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BASIS Lesson Plan

Lesson Name: Heavy Metals: Exploring the Properties of Metals

Grade Level Connections:

Next Generation Science Standards: Grade 5, Physical Science (5-PS1)
FOSS Next Generation Edition: Grade 5, Physical Science (Mixtures & Solutions)

**Note to teachers: Detailed standards connections can be found at the end of this lesson plan.*

Teaser/Overview

Metal as a category of music is characterized by intense drum beats and guitar riffs. But what are the properties that characterize metals in the periodic table of the elements? In this hands-on lesson, students will learn about three unique properties of metals: high density, electrical conductivity, and heat conductivity. Through observations and experiments at three hands-on and interactive stations, students will make hypotheses and experiment to understand these properties and how these properties affect the materials of objects that we use in our day-to-day lives.

Lesson Objectives

- Students will understand that materials have different properties and that these properties can help us to understand those materials and how to use them in our every day lives
- Students will test several different materials to figure out which ones are able to conduct electricity the most effectively
- Students will observe the rate of ice melting on two different surfaces and relate this back to heat conductivity
- Students will test the weights of different blocks to start building an understanding of density.

Vocabulary Words

- **Metals:** One of the major categories of the periodic table of the elements. They are characterized by the ability to conduct electricity, the ability to conduct heat, and their high density.

- **Properties:** Observable characteristics that help us understand things.
- **Conductor:** Any item or material that provides a path or energy (heat or electricity) to flow.
- **Density:** How heavy something is in relation to how much space it takes up (technically, the mass of an object divided by its volume).
- **Hypothesis:** A guess based on current understanding and on previous observations; your hypothesis can either be rejected or supported.

Materials

Volunteers will bring:

Ziploc bags (16) filled with:
Penny (1), feather (1), Play-doh (1 small piece), glass marble (1)
Periodic Table

Density Station
Bag of feathers (10 grams)
Bag of pennies (10 grams)
Density blocks
Beaker filled with water
Thermal Conductivity Station
Frying pan (or picture of frying pan)
Ice (at least 12 equally sized pieces)
Hand warmers (optional)
Melting blocks (set of 2)
Electrical Conductivity Station
9V Battery
Alligator clips
LED light bulbs
Small piece of metal, glass, plastic, rubber

Teachers should provide:

Students should have paper and pencils ready.

Classroom Set-Up

We will start the lesson with an introduction while the students are seated at their desks. Students should then be divided into three groups. Each group will have about 10 minutes at each of three activity stations to explore a specific property of metals. At the end of the lesson, students should go back to their desks for a wrap-up discussion. Nametags for calling on students are always helpful. We will need white board space, markers, and access to a sink for cleanup.

Classroom Visit

1. Introduction (12 minutes)

Role Model Introduction:
Being a role model for students is an important part of being a BASIS volunteer. Begin your lesson by introducing yourselves! Every team member should take a moment to explain who they are and what they study/do as a scientist. A bonus will be to tell your "story," as if giving an elevator pitch to 10-year-olds: Why did you become a scientist? What made you interested in your topic? Why should students relate to you, or be interested in you? And remember, you can also weave your story throughout your lesson through examples from your own life, and/or return to it with Q&A at the end.

Topic Introduction:
After you introduce yourselves as role models, take some time to introduce the topic of this lesson: *metals and their properties*. It may be helpful to keep the suggested take-away in the back of your mind throughout the lesson: **Materials, such as metals, have unique properties that we can observe. Those properties can help us to make future predictions about how those materials will behave.**

Your topic introduction should follow the outline below. As much as possible, try to frame this information as questions posed to the class, rather than as a lecture. This helps activate students' prior knowledge and facilitate student-guided conversation.

- Distribute bags of materials to each table group of students. Ask students to brainstorm within their table groups so that they can provide five **properties** [define, write on board] for each material.
- Circulate amongst groups of students, asking about their ideas for each object.
- After a few minutes, gather student ideas on the board.
- You've all just explored and discussed how different materials have different properties.

- All the materials in the world are made of just a little over 100 elements. You can think about this like an alphabet. All the words that we use are made from just 26 letters.
- Show students periodic table. We use this periodic table to organize those elements into categories based on their properties.
- And those properties affect how we use materials in our everyday lives. For example, if you were going to build a skyscraper, what material would you use out of the four you were given a moment ago? Why?
- Today we are going to talk about **metals**!
- We already have the start of a list for **properties** of **metals** [refer to list generated for the penny]
- Now we're going to do some science activities to help us understand even more properties of metals and how those properties can help us to make future predictions about materials!

Teaching Tip: Say, Write, Show

- Bring in photos and props to illustrate the topic intro
- Write new vocabulary words, key terms, and brainstorm lists on the board
- Refer back to the board to engage visual learners and English Language Learners

2. Learning Experience (33 minutes)

Divide students into three groups. Each group will start at one of three stations set up around the room, and rotate every 10 minutes. At each station, a BASIS volunteer will lead an activity to explore metals and their properties. An additional BASIS volunteer will keep time and offer support to the other stations as needed. Remember that all three of these stations are designed to address the take-away in a particular way: **Materials, such as metals, have unique properties that we can observe. Those properties can help us to make future predictions about how those materials will behave.**

Classroom Management Tips: Station Rotation

- Keep students from getting too restless by moving them through stations
- It helps to keep things orderly. When it's time to rotate, have the leader announce that all students should stand up in place and NOT MOVE until you say so; point out where each group will move to; confirm that everyone understands; THEN instruct students to move to the next station.
- Have a volunteer keep time and tell station leaders to wrap up at 9 minutes.
- Ask the teacher if you need help!
- Remember that students might visit your station first, second, or third: don't assume prior knowledge from another station!

Station 1: Electrical Conductivity of Metals

1. Engage students in a conversation about circuits and electricity
    a. Ask students what they already know about electricity. Do you know what a circuit is? A circuit is a path through which electrical current flows.
    b. Show students a simple circuit using a 9V battery, alligator clips, and a small lightbulb. Discuss the flow of electricity and the different parts of the circuit.
    c. Prompt students with some guiding questions: "What materials are inside the alligator clips?" "What materials are wires generally made of?"
2. Do the Electrical Conductivity Activity
    a. Pass around the different materials that you will be testing in the circuit. Describe these materials and talk about their visual properties (size, shape, color, etc).
    b. "What are differences between these materials?" "What do you think they're made of?"
    c. In a moment, we're going to place each of these materials in our circuit. "What do you think will happen?" Let's make a **hypothesis** about which material we think will be able to conduct electricity the best and which will not be able to. Define **hypothesis** if needed.
    d. Once students have formulated their individual hypotheses, then have students place one material in the circuit at a time. Watch what happens. What do students observe? What is happening to the light? Why is this happening?
    e. Do our observations support or reject your hypothesis? Why or why not?
3. Connect the activity to the big picture
    a. Invite students to reflect on the difference between the different materials that were tested within the circuit – one is metal and the others are not. The lightbulb is brightest with the metal because metals have high electrical conductivity. This just means that electricity is able to travel very easily within metals.
    b. Emphasize the overall takeaway of the station: Metals have high electrical conductivity compared to other elements.
    c. Emphasize the overall takeaway of the lesson: **Materials, such as metals, have unique properties that we can observe. Those properties can help us to make future predictions about how those materials should behave.**

Station 2: Thermal Conductivity of Metals

1. Engage students in a conversation about the differences between solid materials
    d. Show students a metal pot (or picture of one).
    e. Prompt students with some guiding questions: "If this was on the stove, would you touch the handle? Why or why not?" "What would you need in order to touch the handle?" "Why does that work?" "Why don't you burn your hand?"
2. Do the Thermal Conductivity Activity
    a. Have students look at the Melting Blocks and describe their size, shape, color.

   b. Pass the Melting Blocks around so that students can feel and tough them. “What is the main difference between the two?” “What do you think they’re made of?”
   c. In a moment, we’re going to place one piece of ice on each of these blocks. What do you think will happen? Let’s make a **hypothesis** about which block will melt the ice the fastest. Define **hypothesis** if needed.
   d. Once students have formulated a group hypothesis, then have two students help by placing one piece of ice on each block. Watch what happens. What do students observe? What is happening here?
   e. Do our observations support or reject our hypothesis? Why or why not? How do your observations here relate to the metal pot that we discussed at the beginning of this station?
   f. ***Maybe add hand warmers onto the plates to see what happens!***
3. Connect the activity to the big picture
   a. Invite students to reflect on the difference between the two melting blocks – one is metal and one is not. The metal block melts the ice so much more quickly because metals have high thermal conductivity. This just means that heat is able to travel very easily within metals.
   b. Emphasize the overall takeaway of the station: Metals have high thermal conductivity compared to other elements.
   c. Emphasize the overall takeaway of the lesson: **Materials, such as metals, have unique properties that we can observe. Those properties can help us to make future predictions about how those materials should behave.**

Station 3: Density of Metals

1. Engage students in a conversation about the difference between the weight* and space of objects (*technically you are talking about the mass of an object and not the weight, which is dependent on gravity, but the concept is simplified here)
   a. Begin by asking students a trick question (feel free to tell them it’s a trick!): “Which is heavier, ten grams of pennies or ten grams of feathers?” [They both weigh the same, but students might get tricked because they might be thinking about the density of pennies]
   b. Guide students to think about how ten grams of pennies and ten grams of feathers are equally heavy.
   c. Pass around a large bag of feathers and a small bag of pennies (pre-measured so that they weigh the same).
   d. Prompt students with some guiding questions: “Which of these two bags is heavier?” “But what is the difference between them?” [The bag of feathers is a lot bigger!] We call this **density**. We say that pennies have a greater density than feathers because they weigh a lot, but take up a small amount of space.
2. Do the Density Block Activity

a. Show students the beaker of water. Do you think that water has a density? [Yes! It weighs something and takes up space]. Everything has density, even the air around us. Invite students to feel how heavy the beaker of water in in front of them.
b. Instruct students that in a moment, they will be making a **hypothesis** about which mystery block has the higher **density**. Define **hypothesis** if needed.
c. For the first round, pass around two blocks so that students can feel the weight difference between them.
d. After students have made their hypothesis, place into water and see what happens. Watch what happens. What do students observe? What is happening here?
e. Do our observations support or reject our hypothesis? Why or why not? How do your observations here relate to the feathers and pennies that we discussed at the beginning of this station?
d. Repeat the activity with different sets of blocks. See if students can make a hypothesis about which will sink or float without even feeling their weight [guide them to ideas from the beginning of the lesson – metals are shiny/lustrous and we just saw that metals tend to have high density and sink, so based on those observations…]

3. Connect the activity to the big picture
    a. Invite students to reflect on the difference between all the density blocks that they observed during the activity. Some of them are metals and others are not. The metal blocks sink in the water because metals have high density. This just means that metals weight a lot in a small amount of space.
    b. Emphasize the overall takeaway of the station: Metals have high density compared o other elements.
    c. Emphasize the overall takeaway of the lesson: **Materials, such as metals, have unique properties that we can observe. Those properties can help us to make future predictions about how those materials should behave.**

3. Wrap Up: Review and Discuss the Learning Experience (5 minutes)

Have students return to their original seats at their desks for a wrap-up discussion.

- What is a **metal** and what are some of the **properties** of metals? Review of vocabulary words.
- What did we learn at station 1, 2, & 3?

4. Connections & Close (5 minutes)

Connections to the real world around students:

- What are some of the metals that you use every day? Why do you think metals are used? What properties of metals are useful to have for these particular objects? (Example: Frying pans are made of metal so that it can quickly transfer heat from the burner to the food that you're cooking.)

- If we were to dig into the ground and find a mystery material, what tests could we perform to figure out if it's a metal or not?

If possible, tie lesson back into your research or role model story.

Close:

- Reiterate for students that science helps us learn about the properties of materials, such as metals, and how that can help us in our everyday lives.
- Ask students if they have any questions about science or being a scientist
- Close with a good bye and a thank you, and encourage the students to keep thinking about the metals they see around them every day and how they are used!
- Don't forget to help clean up!

Follow Up: After the Presentation

Teachers who wish to extend the impact of this lesson may find the following CRS web pages useful:

- http://www.crscience.org/educators/helpfulreports
- http://www.crscience.org/educators/treasuretrove

Standards Connections

NGSS:

- Connections by topic
  Physical Science: 5. Structure and Properties of Matter
- Connections by disciplinary core ideas
  Physical Science: 5-PS1. Matter and Its Interactions
- Connections by scientific & engineering practices
  1. Asking questions
  6. Constructing explanations and designing solutions
- Connections by crosscutting concepts
  1. Patterns.
  5. Energy and matter: Flows, cycles, and conservation
- Connections by performance expectation
  5-PS1-3. Make observations and measurements to identify materials based on their properties

FOSS Next Generation Edition: Grade 5 Physical Science: Mixtures and Solutions Module