Specific Heat

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Objective:
To identify the composition of different metal specimens by measuring their specific heats.

Theory:
Heat transfer into or out of an object involves a temperature change. Heat added causes as increase in temperature; heat removed causes a decrease in temperature. Over a reasonably range of temperatures, experiments show that the heat transfer is proportional to the temperature change. In addition, it is observed experimentally that for the same temperature change in a given material, heat transfer is proportional to the mass of the object. The constant of proportionality is defined to be the specific heat of the material, c. The constant c represents the amount of heat that is transferred in/out of a material per unit mass per unit temperature change. It is a material constant, independent of the shape or mass of the material.

Procedure:
First, we received five, 5, metal specimen. For each of the metals we did the following:

* Using a triple beam balance, determine the specimen mass.
* Determine the mass of a Styrofoam cup (which will be used for all the specimens).
* Fill the cup ¼ full with tap water at room temperature.
* Determine the mass of the cup/water – subtract the cup mass to determine the mass of the water with will be heated.
* Start DataStudio software; create experiment; setup and select ‘stainless steel temperature sensor’. The sensor plugs into the analog input on the interface.
* Put the sensor in the water and record the water temperature before immersing the metal specimen into the water.
* Fill a glass beaker with tap water and bring it to a boil on a hotplate. Suspend the specimen in the water from a cord so that it doesn’t touch the beaker. Allow to boil for at least 5 minutes so that the temperature is 100 ̊C.
* Quickly move the hot specimen into the Styrofoam cup and cover with the lid. Insert the temperature sensor through a hole in the cover so that it doesn’t touch the specimen.
* Restart the data taking and select digital and graph display. To facilitate heat transferr, gently swish the fluid periodically.
* The water temperature will gradually rise. When you observe that the temperature has equilibrated, note the final water temperature.

Data:

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Specimen ID | ms, g | mw, g | Tw, ̊C | Tfinal, ̊C | ΔTw, ̊C | ΔTs, ̊C | Qw, cal | cs, cal/g ̊C |
| A | 80 | 172.45 | 22.7 | 25.6 | 2.9 | 74.4 | 500.12 | .084 |
| B | 80.1 | 175.55 | 22.5 | 29.0 | 6.5 | 71 | 1141.08 | .201 |
| C | 80.7 | 177.15 | 22.5 | 26.1 | 3.6 | 73.9 | 637.74 | .11 |
| D | 80.1 | 295.65 | 21.9 | 23.7 | 1.8 | 76.3 | 532.17 | .087 |
| E | 80.7 | 184.55 | 22.3 | 25.1 | 2.8 | 74.9 | 516.74 | .085 |

Formulas:
Q = mcΔT
Qw = mwcwΔTw
cs = Qw/msΔTs
% error = |Measured – Accepted|/Accepted \* 100

Results:
A was Zinc with a 9.7% error.
B was Aluminum with a 4.3% error.
C was Stainless Steel with a 0% error.
D was Copper with a 5.4% error.
E was Bronze with a 5.6% error.

Error analysis:
Some of the errors that we came up with were that we did not let the metal quite get to 100 ̊C, we used too much water in the cool down process, the thermometer took some of the heat from the metal, and we could have had it out too long between the hot and cool water.

Conclusion:
In conclusion the experiment went exactly how it is supposed to and I learned that you can tell what kind of metal it is just by simply heating it up and seeing the change in temperature of the water you cooled it with.

References:
We only used ourselves and you as a reference.