**SPECIFIC HEAT**

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**OBJECTIVE:** To identify the composition of metal specimens by measuring their specific heats.

**THEORY:** When heat moves from one substance to another it requires a temperature change, when heat is added to a substance the temperature increases, and when heat leaves the other substance its temperature decreases. This change of heat between the two substances is proportional to the mass of the substance and the change in temperature of the substance. The change in temperature refers to the point where the cooler substance warms to the same temperature that the warmer substance cooled to. This state is called temperature equilibrium. In order to calculate the heat involved in the transfer this equation is used:

Q = m\*c\*

Where Q is the heat exchanged because in a closed or insulated system no heat will escape, m is the mass of the substance involved, is the change in temperature and c is the specific heat constant of the substance. Using this equation it is possible to solve for the specific heat of the substance if you know the amount of heat transferred.

By placing the heated substance in water inside an insulated calorimeter it becomes possible to determine the amount of heat transferred between the object and the water. The water’s specific heat is known and the temperature change between the substances is approximately equal and opposite. Therefore this amount of heat calculated for the water is also used to find the specific heat of the substance

**PROCEDURE:** A metal substance was weighed and its mass was determined. The mass of the Styrofoam cup with a lid (calorimeter) was also determined. The cup was filled between ½ and ¾ with water then weighed and the mass of the water was determined. A glass beaker was filled approximately 5/6 of the way full and placed on a hot plate and brought to a boil, which means that the water remained at a constant temperature of 100 degrees Celsius. The metal specimen was suspended in the boiling water for five minutes. The initial temperature of the water in the cup was recorded using a *DataStudio* program to measure temperature. The heated metal was quickly placed into the cup and the thermometer was inserted as the whole system was mixed. The change in temperature was recorded. An experimental specific heat was calculated then compared to a specific heat of a known metal and percent difference was calculated.

This process was repeated for four more materials.

A separate calculation was done to determine the effect of ignoring the Styrofoam calorimeter and to see how much more accurate the calculated specific heat would be.

**DATA:**

Mass of cup = 18.3 grams

Specific heat of water = 1.00 cal/g\*0C

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Substance | Masss,  g | Massh2o,  g | Th2o, initial | Th2o,  Final | h2o,  0C | s,  0C | Qw,  cal | Cs,  cal/g\*0C | % difference |
| A | 80.2 | 281.6 | 22.2 | 24.1 | 1.9 | 75.9 | 535.04 | 0.088 | 5.38 |
| B | 80.2 | 281.9 | 22.0 | 26.4 | 4.4 | 73.6 | 1240.35 | 0.210 | 0 |
| C | 81.0 | 237.9 | 22.1 | 24.9 | 2.8 | 75.1 | 666.12 | 0.110 | 0 |
| D | 80.3 | 286.5 | 22.2 | 24.1 | 1.9 | 75.9 | 544.35 | 0.089 | 3.26 |
| E | 81.0 | 262.3 | 22.2 | 24.3 | 2.1 | 75.7 | 550.83 | 0.090 | 0 |

Sample Calculations:

Cs = (Massh2o\*1.00 cal/g\*0C\*h2o)/( Masss\*s) = specific heat

s = 100 - Th2o Final

% difference = |(experimental – accepted)|/accepted \* 100

Including the Styrofoam cup for specimen A results in:

Specific heat of Styrofoam = 0.311 cal/g\*0C

Qcup = 18.3g\*0.311 cal/g\*0C\*

Cs = (Massh2o\*1.00 cal/g\*0C\*h2o)+ (Qcup )/( Masss\*s) = 0.090

% difference = 3.23

**RESULTS:**

Specimen A was Zinc, specific heat = 0.093, calculated = 0.088

Specimen B was Aluminum, specific heat = 0.21, calculated = 0.21

Specimen C was Stainless Steel, specific heat = 0.11, calculated = 0.11

Specimen D was Copper, specific heat = 0.092, calculated = 0.089

Specimen E was Brass, specific heat = 0.090, calculated = 0.090

**ERROR ANALYSIS:** When placing the thermometer into the room temperature water, error could occur because the water may have warmed or cooled in the timeframe between removing the thermometer and placing the 100 degree material into the water. Ignoring the effect of the Styrofoam cup in the exchange of heat will result in error. When the hot metal was placed into the cooler water it brought a miniscule amount of 100 degree water which also would contribute to errors in mass and temperature change.

**CONCLUSION:** By calculating the change in temperature that the water experienced and that the specimen experienced, and knowing the mass of each the total heat transfer could be calculated. This could then be used to find the specific heat of the tested substance.