612-1345 (15-055) Specific Heat

This kit consists of 4 different metal specimens of equal mass, all of equal weight (**56 g**) and diameter (**19 mm**) but varying lengths.Each contains an attached or molded hook for handling specimens with tongs. Metals are chosen to represent all major groups of Periodic Table.

Warranty and Parts:

We replace all defective or missing parts free of charge. Additional replacement parts may be ordered using the part numbers above. We accept Mastercard, Visa, American Express, checks, and School P.O's. All products warranted to be free from defect for 90 days.

Additional Materials:

Calorimeter
Method of heating

How To Use:

Heat a sample to a known temperature and transfer it to the calorimeter with tongs. Each specimen has a hook for easy handling. Samples can be heated by suspending in boiling water or steam in a watertight container for about 10 minutes. If this method is chosen, the container should be close to the size of the sample, preferably metal, with its opening covered with insulation.

Important tip: Weigh samples first on an accurate scale.

Although they have been manufactured to an approximately equal weight of grams (2 ounces), for best results the **mass should be checked before using.**

Theory:

Heat capacity is the capability of a material to contain heat energy. The amount of anything a container delivers depends upon the size of the container, how full it is and what is in it. In the case of heat, the capability of a material to contain heat energy can be boiled down to this relationship:

Amount of heat delivered is equal to the **amount of material delivering heat** times a **constant** C times the **temperature change** associated with delivering heat, or

$$H = M C \Delta T$$

Specific heat (the constant represented by the letter C) measures the heat capacity of a unit mass of material. The specific heat of a certain material equals the number of calories that 1 g of material must absorb or give out to undergo a temperature change of 1° C. The units of specific heat are cal per g per ° C, or cal/g °C. A similar relationship exists in the English system of units involving Btu, pounds and F.

Therefore, from the way they are defined, the specific heat of a material has the same numerical value in both the metric and English systems.

Part of the reason for the variation of specific heat from substance to substance lies in the different masses of atoms making up each substance. A given mass of a substance such as lead contains only 1/7.7 times as many atoms as the same mass of aluminum. In adding heat to 1 g of lead, you therefore set fewer atoms into motion and need less heat to increase the kinetic energy of individual atoms to account for a 1 °C temperature rise.

The specific heat of water is 4.18, one of the highest. For this reason, water is frequently used in heating and cooling systems.

To measure C, it is necessary to measure the other 3 terms of the equation. M can be measured in two ways: MASS of the metal sample or NUMBER OF GRAM ATOMIC WEIGHTS contained by the sample.

For most elements, the specific heat multiplied by the relative mass of its atoms yields a number that is approximately the same for all. The Law of Dulong and Petit observes that the product of specific heat and atomic weight is about 6 calories.

To measure the change in temperature (T) it is necessary to know the temperature to which a sample is heated (i.e., 100° C).

You then need to know the temperature of the sample after it has released all the heat it can release in a calorimeter. To measure H, multiply mass times specific heat times the change in temperature.

Specific heats for common materials, including those in this set, are included.

Application:

To use the specific heat samples, weigh the samples first on an accurate scale. Heat them in boiling water and drop them into a calorimeter. Stir the water in the calorimeter and measure the highest temperature it reaches. The heat gained by the water equals the heat lost by the metal. Weight of water x (t_2 - t_1) x specific heat of water = weight of metal x (t_3 - t_2) x specific heat of metal, where **t_1** equals initial temperature of water; **t_2** the temperature of the mixture; and **t_3** the higher temperature of the metals.

A simple comparison of specific heats of different metals can be made by heating an equal weight of each in boiling water and dropping them onto a large chunk of ice. The metal of largest specific heat will melt the largest amount of ice.

All samples may be identified by appearance.

The chart in the next column lists a sample material and its specific heat and mass, in order of longest to shortest cylinder.

Substance	Spec. Heat	Mass
Aluminum	.900	56g
Zinc	0.387	56g
Stainless steel	0.460	56g
Copper	0.387	56g

Specific heat values of common substances:

(Values at room temperature and atmospheric pressure)

Substance	Specific Heat J/g/°C
Ice (-10°C/-0°C)	2.093
Iron	0.452
Nickel	0.440
Alcohol (ethyl)	2.45
Mercury	0.138
Water (defined)	4.18
Air (50°C)	1.046
Hydrogen	14.30
Steam (100°C)	2.009

How to Teach with Specific Heat Specimens

Concepts Taught: Heat capacity of a body. Specific heat of a material. Calorimetry principle; determining specific heat using calorimeter - measuring heat loss/heat gain.

Curriculum Fit: Physics Sequence/ Energy. *Unit: Conservation of (heat) energy (Specific Heat)* **Grades 9-10.**

Concepts Taught: Density. Specific Gravity. Buoyancy. Flotation principle.

Curriculum Fit: Physics Sequence & Chemistry Sequence/ Matter. *Unit: Observation and Measurement of Physical Properties.* **Grades 6-8.**

Related Products:

Science First® *products are available from most science education distributors or, if unavailable, directly from us.*

612-1330 Aneroid Calorimeter- Five times as sensitive as conventional student calorimeter. Contains l lb. aluminum core in styrofoam insulation. Instructions include graphical workup. Use with 15-060, below.

612-1332 Specific Heat Set- (Equal Volume). Same 5 specimens as 15-050, same diameter and length, different mass.

612-1331 Calorimeter Resistor - Determine electrical equivalent of heat by passing known current through known resistance for known time and measuring temperature change. Great with 15-120 Calorimeter due to low heat loss. Consists of power resistor mounted to cover, attached terminals, instructions.

612-1300 Steam Generator - Safe, corrosion-resistant, all-aluminum. Won't collapse even if boiled dry. Includes sample cup with wood handle. Good source of steam for experiments.

015-0300 Linear Expansion Apparatus - Only needs warm tap water to study linear expansion of different metals.

612-0025 Thermostat Model - Demonstrates action of a switch with bimetallic strip that opens, closes circuit when you connect battery.

P/N 24-1550