items **(20 min)**. Consider encouraging students to create their own item and add a new check-box in the blank space on the worksheet. They can discuss what sensor is needed to identify this item. *(May be multiple.)*
4. **Grades 2-up:** Ask students to share their writings with each other. **(5 min)**
5. **Guiding questions, all grades:**
   (You may wish to write these on the board.)
   - Did we use all sensors each time we found an item? *(Should be no)*
   - What was the thing that "sensed"? *(Should vary: nose, ears, eyes, etc.)*
     From these two answers, guide students to realize that we need a general term for "things that sense" and that this term is "sensor."

Wrap up / Closure / Cleanup

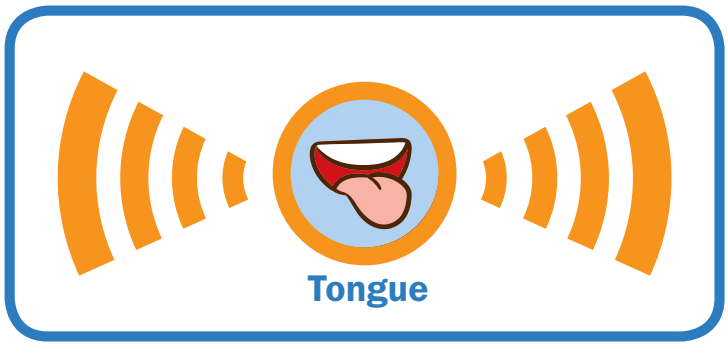
Today's goal was to observe objects using our own *"sensors"* — which we usually just call *senses.*
Great work making your observations!

Materials Needed

- **Grades K-1:** One set of five Sensor Cards per student.
- **Grades K-1:** A bin or "grab bag" in which you have hidden various objects that are red, cold, smooth, shiny, squeaky, round, yellow, sticky, hard, sweet and squishy.
- **Grades 2-up:** Sensor Scavenger Hunt student handout (one per student or team)
- Snacks (if you choose to use the taste sense; otherwise ask students to cross out this sensor so that they do not taste items inappropriately)
- Whiteboard to capture students' responses
- Pencils for students to fill out handout
- Guiding questions (see Procedure) either printed or written on a white board

Educator Preparation

- **Grades K-1:** Project the handout or print one for your own reference. Gather a bin or bag of objects as described above. Print and cut a set of Sensor Cards for each student.
- **Grades 2-up:** Print out an appropriate number of handouts.
- Consider whether to provide snacks for the "taste" sensor. Again, if choosing to provide snacks you should **be aware of and avoid any allergies** that might be present for your students.
- Consider whether you would like to have guiding questions for the students written on the board ahead of time, or if you would like to write these on the board as you ask them.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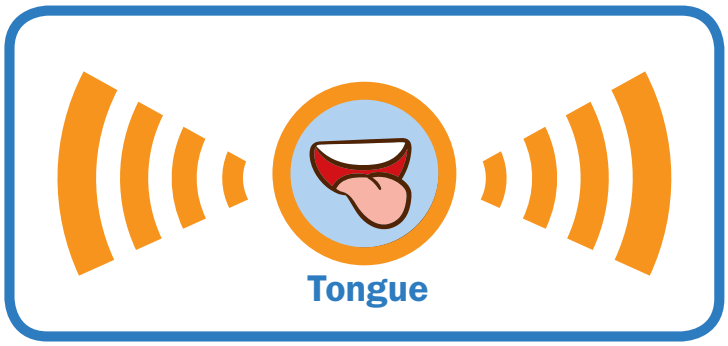
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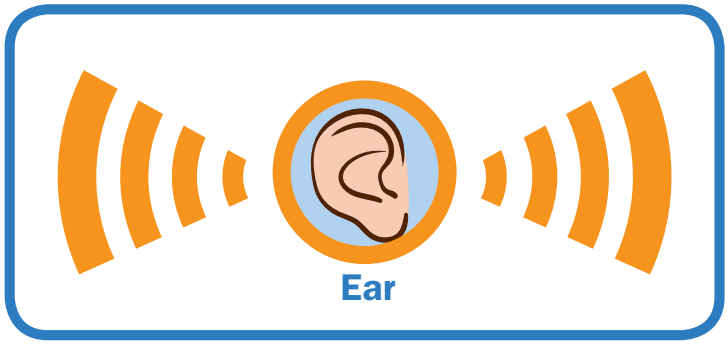
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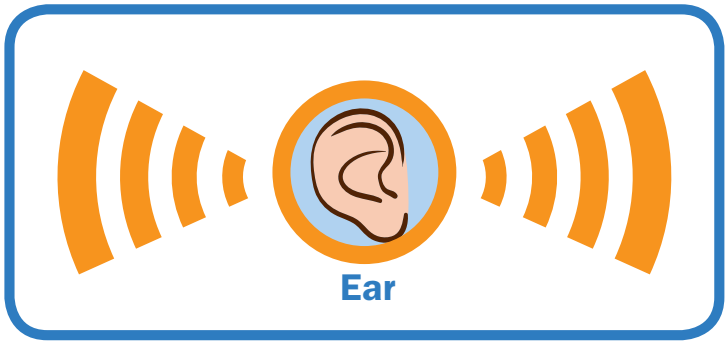
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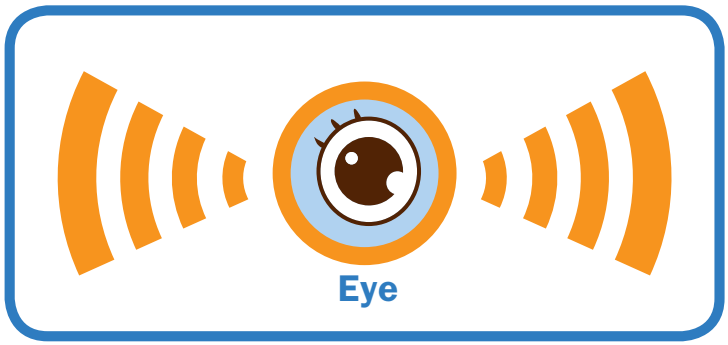
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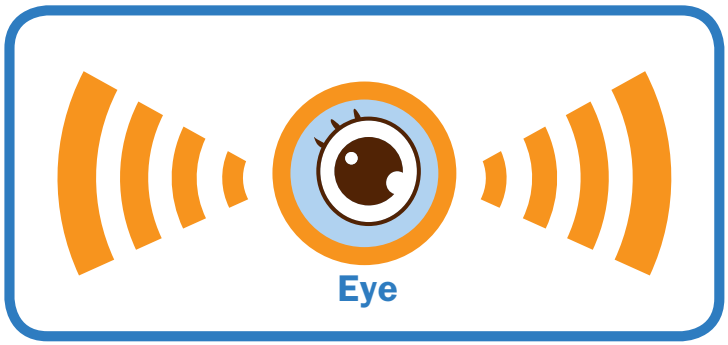
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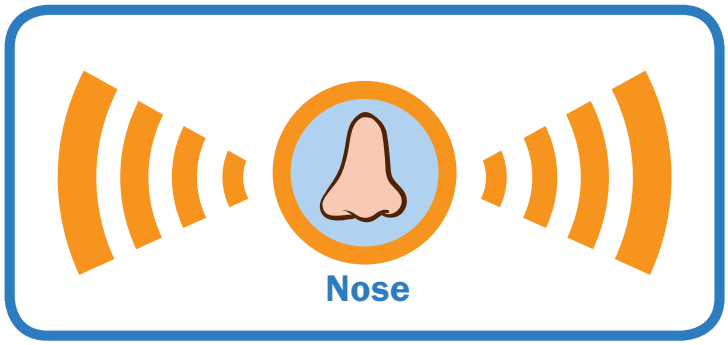
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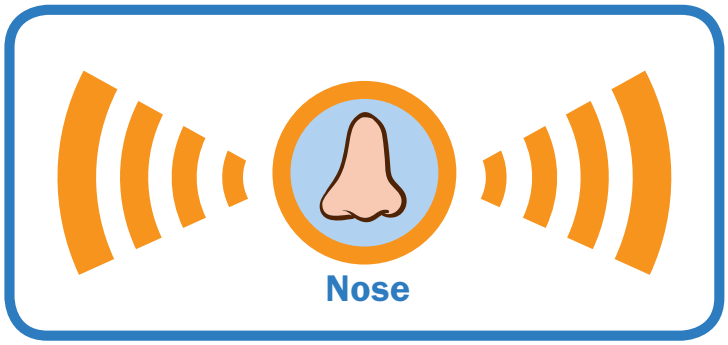
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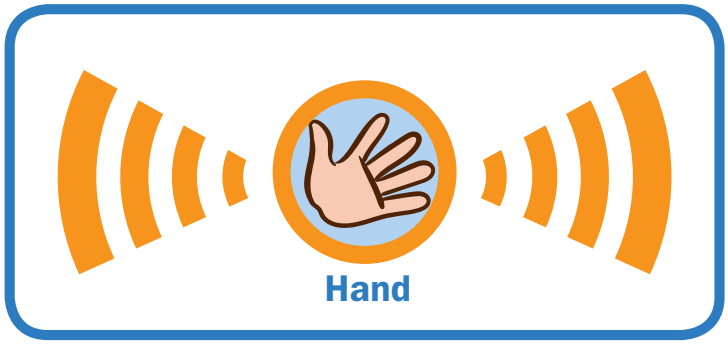
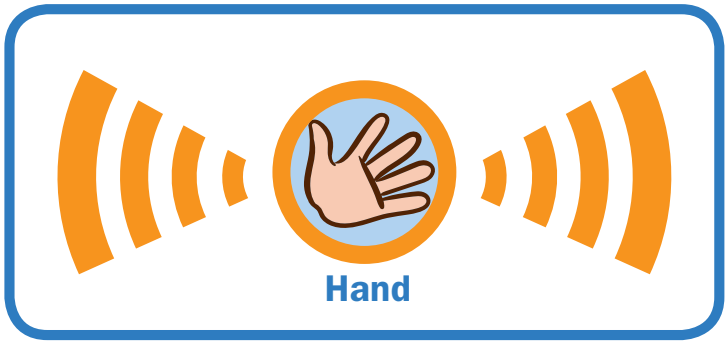

Hand


Hand

NAME: _____

DATE: _____

SENSING FOR SCIENCE
Activity 2

SENSOR SCAVENGER HUNT

Directions:
Use your ***sensors*** to search for signals! If you find something on the list, check its box and write or draw what you found. Then circle the ***sensor*** you used to find it.

Signals to hunt for	What did you find?	Which sensor did you use?
☐ Something **red**		
☐ Something **cold**		
☐ Something **smooth**		
☐ Something **shiny**		
☐ Something **squeaky**		
☐ Something **round**		
☐ Something **yellow**		
☐ Something **sticky**		
☐ Something **hard**		
☐ Something **sweet**		
☐ Something **squishy**		

How many signals did you find? (Write the number) ☐

SENSING FOR SCIENCE

Activity 3 Sensor/Signal Memory Game

Sensor Memory Game Instructor Overview

The goal of this introductory activity is to assess student understanding of a connection between **"sensors"** and **"signals"** through game play. This game ideally would be played non-competitively and encourage collaboration instead. In collaboration, we would hope that all teams can meet a specified time mark. Teams can encourage each other and provide helpful hints if needed. Teams of two might work together on the first set of sensors/signals and a student could then work individually (or again in twos) for the second set.

Procedure – STEPS, EACH WITH TIME ALLOTMENT

1. Introduce the memory game and create teams **(5 min).**
   Consider whether this will be collaborative and students are working together to make the matches before a specific time goal, or whether students are competing.
2. Enable students to play the first round of memory cards with Game 1.
   The game is played by turning the cards over so that you can't see the sensor/signal. Players take turns turning a card over and trying to match it to the corresponding signal. If they do not find a match, they replace them face down and it is the next player's turn. If they do find a match, they set it aside and it is the next player's turn.
   Note the correct matching pairs are listed below. **(10 min).**
3. Provide students with the second set of memory cards and either provide directions to change teammates or to complete this round independently **(10 min)**.
4. Debrief as a whole group, encouraging students to reflect on which sensors were more difficult to match with their signal.
   What steps did students take that were really successful?
   In what ways did we help a friend to learn?

Wrap up / Closure / Cleanup

Ask students to consider three sensory observations they might make as they walk through school the next day so they can report back. Tell them the goal is to notice when they use senses so that in the next activity we can use our external sensors like some of those in the pictures from the memory game.

Materials Needed

- Sensor/Signal Memory Game Set 1 (one per student or per team of 2)
- Sensor/Signal Memory Game set 2 (one per student, or per team of 2)
- Whiteboard to capture student responses

Educator Preparation

- Print and cut appropriate number of memory games. (Card size is 4.25"x2.2")
- Consider whether you would like to have guiding questions for the students written on the board ahead of time, or if you would like to write these on the board as you ask them.

KEY for Memory Game Set 1

- Tongue/Pizza
- Ear/Trumpet
- Eye/Rainbow
- Nose/Skunk
- Hand/Cactus

KEY for Memory Game Set 2

- Tongue/Pickle
- Ear/Drum
- Eye/Light bulb
- Nose/Garbage
- Hand/Blanket

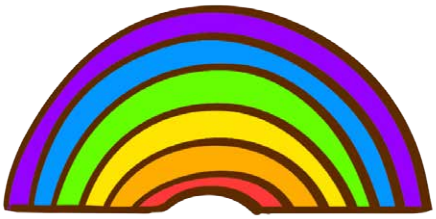
Tongue

Pizza

Ear

Trumpet

Eye

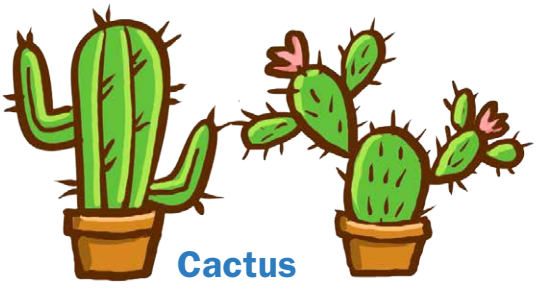


Rainbow

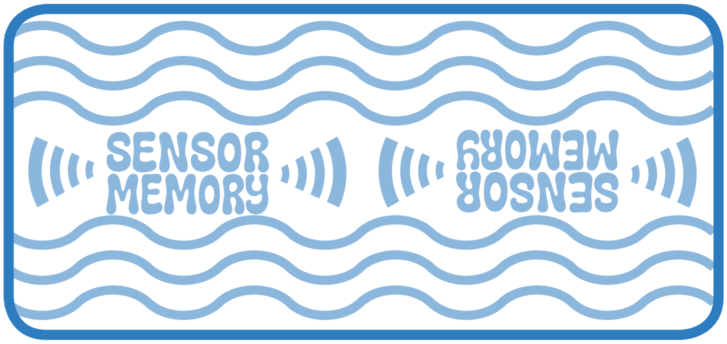
Nose

Skunk

Hand



Cactus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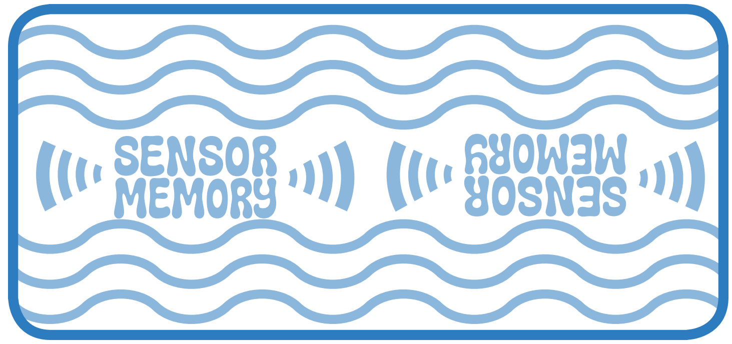
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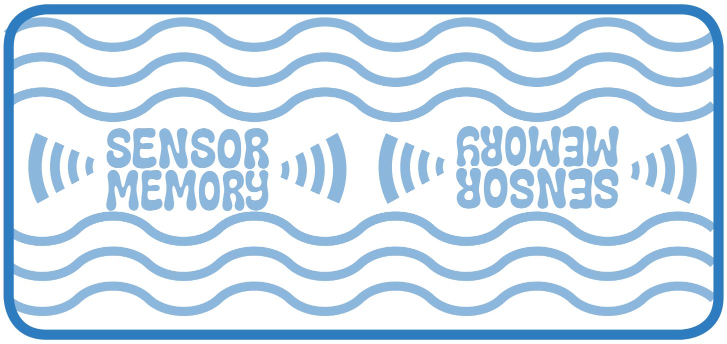
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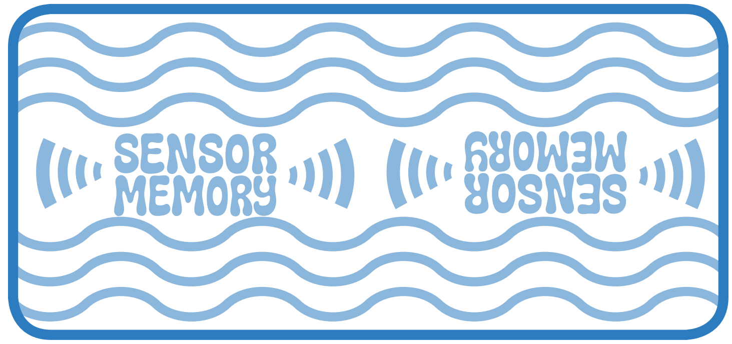
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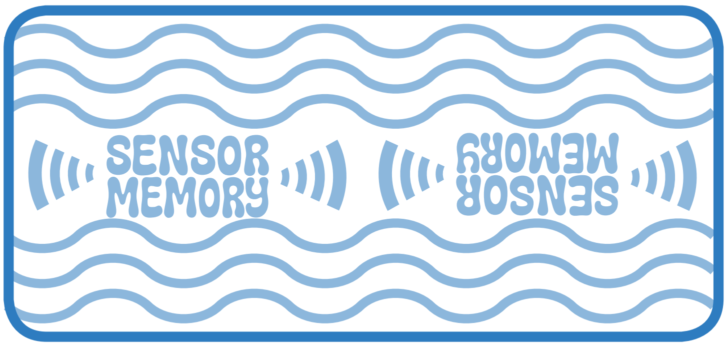
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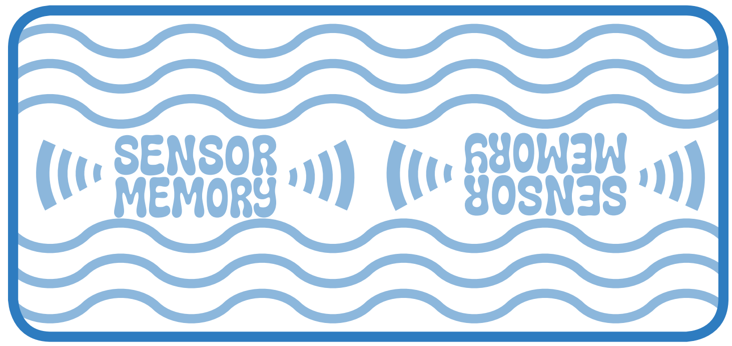
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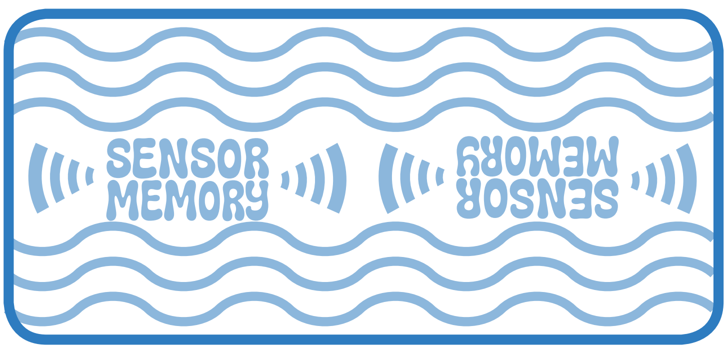
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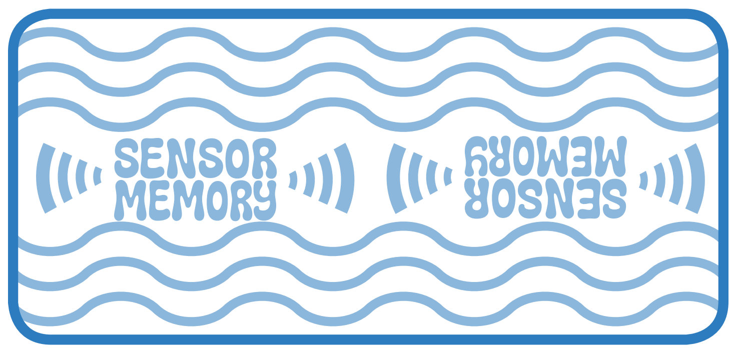
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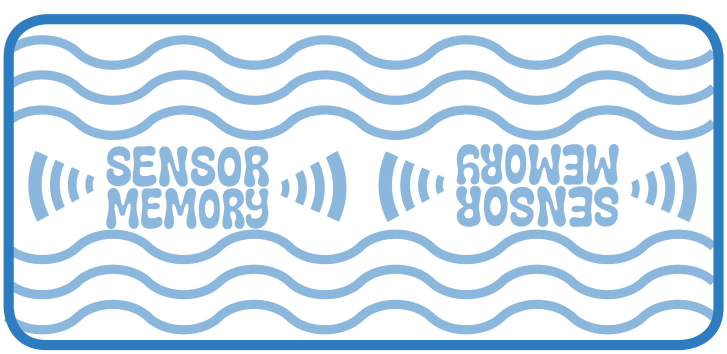
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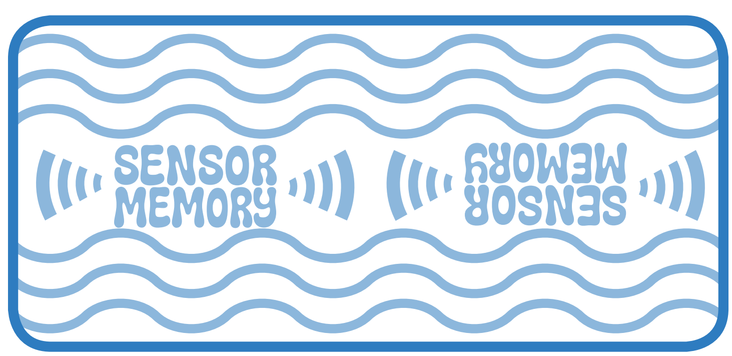
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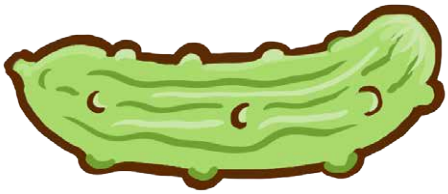
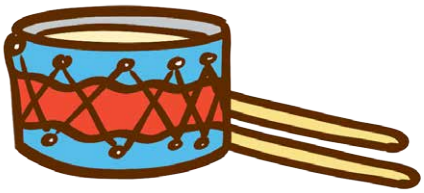
Tongue



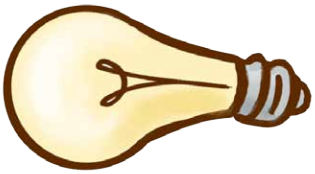
Pickle

Ear



Drum

Eye

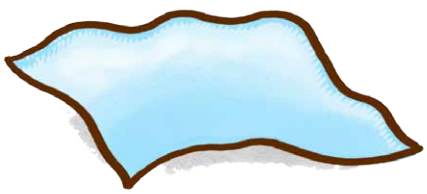


Light bulb

Nose

Garbage

Hand



Blanket

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SENSING FOR SCIENCE

Activity 4
Sensing the Light

Sensing the Light Instructor Overview

The goal of this activity is for students to explore various types of light sensors. Note that students may be confused by how the light is detected. Some light sensors look for "brightness" of light, and others sense "color" of light. This is an important difference, and we are going to ask students to explore that within the activity. Both the UV beads and the UV paper will turn color when exposed to ultraviolet light provided by the sun, or by a black light. There might be a small amount of color change in a classroom with windows provided by the ambient lighting, but it will be more obvious under direct sunlight or black lights.

Procedure – STEPS, EACH WITH TIME ALLOTMENT

1. Introduce the day's activity as **Sensing the Light.**
   Note: For grades K-1, modify this activity to be *discussion only.* Lead the students through the steps and invite them to observe how the sensors change, then use the worksheet to guide a class discussion.

a. If possible, take the students outside and have them find spots of shade and brightness. Ask them to find the "brightest" and "darkest" spots. Remind them which **sensor** and **signals** they are using in these cases (eyes and light) and then bring the students back to the classroom. *Note that this activity can be done indoors, particularly if you can turn off some but not all lights.* **(5 min)**

2. Explain that there are two ways to sense light signals. In one, you are looking for the *amount* of light and another when you are looking for the *color* of light.
   a. Encourage the students to come up with which sensor detection system was being used when they found the "brightest" spot (looking for the amount of light with eyes as sensor). **(5 min)**

3. Explain that light that we see from the sun is a form of energy and actually contains lots of different colors (wavelengths is the appropriate scientific term). Some of the energy it contains can be harmful because it sends high energy into our bodies, which we call a sunburn. This is called UV (ultraviolet) energy, or UV light. **(5 minutes).**
   Note: the UV light in the flashlight is not harmful in small doses, but could be an issue if there were long exposure to UV light.
   a. Show students the UV flashlight and ask if they have ever seen something like this. (They may have seen UV lights in reptile cages, nail salons, or use as a black light.)

4. Provide students with a UV paper and ask them to walk to the "brightest" spot with it. (Consider sending some groups to the darkest spot, so you can get a range.)
   a. Write the values that the students see on the UV paper for each spot on a whiteboard or chart paper **(5-10 min)**

(Procedure continues on next page)

Materials Needed

- UV (ultraviolet) flashlight (sometimes called "black light")
- UV beads (NOTE: Be sure to keep some UV beads for later activities)
- UV paper
- Sunscreen
- Sheet protectors (2 per group)
- String or pipe cleaners (Cut 1 string or provide 1 pipe cleaner per student.)
- Whiteboard or chart paper
- Pencils for students to fill out handout
- Colored pencils or crayons

Educator Preparation

- **Grades K-1:** Print an Activity Sheet for your own reference. You will probably want to prepare the sheet protectors and thread the UV beads on strings/pipe cleaners ahead of time.
- **Grades 2-up:** Print out Activity Sheet 4 (one per student)
- Determine whether you will take the students outside to detect UV from sunlight or through a window.
- Decide whether you will prepare sheet protectors with sunscreen ahead of time or allow students to complete this step:
  – Smear a thick patch of sunscreen on or inside sheet protector. (You don't need to coat the whole sheet.)
  – One layer of sunscreen should block the light; if you find it isn't, try adding more.
  – *Sunscreen may need to be fully dry before it blocks the light.*
  –Test at least one sunscreen-coated sheet protector beforehand to determine that when it is covering a UV bead and the UV light is on, the bead does NOT glow.

Activity 4
Sensing the Light
(continued)

Procedure continued

5. Then use the direct UV flashlight on a UV paper for comparison
   a. Ask students to determine where they found the most UV light in the places that they sampled (should be the flashlight) **(5 min)**
6. Next, provide students with a UV bead or beads and ask them to place it on a string or pipe cleaner.
   a. Ask the students to go outside and see what happens (or turn off the lights in the room and use the UV flashlight near each student's bead). The bead should begin to change color and "glow".
   b. **Grades 2-up:** Ask students to return to their places and describe what happened with the UV bead, based on what they observed. **Grades K-1:** lead a group discussion instead. **(5-10 min)**
7. Provide the sheet protectors with and without sunscreen. Turn the lights off and ask the students to place the beads under the sheet protector without sunscreen. Next, walk around with the flashlight to show that the bead glows. Repeat this with the sunscreen-covered sheet protector and the students should see that it does not glow.
   a. Ask students to describe what they think is happening.
   b. Ask students when the UV bead might be useful and when the UV paper might be useful (answers could include things like putting the beads on a bracelet and covering it with sunscreen to know when to re-apply sunscreen based on when the bead starts changing colors. UV paper is often used with pet reptiles, so this might also be discussed.)

Wrap up / Closure / Cleanup

The UV paper and UV beads are both re-usable, so do not throw them away. The paper typically lasts about 20 trials, so you may want to tell students not to overuse the paper.

See video explanation

NAME: _____

DATE: _____

SENSING FOR SCIENCE
Activity 4

SENSING LIGHT

Directions:

1. Describe where you found the "brightest" and "darkest" spots.

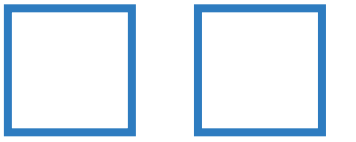
_____

_____

_____

_____

2. Color in the boxes to show what happened to the **UV paper** in the "bright" and "dark" spots. (It's OK if you don't have the exact colors.)



UV paper in bright spot | UV paper in dark spot

3. Finish the sentences to describe what happened to the **UV bead** in the "bright" and "dark" spots.

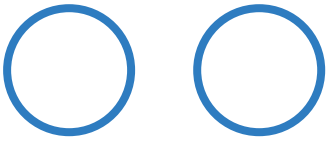
In the **bright** spot the UV bead... _____

_____

In the **dark** spot the UV bead... _____

_____

4. Color in the circles to show what happened to the **UV bead** in the "bright" and "dark" spots



UV bead in bright spot | UV bead in dark spot

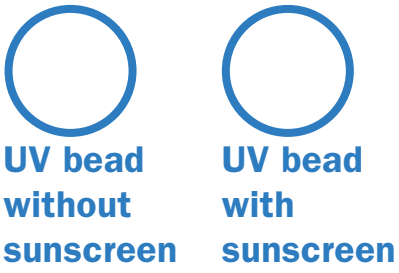
5. Describe what happened to the UV bead **without sunscreen** on the sheet protector.

_____

What happened to the UV bead **with sunscreen** on the sheet protector?

_____

6. Color in the circles to show what happened to the **UV bead** with and without sunscreen.



7. Draw and describe your idea for when the UV bead and the UV paper might be useful.

_____

_____

_____

SENSING FOR SCIENCE

Activity 5
Sensing Heat
(Grades 2-up)

Sensing Heat
Instructor Overview

The goal of this exploratory activity is to engage students in understanding how different sensors are used to explore heat. You will use two types of thermometers – a traditional liquid theremometer and an infrared theremometer with a laser beam.

Grades K-1: ***Modify this activity by demonstrating the sensors yourself.***

- On the infrared thermometer, show the numbers on the readout. Demonstrate how the change in temperature corresponds to the change in number. Compare numbers. (Which is bigger?)
- Invite students to observe the line on the alcohol thermometer and ask them what they think the change in line size indicates.

Grades 2-up: Students will begin to create a drawing about their learning regarding how sensors work. The goal at the end of the activity is that their drawing will include some natural phenomenon related to heat (campfire, sunlight, cooking, etc) and words like "sensor," "signal," "heat," "temperature" and "energy." To clarify the terms "heat" and "temperature" it is best to say that heat "flows" from items that we call "hot" to items that we call "cold."

NOTE: Technically, the terms *hot* and *cold* are not scientific measures of temperature; they measure human experience, but you don't need to go into that level of detail. We use them in the student worksheet to simplify. If you prefer, you can say "high temperature" and "low temperature."

The provided thermometers are an infrared thermometer and an alcohol-based thermometer. The infrared thermometer can be used to measure higher temperatures, but it should be noted that although it has a laser pointer for guidance, the actual sampling area for the infrared is larger. The alcohol-based thermometers can be used in warm water, *but* ***not*** *hot water,* as they contain plastic that can melt.

Procedure – STEPS, EACH WITH TIME ALLOTMENT

1. Hand out worksheets. Explain to students that they will be taking measurements with sensors and then noting what they think is happening. **(5 min)**
2. **INSTRUCT STUDENTS ON SAFETY TODAY.**
   Issues to discuss: (5 min)
   - **Hot/cold water can hurt the skin**
   - **Lasers in the infrared thermometer should NEVER be pointed at the face**
   - **The alcohol thermometers can break**
3. Hand out both thermometers **(5 min., Review safety issues in Step 2)**

(Procedure continues on next page)

Materials Needed

- **(Grades 2-up)** Student Sensing Heat worksheet – one per student
- Pencils for students to fill out worksheet
- Whiteboard to capture student responses
- Guiding questions (either printed or written)
- Ice and/or hot water (must be different than room temperature water)
- Room temperature water
- Heat sensor 1: Standard liquid thermometer
- Heat sensor 2: Infrared thermometer
- Access to outdoor environment with shade and sunny areas (if this is not possible, the activity can be completed entirely indoors with different temperatures of water)

Educator Preparation

- **(Grades 2-up)** Print out appropriate number of worksheets.
- **(Grades 2-up)** Consider whether to enable students to explore outside with the thermometer and infrared thermometer. Note that the activity can be done entirely indoors, but in step 7 students will be asked to walk around and locate the place where they can find the hottest spot (or coldest spot) and this might work best indoors if there is an AC or heater. Otherwise, an open door/window might allow students to measure temperature differences.
- Consider having a "word wall" with key terms like "sensor" "signal" "temperature" and "heat"

Procedure continued

4. Hand out different water samples **(NOTE: Be sure that the hot water is not unsafe)** and ask students to record the measurement of the temperature of each type of water. Ask them to write this on their sheet. **(10 minutes).**
5. *Optional* Ask students to determine which sensor was better (you can say safer or more accurate) to use when measuring water. The more accurate sensor is the one that safely (without melting/breaking) provides a consistent temperature that is reasonable (you can test with an additional thermometer if you'd like, but typically they will both be accurate for most cases, but the IR thermometer is taking a temperature of a wider range of area so it is more likely to have fluctuations and may end up being both less accurate and less consistent). **(2 min)**
6. Explain that the alcohol thermometer works better to measure the water in the cup because the infrared thermometer measures a bigger area than just the water in the cup. When we want to measure bigger areas, like outdoors, we could use the infrared thermometer. **NOTE:** *Scientifically, these two devices also measure temperature in a different process, but this is beyond the grade level understanding so we are simplifying.*
7. Challenge students to use the infrared thermometer to find the highest temperature (and lowest) outside. Have the students draw each spot on their worksheet and ask them to describe their findings using some of the terms "sensor" "signal" "temperature" and "heat." **NOTE:** This step requires access to outdoor area with shade and sunny regions to explore. Students could also explore a classroom with differing temperature areas (an open window or door might allow for hot/cold air in. **(10 min)**

Wrap up / Closure / Cleanup

1. Ask students to draw how they think temperature sensors (thermometers) work in the final box **(5 min)**.
   Encourage them to think about how to represent how heat travels to the sensors (they may use lines, squiggles, etc).
2. Explain to them that the sensor is the thermometer and that it is measuring a signal given off by each material. Technically the infrared thermometer is measuring heat given off by an object.

See video explanation

NAME: _____

DATE: _____

SENSING FOR SCIENCE Activity 5

SENSING HEAT

1. Measure the temperature of each water sample using both thermometers, Write the temperature from each sensor in the boxes.

Warm water	Cold water	Room temperature
_____ ° F Liquid thermometer	_____ ° F Liquid thermometer	_____ ° F Liquid thermometer
_____ ° F Infrared thermometer	_____ ° F Infrared thermometer	_____ ° F Infrared thermometer

2. Find nearby places that you think have the **highest** (hottest) and **lowest** (coldest) temperatures. Measure them each with the **infrared** thermometer.

Draw the places you observed, and show the infrared thermometer sensing the temperature. Write the temperature from the **infrared** thermometer.

Highest temperature

_____ ° F

Lowest temperature

_____ ° F

Use words like “sensor” “signal” “temperature” and “heat" to tell how you think the sensor works.

_____

_____

_____

SENSING FOR SCIENCE

Activity 6
Sensor Playground
Grades 2-up

Sensor Playground (Grades 2-up) Instructor Overview

The purpose of this exploratory sensor playground is to empower students to explore how various tools/devices have sensors built in them. Some of the provided materials (like the heat sensor) might be used in a scientific context or at home, while others might be used purely in one setting. Feel free to encourage students to think about what is being sensed and where it might be used! The goal in the exploration is to have them practice "noticing" and "wondering."

NOTE: ***For grades K-1, you can modify this activity by removing sensors that pose any safety concerns (e.g. lasers)*** *and set up sensor play stations. Allow groups to take turns observing how the sensor toys behave, then show each sensor as you use the worksheet to guide a class discussion.*

Procedure – STEPS, EACH WITH TIME ALLOTMENT

1. Explain that the goal for the day is to **play SAFELY** with multiple sensors to understand how they work and how scientists at home and in labs use them. Be sure to go over any appropriate safety rules (for example, "we don't ever point lasers at anyone"). **(5-10 min)**
   a. Describe that at the beginning of each exploration, before they have touched the sensor they should do a first-look "notice" and "wonder"
   b. **(Grades 2-up)** Ask them to fill out the boxes to predict what the sensor does.
2. **Sensor playground:** Have the students explore at least 2-3 sensors and provide 5-10 minutes for each exploration. **(30 min)**
   a. During the exploration, walk around and support the noticing and wondering. (For pre-readers, discuss the questions one at a time.)
   b. Consider asking the following to advanced students:
   Can you think of how this particular item could be useful – not just as a toy, but as something to keep people or pets safe?

   Can you think of something you could invent with this same kind of sensor that could help solve a problem and help people?

   Can you think of other machines or toys that work in the same way?

Wrap up / Closure / Cleanup

1. Encourage students to put away materials/assist with any sensor clean up that is required.
2. Ask students to consider whether the sensors and signals were similar to what they learned about in terms of how our bodies sense signals.

Materials Needed

- **Grades 2-up:** Sensor Playground box (a collection of multiple sensors such as a motion-sensitive chirping bird; a toy duck that turns white in hot water; a light that turns on at dark; etc.)
- **Grades K-1 modification:** Sensor Playground box ***with safety-concern items removed.***
- **Grades 2-up:** One copy of student worksheet per group. *(No worksheets are needed for grades K-1, but print one for your own reference.)*
- Pencils for students to fill out worksheet

Educator Preparation

- **Grades 2-up:** Print out student worksheets.
- Lay out all sensors so that they are visible to students. ***(Remove safety-concern items for grades K-1.)***
  – Consider whether you would like to group the sensors together by functionality or just present them randomly.

See video explanation

NAME: _____

DATE: _____

SENSING FOR SCIENCE
Activity 6

SENSOR PLAYGROUND

Today your goal is to explore a few different sensors.

Now you get to touch and explore the sensor. Use what you learned to fill out this table.

Sensor 1

I notice that...	I wonder...

Before you even touch the item:

What do you think it does? _____

Why do you think this? _____

What is the sensor?	What signal can it sense?	Which of your body's senses can do this?

Sensor 2

I notice that...	I wonder...

Before you even touch the item:

What do you think it does? _____

Why do you think this? _____

Now you get to touch and explore the sensor. Use what you learned to fill out this table.

What is the sensor?	What signal can it sense?	Which of your body's senses can do this?

SENSOR PLAYGROUND

SENSING FOR SCIENCE
Activity 6

Now you get to touch and explore the sensor. Use what you learned to fill out this table.

Sensor 3

I notice that…	I wonder…

Before you even touch the item:

What do you think it does? _____

Why do you think this? _____

What is the sensor?	What signal can it sense?	Which of your body's senses can do this?

SENSING FOR SCIENCE

Activity 7
Sensor Inquiry
Grades 2-up

Sensor Inquiry Instructor Overview

The goal of this activity is for the students to determine the appropriate sensors and design a research experiment to address a problem posed by the instructor (note there are multiple problems to choose from, and you could offer all options to students). It might be good to remind students of the activities they have done so far and the sensors they used--maybe hold each sensor up and as a group say what the sensor and signal was to prompt students. The first option below is likely to be a bit easier for students because they have done a full activity related to sunscreen, and there are multiple sensors that could be used (UV card or UV beads).

Option 1: How to sense whether spray sunscreen is as effective as lotion (requires instructor to supply additional spray sunscreen)

Option 2: How to sense whether an animal is trying to open a box/ trashcan (requires use of motion detector)

Option 3: How to sense the best place to keep a water bottle cool all day on the playground

Procedure – STEPS, EACH WITH TIME ALLOTMENT

1. Introduce the problem that you have chosen from the options above. **(5-10 min)**
2. Ask students to describe the problem to each other and start to draw it as a group **(5-10 min)**.
   For example, students in the sunscreen group might draw what would happen if you didn't have sunscreen on, or if the sunscreen wasn't working.
   a. Note: this is a chance for students to think as an engineer and engage in defining the problem in their own words. You may need to prompt them with guiding questions. It is also helpful to tell them how engineers define problems and design solutions to address human needs and wants using a systematic approach.
   b. During this step, prompt the students to include a sensor in their drawing. (For the sunscreen activity, this should be a light sensor, as we are trying to sense light.)
3. Have students determine which sensor they should use for this problem. Encourage them to report out which sensor they wrote in their drawing. **(5-10 min)**

(Procedure continues on next page)

Materials Needed

- Sensor Playground Box (a collection of multiple sensors such as a motion-sensitive chirping bird; a toy duck that turns white in hot water; a light that turns on at dark; etc.)
- One copy of student worksheet per group
- Pencils for students to fill out worksheet

Educator Preparation

- Print out student worksheets
- Lay out all sensors so that they are visible to students.
  —Consider whether you would like to group the sensors together by functionality or just present them randomly

Procedure continued

4. Explain to students that you are going to engage in an inquiry now that uses data from the sensor to address the identified problem. To do that the students must design an experiment as scientists. **(5 min)**
   a. In science, we can only change one thing at a time, so guide the students to design a simple experiment that either varies the level of one variable (could be as simple as being present/absent) and measures another variable. For instance, if you want to explore whether spray sunscreen or lotion-based sunscreen are more effective you would want to change the variable of "sunscreen type" and keep the variable "amount of sunscreen" as constant as possible.
   b. In this situation we have prompted the students to determine what might be called the "dependent variable" first, but this term is likely not appropriate at this developmental stage/grade level so feel free to suggest that it is what we measure as scientists to know our experiment is working/successful.
   c. You might need to scaffold this as a yes/no project. For instance, does higher SPF level sunscreen let less UV light through or does spray sunscreen let the same amount of light through as lotion sunscreen? A yes/no question is appropriate at this age level, but we might ask more open-ended questions for later grades.
5. Enable the students to engage in the research project **(10-20 minutes)**
   a. Encourage them to track their data publicly on a whiteboard/chart paper.
6. Come back together and determine the answer based on the data collected. **(5 min)**
7. Ask students to return to their student worksheet and re-draw their thoughts, encourage them to name the sensor they used in the experiment if it wasn't there before.

Wrap up / Closure / Cleanup

Congratulations! You have successfully designed and conducted an experiment using sensors! You are ready to go find sensors in the world around you, and try to figure out how they work!

NAME: _____

DATE: _____

SENSING FOR SCIENCE
Activity 7

SENSOR INQUIRY

Today you will use sensors to solve a problem or answer a question.

1. Draw and describe the problem or question you chose. In your drawing, include the **sensor** you will use.

My problem or question is: _____

_____

2. Next, determine what you need to measure to know you have the answer to the problem.

I will measure: _____

I will have solved the problem if: _____

I will also try to change: _____

MY EXPERIMENTAL RESULTS:

What I did:	What happened:
What I did:	What happened:
What I did:	What happened:

MY CONCLUSIONS

My problem or question was: _____

_____

_____

_____

_____

_____

My solution/answer is: _____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____