Identify the Marvelous Metals!

Introduction
Metals are important materials that have distinctive properties and special uses. We use them for everything from forks and knives to airplanes and computers. This activity explains some of the important properties of metals, and encourages you to learn to identify the metals in a set of samples.

Materials
- Data collection table for each person, along with pens or pencils to write with
- Several sets of reference tables for everyone to share (can be laminated)
- Strong magnets
- Object made of iron (such as a washer, pan, nail, or tool) to use as magnetic example
- Create a set of around 10-15 samples that contains both metals and non-metals. Use small common household objects to test, such as coins, aluminum foil, keys, pieces of metal (be sure they are not sharp), rocks, pieces of wood, plastic objects, plastic bottles, glass objects (be sure they are not sharp or breakable; use small objects to reduce the chance of breaking), fabrics or stuffed animals, paper or origami, rubber balls, small clay pots, ceramic mugs, and other similar objects.
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Safety Suggestions
- Do not eat or drink any of the materials used in this activity.
- Thoroughly wash hands after this activity.

Procedure
1. Each participant should receive their own data table and pencil, so an appropriate number of copies should be made, with multiple data tables on one page to be cut apart.
2. Set up the samples to observe and test. Take notes about each object in the various columns, and then compare your observations to the reference tables in order to identify the substance.
3. Try to explain what each substance should be identified as, and why. Also, try to explain what transparent means, and that only certain metals are attracted to a magnetic field.

How does It work? Where's the chemistry?
Metals are important substances. Their ability to conduct heat and electricity allows us to use them for pots and pans and to create electrical wiring and batteries. Their ability to bend and flex allows us to shape them in many ways, from thin foils to springs and wires. Their strength and hardness allows us to build many things with them, from bridges to cars to rocket ships. The majority of the periodic table of the elements is made up of metallic elements; they are everywhere! Some metals and alloys (mixtures of metals) respond to a magnet because they have unpaired electrons in their electronic structure. It is very useful to be able to identify substances that are metals, and this activity will show you how.

Scientists often make observations and then compare their results to a known set of facts in order to identify substances. We have collected facts about metals and non-metals in our Reference Tables for you to use, and included a table of Common Materials to assist with identification. You should look at the following properties of your samples, and try to match your results to the substances in the tables.

Color: Most metals tend to be gray or silver-colored, while other non-metallic materials such as plastic and wood are many different colors. There are a few metals that are not gray; **copper** is a bright reddish-brown color that turns green over time when the metal is oxidized. **Brass** and **bronze** are alloys of copper, which means they are mixtures of copper with other metals; they are both a reddish-yellow color. **Gold** is a bright yellow color.

Transparent: A material that is transparent is see-through; light passes through the object readily. Metals are not transparent at all. If a substance is transparent, it is most likely plastic or glass.

Magnetism: Only some metals and alloys are magnetic; if your sample responds to a magnet, then it is most likely either **iron** (Fe), **nickel** (Ni), **cobalt** (Co), or an alloy of one or more of these.

Hardness: Metals have different degrees of hardness, but in general they are harder than most other substances. The hardest metal is tungsten, but iron is also very hard. Hard metals do not bend easily, and withstand large amounts of heat without melting or weakening.

Bend Test: Many metals can bend without breaking, and they can be formed into the desired shape by bending or molding. A blacksmith can bend and shape iron using a hammer and forge, even though iron is very hard. If you tried to hammer a piece of wood, pottery, or plastic, it would break rather than take a new shape. Some metals are soft and easily bent, such as **aluminum** (Al). A metal that is easily bent is called malleable.

Weight: Many common metals such as iron, copper, and zinc are very heavy (dense), although the smaller metals such as aluminum and **lithium** are fairly light.

Shiny: One of the most recognizable properties of metals is that they are often shiny, which means that they reflect light, especially if they have been polished or cut. Mirrors are made by putting silver metal on a piece of glass, so that it shows your reflection. If the metal is old and has been exposed to wet and salty conditions, it may no longer be shiny because it has been oxidized. For example, orange rust is the oxidized form of iron after it has reacted with oxygen in the air, and copper forms a green color known as a **patina** when it reacts with air and water.

What did you experience?

Data collection table:

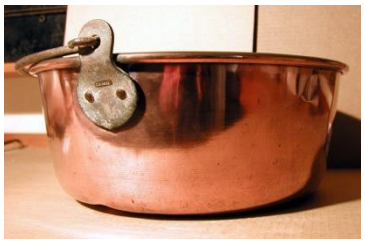
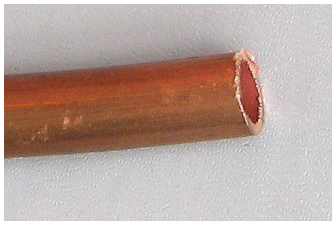
Object	Color	Is it transparent?	Magnetism	Hardness	Bend Test	Weight	Shiny	Is it a metal?
1.								
2.								
3.								
4.								
5.								

Reference tables:

Common Metals	Color	Transparent	Magnetism	Hardness	Bend Test	Weight	Shiny
Cast iron (Fe)	dull gray/black	no	yes	very hard	will not bend	heavy/dense	no
Steel (Fe alloy)	dark gray	no	yes	very hard	will not bend	heavy/dense	no
Copper (Cu)	reddish brown (or green if oxidized)	no	no	soft	wires, foils and thin plates will bend	light	yes
Brass and bronze (Cu alloys)	reddish yellow	no	no	hard	will not bend	medium	yes
Aluminum (Al)	light gray	no	no	soft	wires, foils and thin plates will bend	light	yes
Nickel (Ni)	dark grey	no	yes	medium	will not bend	medium	no

Common Non-Metals	Color	Transparent	Magnetism	Hardness	Bend Test	Weight	Shiny
Plastic	many possible colors, opaque or clear	yes, sometimes	no	can be hard or soft	some are flexible, some are not	light	no, but it can reflect light
Glass	many possible colors, clear	yes	no	hard	will not bend	heavy	cut glass can shine
Wood	brown with wood grain lines or particles	no	no	soft	live wood bends, dried wood does not	light	no
Rock	gray or brown	no	no (unless it is iron or nickel ore)	hard	will not bend	heavy	no
Fiber or fabric	many possible colors, woven or pressed	no	no	very soft	flexible	light	no
Ceramic	many possible colors	no	no	hard	will not bend	light	shiny if painted or glazed
Paper	many possible colors	no	no	very soft	flexible	very light	no
Rubber	many possible ;colors	no	no	very soft	flexible	light	no

Common Materials: (fill table with pictures of common uses of the material to help with identification. These are some examples.)

 *Nickel*	 *Aluminum*	 *Brass*
 *Cast Iron*	 *Copper*	 *Bronze*
 *Stainless Steel*	*Rubber*	*Plastic*
Glass	*Wood*	*Rock*
Fiber	*Ceramic*	*Paper*

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