

Educational Innovations^{INC}[®]

MOL-500

Mole Element Sample Set

Teacher Guide

Lesson Ideas

- Each metallic element comes as an unmarked bar. Have your students identify each. The mole samples can be identified by mass, density, ferromagnetism, or even color.
- Instruct your students to observe the relative sizes of the metals. Since each bar is 1.0 mole and therefore contains 6.0×10^{23} atoms, what does that say about the size of the atoms themselves? Is one type of atom larger than another? Since each sample contains the same number of atoms, this does indeed mean that aluminum atoms are larger than copper atoms.
- Have your students calculate the mass of one atom! Weigh a sample, and then divide by the number of atoms in that sample, 6.0×10^{23} . Since each sample weighs a different amount, the atoms in that sample weigh different amounts. For example, a copper atom is heavier than an aluminum atom.
- Calculate the volume of one atom! Multiple the length, width, and height of one of our samples, then divide by 6.0×10^{23} , which will result in the volume of one atom.
- Dividing the mass of one atom by the volume of one atom will result in the density of a single atom.
- Compare the densities of copper and aluminum. Aluminum is less dense than copper, which explains why a copper atom can both weigh more and take up less space than an aluminum atom. Have your students compare and contrast the different properties of the samples.



5 Francis J. Clarke Circle
Bethel, CT 06801
www.teachersource.com

Phone (888) 912-7474
Fax (203) 229-0740
info@teachersource.com

© Educational Innovations, Inc.

Specific Heat Experiment

The purpose of this experiment is to determine the molar specific heat of the elements aluminum, copper, iron, and zinc.

Procedure:

1. Tie a piece of string tightly around each of the four samples. Heat the samples in boiling water to a constant temperature of 100 °C.
2. Prepare four styrofoam cups to act as calorimeters. Each cup should be filled with cool water, but no ice. Record the mass of water in the cup. Place a thermometer in the cup and record the temperature of the water.
3. Quickly remove one metal sample from the boiling water and place it in a calorimeter. Gently raise and lower the metal to ensure that heat is transferred to the water uniformly, but do not remove the sample from the water. Record the temperature of the water every 30 seconds until a maximum temperature is reached.

Calculations:

The amount of heat absorbed by the water will equal the amount of heat released from the metal sample. The amount of heat absorbed by the water can be calculated using the formula

$$Q = nC_M\Delta T$$

where Q is the heat absorbed, n is the number of moles of water present, C_M is the molar specific heat of water ($75.3 \text{ J}/(\text{mol})(^\circ\text{C})$), and ΔT equals the final temperature of the water minus the initial temperature of the water.

Once the heat absorbed by the water has been calculated, the specific heat of the metal can be calculated using the same formula, where C_M is the only unknown variable. (Hint: there is one mole of the sample, and the final temperature of the sample will be the same as the final temperature of the water). The accepted values for the molar specific heats of the samples are:

$$\text{Al: } 24.3 \text{ J}/(\text{mol})(^\circ\text{C})$$

$$\text{Cu: } 24.5 \text{ J}/(\text{mol})(^\circ\text{C})$$

$$\text{Fe: } 25.3 \text{ J}/(\text{mol})(^\circ\text{C})$$

$$\text{Zn: } 25.2 \text{ J}/(\text{mol})(^\circ\text{C})$$

While the specific heats of each metal measured in $\text{J}/(\text{g})(^\circ\text{C})$ differ, the specific heats measured in $\text{J}/(\text{mol})(^\circ\text{C})$ approach $25 \text{ J}/(\text{mol})(^\circ\text{C})$.

For a discussion of why these values are so similar, have your students research the Law of Dulong and Petit. Enjoy!