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HEAT TRANSFER KIT

CAT NO. PH1120146



Apparatus Guide

INTRODUCTION

The Heat Transfer Kit efficiently introduces concepts of thermal energy and heat transfer to students. The aluminum heat transfer bar effectively demonstrates the migration of thermal energy between the two Styrofoam calorimeters. Comes with two thermometers specifically designed for hot and cold temperatures.

KIT CONTENTS

2 Styrofoam Calorimeters with lids
Aluminum heat transfer bar
Low range thermometer (-40 – 50 °C)
High range thermometer (-30 – 110 °C)

GENERAL BACKGROUND

Heat conduction is the transfer of energy by diffusion and collision of particles in a body due to a temperature gradient. Heat always flows from a higher temperature to a lower temperature. The more thermal energy a substance contains, the higher the kinetic energy, or speed of vibration, of the particles and molecules in the substance.

The amount of heat transferred is called the calorie (symbolized Q) and for water is given by the thermodynamic equation:

$$Q = mc\Delta T$$

Where m is the mass of water being heated, c is the specific heat of water and ΔT is the change in temperature of the water. The specific heat is the heat capacity per unit mass and for water is equivalent to 1.0 cal/g °C. Thus one calorie is the amount of heat needed to increase the temperature of one gram of water by 1°C.

We will use the above equation in this experiment to determine the amount of heat transferred from one from calorimeter to the other.

ADDITIONAL REQUIRED MATERIALS

250 mL Graduated cylinder or beaker
200 mL tap water
200 mL boiling water
Digital timer

PROCEDURE

1. Measure 200 mL of tap water into a graduated cylinder or beaker. For this activity, water can be room temperature or cooler. Pour into one of the foam calorimeters. Place a lid onto the foam calorimeter.
2. Measure 200 mL of boiling water into the graduated cylinder or beaker. Pour into the second foam calorimeter. Immediately place the second lid on the calorimeter with the boiling water.
3. Insert the low range thermometer ($-40 - 50\text{ }^{\circ}\text{C}$) into the smaller slit in the first calorimeter with the cooler water. Insert the high range thermometer ($-30 - 110\text{ }^{\circ}\text{C}$) into the smaller slit in the second calorimeter. Wait about 30 seconds to allow each thermometer to come to equilibrium with the water. When the levels of each thermometer are steady, record the two temperatures in the data table. Insert the aluminum heat transfer bar into each of the calorimeter's larger openings, thus connecting the two calorimeters together. Start the timer.
4. Record the temperature on each of the thermometers every two minutes for thirty minutes in the table.



DATA TABLE

Time (minutes)	Hot Water Temperature (°C)	Cool Water Temperature (°C)
0		
2		
4		
6		
8		
10		
12		
14		
16		
18		
20		
22		
24		
26		
28		
30		

ANALYSIS

1. In which direction did the heat flow?
2. By how many degrees Celsius did the boiling water decrease?
How many degrees Celsius did the cooler water increase?
3. Calculate the heat lost by the container of boiling water. Calculate the heat gained by the cooler water. Remember that 1 mL of water is equivalent to 1 gram of water, and that the specific heat for water, C_w is 1 cal / g °C. Is the heat loss equivalent to the heat gain? If not, where did the missing heat go?

ANSWERS TO QUESTIONS

1. Heat always flows from hot to cool. The thermal energy from the boiling water was transferred to the cool water through the aluminum bar.
2. Results may vary, but students can expect to find about a 30 degree drop in temperature for the boiling water in half an hour, and a 15 degree raise in temperature of the cool water.
3. Using the equation $Q = mc\Delta T$, we can find the amount of heat lost and gained.

For the boiling water that decreased by 30 degrees Celsius we have:

$$Q = mc\Delta T = 200 \text{ g} * 1 \text{ cal / g } ^\circ\text{C} * -30 ^\circ\text{C} = -6000 \text{ calories.}$$

For the cool water that increased by 15 degrees Celsius we have:

$$Q = mc\Delta T = 200 \text{ g} * 1 \text{ cal / g } ^\circ\text{C} * 15 ^\circ\text{C} = 3000 \text{ calories.}$$

Not all the heat from the boiling water was transferred to the cool water. Some of the thermal energy went into heating the aluminum heat transfer bar. Some heat was also lost to the air via convection.

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U.S. Distributor :

Eisco Scientific

850 St Paul St, Suite 15, Rochester, NY 14605

Website : www.eiscolabs.com

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