

Test Your Metal



The properties of a material make them just right for some purposes. In this activity students explore some properties of metals and the challenges of recycling materials that are made from more than one material.



GRADES
K-4



PREPARE:

Required Time: 2 class periods (90 minutes) without extensions

- Gather supplies (see activity pages).
- For the 3-4 metal objects per group, examples might be paper clips, eating utensil(s), key chain(s), notebook ring(s).
- For the 3-4 non-metal objects per group, try to get samples that represent other recyclable materials like plastic, rubber, paper, etc. Objects might include: a piece of fabric, paper, wood (a clothes pin), a rubber toy or stopper, a plastic toy, plastic frosting/decorator nozzle, and a plastic clip from a bread-bag.
- For the 3-4 mixed objects per group, choose items or pictures of items that have metal and non-metal components, like a dollar bill, a real rubber tire, a toy that has parts made from a variety of materials like a wind-up toy or match box car.
- Have a CD available to show as a material that has one property of metals but not others.
- Collection of coins ready to display.



MOTIVATE:

- Show students an image of [The Forevertron](#). Ask them what they see and what they think it is made from. The Forevertron was built in the 1980s by an artist named Tom Every, and is the largest recycled metal sculpture in the world!
- When we think about recycling, we usually think about paper, but the United States recycles nearly 300 billion lbs. of scrap material every year. That's the weight of more than 85 million cars! Optional: Share some more fun recycling facts about metals from ISRI's "[Kids Recycling Facts](#)".
- Ask students how we can tell that the Forevertron is made from metal by looking at the picture – are there certain characteristics or traits?
- Explain that students are going to investigate different materials today and pay special attention to metals and their properties or traits.



TEACH

- Divide students into teams of 3-4 and lay out the full collection of items on the table for each team.
- Have students conduct activity (see activity pages).
- You may need to include a discussion of what "classify" means if this is an introduction to this word. During Part 1, suggest students make at least 3 different groupings or piles and that the objects in each pile must share some common characteristics or properties. Circulate around the room offering guidance where needed. A variety of groupings are possible. This should be as open-ended as possible.

- Discuss what characteristic properties are (those that distinguish an item from other items; properties that can be used to identify an object). Discuss examples. Share with students that today they are going to be discussing metals, and their characteristic properties.
- Show students the pile of coins at the start of Part 2. Ask students what they are made of (metal).
- Challenge students to list some characteristics they believe are properties of all metals on an index card. What makes a metal a metal? Discuss some categories like color – does color always help identify an object? Are all metals gray in color, for example?
- Introduce the categories of luster (shininess), tensile strength (metals are strong and can carry large loads before breaking), malleability (metals can be pounded or bent into shapes, often through heating), and density (if appropriate to the student group).
- Discuss that metals also conduct electricity whereas objects like plastic or rubber do not (optional: use a diode, batteries, and wires to demonstrate this).
- Some metals are also magnetic – but not all. Demonstrate with a magnet. These are called “ferrous” metals, from the Latin name for iron, the metal that is most strongly magnetic. Review the attraction of a magnet to something steel in your classroom. Ferrous metals also have a tendency to rust (cobalt and nickel are the other magnetic elements).
- Ask students to consider where metals come from (mines). If your school is near a mining area, help students relate to its location.
- Discuss that the earliest uses of metal were for weapons and cooking implements. They were hard and strong. When heated, their shape could be changed. Their use was so important and changed human life so much that we define eras of human existence by the metals they used, the “Bronze Age” and the “Iron Age.”
- Today, materials engineers can make some synthetic products with some of the properties of metals. Students may discuss a CD, which has a metallic luster but no metal content. It may be shiny (lustrous) like a metal, but it is light (not dense) and brittle (not malleable). U.S. paper currency and automobile tires are some of the materials that are strengthened with metal.
- For older students, it may also be appropriate to explain to students that many metals are mixed. These alloys have special properties. Heating and cooling metals in special ways can also change their properties. For example, forging iron can make it stronger, less brittle and more resistant to corrosion. This is described in the passage about King Arthur. More exploration of alloys can be found in the ISRI lesson Smash Science.
- Have students identify and collect other items made from metals in the classroom or school. Once back in class, the results of this “scavenger hunt” can be compiled on a board or chart.
- As students discuss other purposes for metals, show some [images of products](#) and/or artwork made from recycled metals.



REFLECT/ASSESS

Students should be able to:

1. List 3-4 characteristics of metal (shiny, strong, shapeable or malleable, heavy/dense).
2. Explain why metal might be used to make certain objects (Metals are often hidden in other products like tires or US currency to make them stronger; to make objects look shiny like in jewelry or sculptures; objects that need to have specific shapes and need to be bendable like a paperclip).



EXTEND

For older or more advanced students:

1. Have students create a table that lists the 3-4 characteristics of metal and how those traits might be used to help in the separation process. Any series of steps that incorporates the properties of rubber and steel can be recognized (breaking down into smaller pieces/grinding; sorting metals from materials like rubber or plastic by their heaviness/density; sorting ferrous from non-ferrous metals by their magnetic properties).

2. Have students read the passage “The Legend of King Arthur” and answer the questions. Use the Internet to find out what kinds of metals were used for weapons in those days and how they were made.



JOURNAL QUESTION

Have students list some things people could do with old items that contain metal instead of throwing them away in the trash.



WEBLINKS

The Forevertron

https://en.wikipedia.org/wiki/Forevertron#/media/File:Forevertron_Panoramic_2.jpg

ISRI's Kids Recycling Facts

https://www.isri.org/docs/default-source/commodities/kids-recycling-fact-sheet-2018.pdf?sfvrsn=2b71a413_16

What Do Your Recyclables Become?
(Maine.gov)

<https://www.maine.gov/dep/waste/recycle/whatrecyclablesbecome.html>

Test Your Metal

Background

Most students will know the term “metal” but associate it with a subset of metallic elements, those that chemists call “coinage metals.” This can be an appropriate building block for a broader understanding later. National, state, and local standards ask students to develop an understanding of the properties of matter. The properties of coinage metals—strength, luster, and malleability (the ability to be pounded into shape) and relatively high density make them easy to spot. Many students may also know that metals combine easily with oxygen (rust or corrode) and a few may know they can melt at high temperatures and form alloys. Metals also conduct heat and electricity more readily than non-metals. Many students may have the misconception that all metals are magnetic.

From a chemical standpoint, a metal’s most important property and what puts it in that category is its tendency to give away electrons in a reaction. The metals occupy the left 2/3 of the Periodic Table. While the atomic structure and reactions of metals are not developmentally appropriate topics at the elementary level, it may be appropriate to explain to students that the atomic structure in a metal (the particles they cannot see) are responsible for the substance’s unique properties. Students may also know or discover that not only iron but two other elements in the “iron family,” cobalt and nickel, are magnetic. Again, this is because of their similar atomic structure and electron spin.

“The Legend of King Arthur”: Answers to Student Questions

1. What is a legend? **An old story that might have some truth in it.**
2. Where do we find metals? **Almost always under the ground.**
3. Are the metals ready to use when we find them? **Not usually; they are almost always ores.**
4. Why did medieval people think that making swords was magic? **The steps were very complex and kept secret by the smiths.**
5. What is needed to make useful metal objects? **Heat, pressure, and other elements like limestone and carbon in very special order.**
6. What are alloys? **Mixtures of metals.**
7. Why should metals be re-used? **They are hard to find, hard to refine, and very valuable. It takes a great deal of energy to find and refine them.**



Test Your Metal

Did you know that the United States recycles more than 250 billion pounds of scrap metal every year? This is the weight of more than 70 million cars! In fact, steel is the most recycled material worldwide. Metal from old cars, farm equipment, railroad tracks, aluminum cans, airplane parts and more can be recycled for use in new structures like roads and bridges, new cars and even cooking supplies. In this activity, you will discover the traits or characteristics of metals and use those traits to sort or classify different items. You will use those traits to explain why metals are used for certain purposes.

Materials

- Copies of activity sheets
- Copies of the Legend of King Arthur Reading (one per student)
- Collections of coins
- 3-4 metal objects per group
- 3-4 non-metal objects per group
- 3-4 mixed objects (items that have metal and non-metal components)
- a CD
- Note cards
- Magnets

Part 1: Classify Objects

1. With your team, sort the objects your teacher has provided you with into different groups so that objects with similar traits are grouped together. List the traits or properties of each group on separate index cards.
2. Share ideas with your class

Part 2: Properties of Metals

1. Observe a pile of coins. List some characteristics you believe are properties of all metals on an index card. What makes a metal a metal? What makes metals different from other objects?
2. Look at your collection of items. Which of these items are metals? Create new groupings to sort the metals from the non-metals. Are there some items that contain a mix of metal and non-metal materials?
3. Using a magnet, test each of the metal objects to find out if they are magnetic, or “ferrous” metals.
4. Make a list of the many things you can think of that are made from metal. What traits make metals ideal for these purposes? Can you think of anything that might be made from recycled metal?

Part 3: Search for Metals

1. Put the characteristic properties of metals on a note card and conduct a search for metals in your classroom or elsewhere in the school as directed by your teacher. Collect objects if possible as directed by your teacher. For objects that cannot be collected or if you find a material that has some but not all of the characteristic properties, describe them on the back of the card for discussion.
2. Test the items you collected to see if any of them are magnetic. (Caution: Make sure students do not put magnets near computer or television screens or computer equipment).
3. Share results with the class. How many metals did you find? Were any metals hidden in other substances? Were some of the metals magnetic? Which ones?

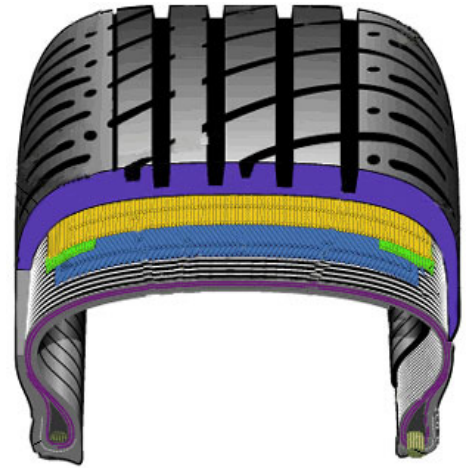
Reflect and Apply:

1. List 3-4 characteristics of metal.
2. Explain why metal might be used to make certain objects.

Extensions

When metal is recycled, it must be separated from other materials. For example, car tires contain rubber. But they also contain metal and fabric. There are steel wires inside the tire to make it stronger and strips of cloth in the rubber on the sides. Imagine you want to recycle all the products in a tire. Can you think of some ways metal might be separated out from other materials based on its properties? Create a table that lists the 3-4 characteristics of metal and how those traits might be used to help in the separation process.

You may have heard the legend of King Arthur and his “magic” sword Excalibur. There are many legends about swords. Some legends come from the time when humans learned to make stronger metals. They made weapons that seemed truly magical to enemies. Read “The Legend of King Arthur” and answer the questions. Arthurian legends date to about 300-400 AD. Use the Internet to find out what kinds of metals were used for weapons in those days and how they were made.



JOURNAL QUESTION

What are some things people could do with old items that contain metal instead of throwing them away in the trash?

The Legend of King Arthur

For hundreds of years Britain was ruled by the Roman Empire. Soldiers lived there with their families. Their empire was far away.

About 300 AD Rome changed. Invaders threatened the empire. A message came: "Come home." But where was home? When your great, great grandparents lived in the British Empire, "home" was there too.

Many Romans stayed in Britain. One of them may have been a King called Arthur. According to legend, he led a band of knights. He defended his town from invaders with a magic sword called Excalibur.

Could a sword be magic? Think about how swords were made in those times. First the iron ore had to be mined. There were no machines to help. Men had to hammer and chisel the ore from caves. Then they had to chip away the rock that wasn't iron.

Iron ore is brittle and hard to shape. In that time special craftsmen called smiths made swords. They used heat from a special oven called a forge to harden the iron into steel. They had to know just how hot to make the forge and how long to leave the iron in the heat. They had to quench (cool) the sword with water at just the right time. Forging swords was a special craft. Smiths kept their methods secret—just like magicians.

In the Middle Ages, metal tools were very valuable. No one would ever imagine using a metal object for a short time and then throwing it away! They handed tools down to their children, and even used them as "money." Metal objects were recycled over and over, in one form or another.

There is another legend about King Arthur. It tells the story about how Excalibur was lost on the bottom of a lake. But metal was too valuable to leave there. Eventually the sword was found, and used again.

Today we know more about metallurgy. That's the science of making and changing metal. We know how iron becomes steel. First the iron must be separated from other minerals in the rock that can't be seen. Limestone is used to remove these other minerals. They fall to the bottom of the forge. Then the element sulfur must be removed from the ore. The elements phosphorus and silicon must also be removed. Carbon is added to the iron, to make it stronger and more malleable (able to be pounded into a shape.)

Iron can be combined (alloyed) with other elements like chromium to help it resist rusting (corrosion.) Alloys like titanium steel can be used to make replacement joints for humans or parts for space ships.



Think About Metals:

1. What is a legend? _____
2. Where do we find metals? _____
3. Are the metals ready to use when we find them? _____
4. Why did medieval people think that making swords was magic? _____
5. What is needed to make useful metal objects? _____
6. What are alloys? _____
7. Why should metals be re-used? _____