CUBES METAL ASSORTED WITH HOOK, 20MM, Set of 6

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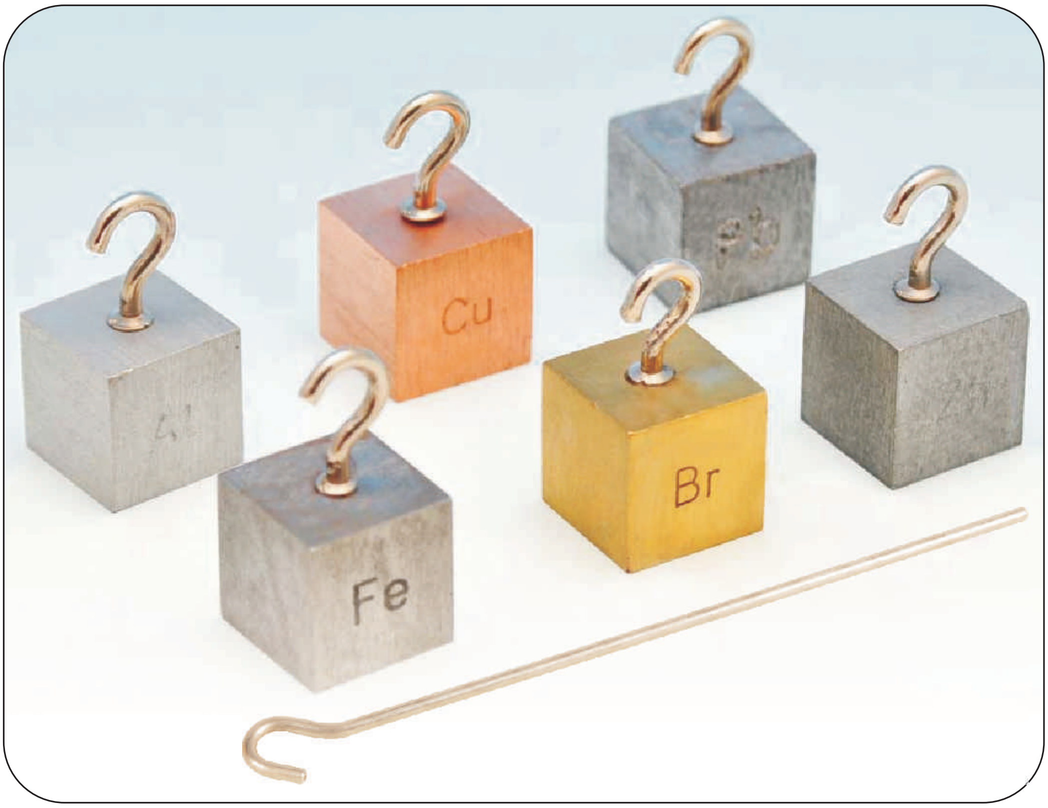

Experiment Guide

GENERAL BACK GROUND OR THEORY ON THE EXPERIMENT:

Specific Gravity is a dimensionless quantity. It is the ratio of the density of a solid or liquid to that of water at a specific temperature. Usually this temperature is chosen to be 4°C because water is densest at 4°C and has a density of 1.000 g/cm^3. Therefore tin, which has a density of 7.3 g/cm^3, would have a specific gravity of 7.3.

Density is the amount of mass an object takes up per unit volume. It is dependent on temperature, phase, and pressure. While some objects' density can change easily and vary widely, the density of a foam block or a person for example, some densities are predictable and reliable at standard temperature and pressure. Therefore, most students start to study density by using metals and expand the concept from there. In order to find the density of any given object, the mass and volume of that object must be determined. Common methods for finding mass include using a triple beam balance, a spring scale, or a digital balance, depending on what you have in your classroom.

There are two basic methods for finding the volume of a solid. The first is to measure volume using a ruler and some basic geometry depending on the shape of your object. The basic formulas you will need are as follows:

Rectangular Prism (including cubes) : Volume = length x width x height

Cylinder : Volume =   x radius^2 x height

Sphere: 4/3 x   x radius^3

A set of calipers can be used to measure the radius of the sphere or cylinder.

The second method for finding the volume of a solid is by finding how much water an object displaces. Acquire a graduated cylinder and fill it about 2/3 full with water. Note and record the original volume of water in the cylinder. Add the object carefully to the graduated cylinder as not to splash water and make sure that the object is completely immersed in the water. Record the new volume of water plus object. Then subtract the original volume of water from the new volume. Alternatively a displacement vessel can be used if the opening on the graduated cylinder is too small.

Although it is disputed as to if this story is fact or not, it is fun to tell students about Archimedes. A Greek tyrant named Hiero contacts Archimedes with a problem. He suspects his goldsmith of cheating him out of his gold. He asked the goldsmith to make him a crown out of pure gold, but believes that the goldsmith has put silver in the middle of the crown and kept some gold for himself. He asks Archimedes how to figure out if the crown is pure gold without destroying the crown. Back in Archimedes time, baths were something one took in public. It is said that Archimedes was in the bath house and noticed that the further he slid into the bath, the more water was displaced from the bath. In a flash of brilliance he realized he could find the volume of the crown using the amount of water it displaced. Therefore, finding the volume and the mass of the crown would give

Archimedes the density. If the density of the crown matched the density of gold, then the crown was real. However, if the density of the crown was less than that of gold, the crown could not be pure gold. Excited he leapt up out of the tub and ran naked all the way home shouting "Eureka! Eureka!" which in Greek means, "I've found it! I've found it!"

Specific Heat

The specific heat of a substance is an intrinsic property of that substance. It tells how much heat would cause the temperature of one gram of that substance to raise one degree Celsius.

The change in temperature that a substance experiences when heat is transferred to or from the object depends on the mass of the substance and the identity of that substance. It can be summed up in the following formula:

$$Q = mc(T_f - T_i)$$

Where "Q" is the amount of heat transferred and is positive if heat is added and negative if heat is removed. "m" is the mass of the object, usually measured in grams. "c" is the specific heat of the object usually measured in $J/g*^0C$. "T_f-T_i" is the change in temperature of the object. Change in temperature is the same in degrees Celsius as well as Kelvin.

Heat always flows naturally from hot to cold. If two objects with different temperatures come in contact with one another, the temperature will reach thermal equilibrium when the temperatures of both objects are the same.

We can use the equation above to calculate the specific heat of a given substance by using the method shown in activity 4.

The specific heat of water is 1 cal/g*°C, or 4.186 $J/g*^0C$.

Density and specific heat values for some common metals included in this Set:

Material	Density (g/cm^3)	Specific Heat (J/g.°C)
Brass#	8.44-8.75*	0.385*
Lead#	11.3	0.13
Iron#	7.87	0.45
Copper#	8.96	0.39
Aluminum#	2.70	0.91
Zinc#	7.14	0.39
Tin	7.6	0.23
Silver	10.5	0.235
Steel	7.8	0.12
Gold	19.3	0.13
Water	1.00g/cm^3 (at4°C)	4.186

These metals are included in this kit, dimensions are 20mm x 20mm x 20mm
* These values can changebased on how the metal is made.
A small metal hook is also included.

RECOMMENDED COMPONENTS (NOT INCLUDED)

Name of Part	Quantity (per student or group)
10 mL graduated cylinder	1
Ruler	1
Triple beam balance	1
Digital Balance	1
Calculator	1
Paper towels to put wet masses on	2-3
6cm x 6cm square of aluminum foil	6
Room temperature water in prefilled pitchers	1
Hot Plate	1
500 mL beaker	1
Thermometer or temperature probe	1
Tongs	1
Styrofoam calorimeter (may be able to use coffee cups with insulated lids)	1
Insulated gloves	1 pair
Displacement vessel and catch bucket	1

MAINTENANCE REQUIRED:

Metals will oxidize (rust) if left in water and this will change the mass and density of the cubes. Store in a dry place and dry cubes off after use.

EXPERIMENTS :

Activity 1: Finding the Density Two Ways

1. Pick out five materials and make some observations about these materials in the space provided below:

2. Using your senses, predict which object is the most dense and which is the least dense. Justify your hypothesis.

3. Find the mass of your objects using a triple beam balance and then a digital balance and record your values in the data table below. Which method do you think is most accurate? Why?

4. Find the volume of your objects using a ruler and/or caliper. Show one sample calculation below using formula and substitution with units.

5. Find the volume of your objects using a graduated cylinder and some water. Show one sample calculation of how you got your volume in the space below. Be sure to include formula and substitution with units.

6. Use your most accurate mass and volume to calculate the density of each of your objects. Show one sample calculation below. Be sure to include formula and substitution with units.

7. Ask you teacher for the actual densities of each of your objects and record those values in your data table.

8. Calculate the percent error for each material. Show one sample calculation below. Be sure to include formula and substitution with units.

DATA TABLE:

Object					
Mass 1					
Mass 2					
Volume 1					
Volume 2					
Calculated Density					
Actual Density					
% error					

(Don't forget to add units to your data table!)

9. List your objects in order from most dense to least dense. How did your hypothesis compare to your actual results? What in your original thinking did you have correct or incorrect based on your results?

ACTIVITY 2: DENSITY CHALLENGE (QUIZ)

Neatly fold a small 6.0 cm square of aluminum foil around each of the blocks to disguise their color. Use a permanent marker to label the foil around the blocks as follows: Brass-A, Zinc-B, Copper-C, Aluminum-D, Lead-E. Iron-F.

Give each student a balance, ruler, a block and sheet of paper. They should supply their own pencil and calculator.

Give each student a different block and instruct them not to open the aluminum foil. Record the letter of their block at the top of their sheet. Read them the story of Archimedes and tell them they have each been given a different piece of Hiero's crown. Their job is to determine which metal the crown in made out of using the tools supplied to them.

Name:______________________________________ Date:_____________

Class Period:_____________________ Cube Letter:____________

Use the Density Table below and your knowledge of density to determine which metal the crown is made out of. Show all work, including a description of how you found the density of the metal, formulas used and substitution of the formula with units.

Material	***Density (g/cm^3)***
Brass	8.4-8.8*
Lead	11.3
Iron	7.9
Copper	9.0
Aluminum	2.7
Zinc	7.1
Tin	7.3
Silver	10.5
Gold	19.3

My Metal is :_________________________

Bonus: How did the aluminum foil wrapped around your block affect your calculated density?

ACTIVITY 3: VISUALIZING DENSITY

Density has to do with how closely packed the molecules of a given substance are. Have the students get up out of their seats and play the density game. Have students arrange themselves in a grid evenly spaced apart and tell the students that they are each a molecule in a solid. "Heat up" your solid by putting an imaginary fire under the students, or sticking them in an imaginary oven. How would they behave? They will move apart from one another. (They may even begin to lose some order and become a liquid) As they move apart they take up more room. Ask the students if they weigh any less? Did any student disappear? No, they just got farther apart. Now put your students in the "freezer" if they are cold what will they do? Come together for warmth. As they come together they take up less space, but they still have the same mass. Tell them that they are increasing their density. Once you are convinced your students have the basic concept, then you can shout out orders at your students such as "increase density" "become less dense" or even "become a solid" become a liquid" etc.

Name:____ Date:____________

Partners:__________________

ACTIVITY 4: WHAT HAVE WE GOT HERE? (USING SPECIFIC HEAT TO IDENTIFY A METAL)

PURPOSE: Using specific heat to identify metals.

MATERIALS NEEDED:

- Hot plate
- 500 mL beaker filled with 2/3 full of water
- Metal cubes with hooks numbered 1-4
- Thermometer or temperature probe
- Hook or tongs (for removing metal from the boiling water)
- 100 mL graduated cylinder
- Calorimeter-Styrofoam
- Digital balance or triple beam balance
- Room temperature water in prefilled pitchers
- Insulated gloves, lab coat, and other necessary safety equipment
- Stirrer

PROCEDURE:

1. Clear the lab area of all extra materials (books, coats, hats, etc.) and tie back hair. Have students follow all safety precautions when using a hot plate or handling extremely hot materials. Students should have only the materials listed above and a paper and pencil for recording information on the lab table.
2. Record the number metal you have acquired.
3. Use your balance to mass your metal and record this value in your data table.
4. Place the beaker with the water on top of the hot plate and carefully add the unknown metal to the beaker.
5. Turn on the hot plate and bring the water and metal to a boil.
6. While the water is heating up, use the graduated cylinder to measure 250 mL of water and place the water into the calorimeter. Measure and record the initial temperature of the water in the calorimeter using your thermometer or temperature probe.

7. When the water is boiling, measure the temperature of the boiling water and record this value as well.
8. Using your hook or tongs, carefully and quickly remove your metal from the boiling water and place immediately into your calorimeter and add the lid.
9. Carefully watch the temperature change in the calorimeter while very gently stirring the water. When the temperature reaches its highest value, record this value in your data section. You will know you have reached the highest value when the temperature starts to decrease.

DATA:

Be sure to label each value with units.

Number of unknown metal ____________________

Mass of the unknown metal ____________________

Initial temperature of the boiling water __________________

Initial temperature of the metal ________________

Initial temperature of the calorimeter water_________________

Volume of calorimeter water ___________________

Final temperature of the water/metal in the calorimeter _____________________

Record anything of note that happened during the lab that could affect your results?

DATA ANALYSIS:

1. Use the formula $Q = mc(T_f - T_i)$ to calculate the amount of heat gained by the water in the calorimeter. Show all work below including formula and substitution with units.

2. Assuming that the amount of heat gained by the water in the calorimeter is equal to the amount of heat lost by the metal, solve for the specific heat of the metal. Show all work below including formula and substitution with units.

3. Using a list of given values for certain metals, which metal do you think you tested and why?

4. Was all the heat from the metal transferred directly into the water? If not, where could some heat have escaped to?

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