

Chemistry 212

SPECIFIC HEAT OF AN UNKNOWN METAL

LEARNING OBJECTIVES

The learning objectives of this experiment are

- To determine the type of metal using specific heat, density and other physical properties.
- Become competent with the technique of constant pressure calorimetry.

BACKGROUND

For years, we have been using these metal blocks without knowing what metal they were made of. You will be determining the identity of the unknown metal by determining the specific heat of the unknown metal and then by comparing that to a list of known metal specific heats (see table below). You will want to also compare the physical properties like color, luster, and density of your metal block to those found in the literature for that type of metal.

Metal	Specific Heat (J g ⁻¹ °C ⁻¹)
Aluminum	0.899
Copper	0.38
Lead	0.16
Nickel	0.443
Tin	0.21
Zinc	0.388
Brass	0.38
Iron	0.46

PROCEDURE

The procedure involves placing the metal in a beaker of boiling water to bring the metal to an initial temperature equal to the temperature of the boiling water. The hot metal will then be placed in a calorimeter containing a known volume of water at room temperature. Your team will decide what volume of water to use in the calorimeter. The heat from the metal will be released into the cooler water until the metal and the water reach the same temperature. In order to obtain consistent readings, you want to make sure that the heat transfer is even throughout the solution so you are encouraged to continuously stir the system. It can be challenging to determine the final temperature reading. To help facilitate this, you will need to record the temperature of the water versus time, every 10 seconds, until a constant temperature reading is obtained (this could

be displayed as a graph). From the change in final and initial temperature measurements, you will calculate the specific heat of the unknown metal and then compare that result to the list of standard metal specific heats to help determine the identify of the unknown metal. You should do enough trials to convince yourself that your data is good (a minimum of three). Determine the density of the metal by finding the volume and mass. Volume can be determined by measuring or by water displacement.

Safety and Waste

Be careful when placing the metal in and removing the metal from the hot water. It is recommended that you use the tongs that have been provided to aid in the transfer. Be careful not to drop the metal block in the beaker because this may cause the beaker bottom to break. Follow all safety procedure for use of a hot plate. When you are finished with the metal block, return it to the instructor.

Materials

Any glassware contained in your locker
Sample(s) of unknown metal – You will be provided with two metals
Coffee-cup Calorimeter
Temperature Probe
Tongs
Hotplate
Steel wool
Boiling Stones (put in beaker of boiling water)
Magnet
(It is up to the instructor's discretion to provide other materials)

Turn in at end of lab period

Data Sheets
Graph – make one graph with all trials represented
Notes

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SPECIFIC HEAT OF AN UNKNOWN METAL

Data Sheet

Name(s) _____

Determination of Unknown Metal #1 - Cube

Quantity	Trial 1	Trial 2	Trial 3	Average	Lit. Value	% Error
Mass (g) of metal				Based on the experimental data the metal is _____		
Volume (cm ³)						
Density (g/cm ³)						
Mass (g) of water						
ΔT (°C) water (attach graphs)						
ΔT (°C) metal						
Energy transferred (J)						
Specific Heat (J/g °C) of metal						

List other physical characteristics of the metal.

Show calculation for specific heat determination in Trial 1.

Based on the density, specific heat and other physical characteristics what metal do you have (use the web to explore the metals properties)? Explain your decision making process.

Determination of Unknown Metal #2 - Cylinder

Quantity	Trial 1	Trial 2	Trial 3	Average	Lit. Value	% Error
Mass (g) of metal				Based on the experimental data the metal is _____		
Volume (cm ³)						
Density (g/cm ³)						
Mass (g) of water						
ΔT (°C) water (attach graphs)						
ΔT (°C) metal						
Energy transferred (J)						
Specific Heat (J/g °C) of metal						

List other physical characteristics of the metal.

Show calculation for specific heat determination in Trial 1.

Based on the density, specific heat and other physical characteristics what metal do you have (use the web to explore the metals properties)? Explain your decision making process.