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Physics
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Period 2
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DETERMINING THE SPECIFIC HEAT OF METAL

The Lab Summary is the heart of your report – here you state and explain all of your findings! If this section of the Lab Report is insufficient then your lab is insufficient! First state why we did the lab – you should be able to do this in a single sentence. Next you must explain what you found as a result of doing this lab – you must include your quantitative results and interpretation of those results (including errors, suspect data, etc.)

Lab Summary:
The purpose of this lab was to experimentally determine the specific heat capacity of the metals lead and copper. The experimental value for the lead shot was 124 J/kgK. The accepted value as provided by the instructor was 130 J/kgK, resulting in a percent error of 4.6%. For the copper the experimental value was 374 J/kgK, resulting in a percent error of 4.1% when compared to the provided value of 390 J/kgK.

The interpretation of your results is very important. Do you agree with the findings that the data suggests? What are the reasons that your data does not match your predictions/accepted values? What could you have done to make the lab better and get more accurate results? Do you believe your data? A very large percent error is suspect and may indicate that there was a fundamental problem in the lab procedure, but a very small (or zero) percent error may also indicate procedural issues. You do not get graded on how well your data agrees with an accepted value but you do get graded on how well you explain the agreement!

The data generally agrees with the accepted values, therefore we can be confident that our experimental procedure was reasonably sound, however it was not perfect. The largest source of error in this lab was heat energy loss to the surroundings during the course of the experiment. In an ideal case 100% of the heat lost by the metal would be gained by the water, but because we have experimental values that do not agree with the actual values we know this was not the case. There was some heat loss during the transfer of the metal shot into the water. There was a small amount of time that passed between when we measured the temperature of the hot metal shot and when we immersed it in the cooler water. During this time the metal lost heat energy to the outside environment (the surrounding air). This lost energy was not transferred to the water and therefore the water temperature did not increase as much as it should have. This hypothesis for a source of error agrees with our data, as our experimental values were lower than the provided values. If the experimental values would have been larger than the provided values that would suggest that the environment added heat energy to our system (and would therefore violate thermodynamic law).

Sources of error must be events in the procedure that could be modified and corrected for. Human error is not acceptable! Reading the thermometer wrong, or being too slow to perform a task is not a flaw with the experiment – it is a flaw with the experimenter!

Another source of heat loss was the stirring rod that we used to mix the water and metal shot. This rod absorbed some of the metal's heat, therefore preventing it from being absorbed by the water. A third source of error was the Styrofoam cups that we used to contain the water / metal

shot mixture. Styrofoam was used because it has good insulating properties, but it is not perfect so some heat was lost to the environment through the walls of the cups. A better container, such as a silvered vacuum flask, would have reduced this heat loss.

Conclude your Lab Summary with what you learned as a result of doing the lab. You have already reported your experimental data, so this section is for reporting the skills and knowledge you have gained.

As a result of performing this laboratory experiment we learned how to determine the specific heat capacity of a metal. This procedure could also be used to determine the specific heat capacity for nearly any material that is capable of relatively quickly transferring heat to a water bath. We also learned that heat loss to the surround environment had significant impact on our results and was the main reason that our experimental values did not exactly match the accepted values provided by the instructor.

The Procedure section is where you outline how you performed the lab. You should provide enough detail so that the lab could be performed by another individual using your procedure. Write this procedure in your own words – do not retype the procedure provided. Outline format or bulleting is acceptable.

Procedure

- Measure and record the masses of Styrofoam cups, water, and metal shot.
- Place the metal shot into a glass test tube and immerse the tube in boiling water.
- Let the metal shot heat for 5 minutes then use a thermometer to measure and record the temperature of the metal shot.
- Add the water to a Styrofoam cup. Use a different thermometer to record the temperature of the water.
- Add the hot metal shot to the water. Stir the mixture to ensure temperature uniformity. Using the thermometer you used to measure the temperature of the water to measure and record the maximum temperature that the mixture reaches.
- Using the data you collected calculate the specific heat of the metal.
- Repeat the procedure for the second metal.

In the Data section you must provide all of the raw data collected during the lab. There are several ways that this can be reported, but usually the easiest and best way is a data table. Data tables must be properly labeled and complete.

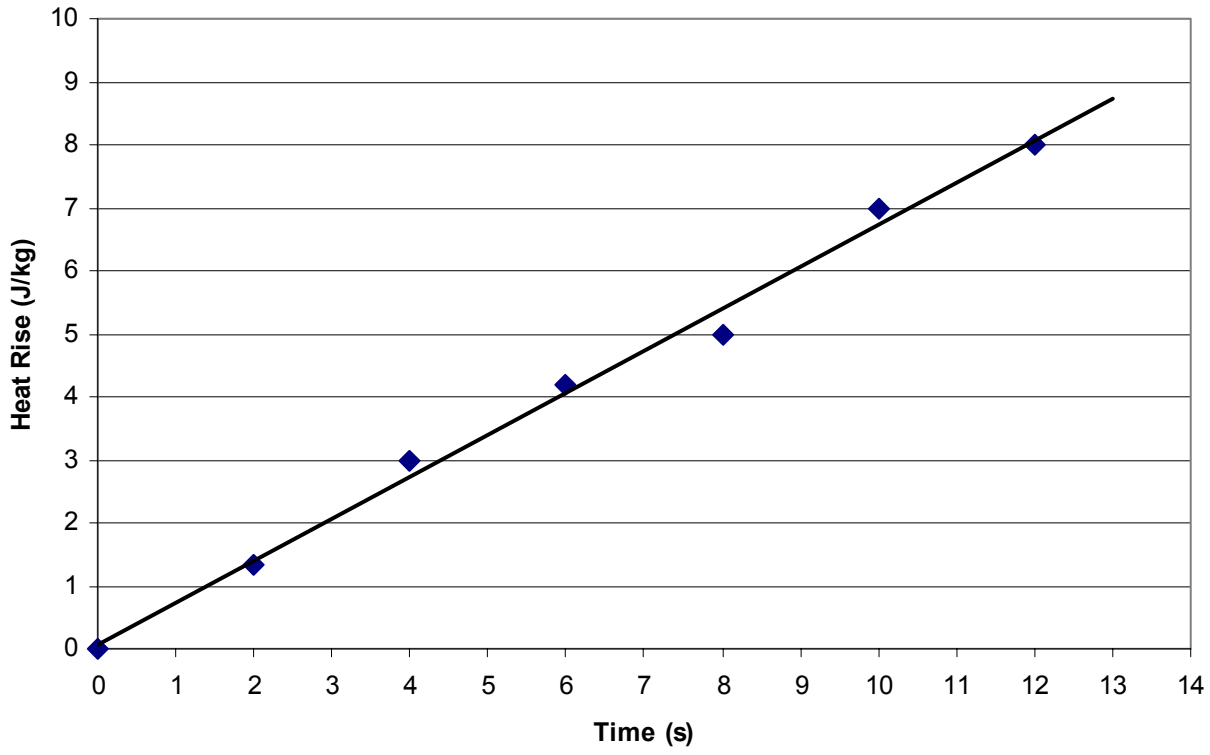
Data

Data Table I: Lead Shot	
Mass of Water	250 g
Mass of Metal	400 g
Mass of Cup	25 g
Specific Heat of Water	4186 J/kgK
Temperature of Water	22.0 C
Temperature of Metal	95.0 C
Temperature of Mixture	23.3 C

Data Table II: Copper Shot	
Mass of Water	225 g
Mass of Metal	575 g
Mass of Cup	25 g
Specific Heat of Water	4186 J/kgK
Temperature of Water	22.0 C
Temperature of Metal	97.5 C
Temperature of Mixture	36.0 C

Many lab reports will require the plotting of data in graphical form. Graphs may be hand drawn using graphing paper and a straightedge, but it is often simpler and easier to plot the data using a computer program such as MS Excel. Follow the graphing format instructions provided on the Lab Report Format handout. Below is a sample graph that is representative of what you are expected to produce. (This graph is only a sample and has nothing to do with this lab data.)

Figure 1: Determining the Specific Heat of a Metal



Note that the graph is neat and easy to read. There is a title to the graph and the axis are properly labeled with what is being recorded and proper units. While (0,0) may or may not be an actual data point, almost all of your graphs should start from the origin. The data points are sufficiently large and the best-fit-line (trend line) is not a connection of the data points! Since there is only one set of data being plotted on this graph there is no need for a legend. Data labels are not required unless specifically requested or you wish to draw interest to individual points.

You must show your work for calculations whenever you report a numerical value that is not simply an observed event. For this lab calculations for the specific heat of the metals and finding percent error are required. However, simple calculations like finding the average of several numbers are not required. When reporting calculations you must write out the equation and then do the calculation by substituting in numbers for variables. Only one sample calculation must be shown for each type of equation even if several calculations are made.

Calculations

$$Q_{LOSS} = Q_{GAIN}$$
$$-(m_{metal}\, c_{metal}\, \Delta T_{metal}) = (m_{water}\, c_{water}\, \Delta T_{water})$$
$$-(0.400\text{ kg})\, c_{metal}\, (23.3\text{ C} - 95\text{ C}) = (0.250\text{ kg})(4186\text{ J/kgK})(23.3\text{ C} - 22.0\text{ C})$$
$$c_{metal} = 124\text{ J/kgK}$$

$$\%E = \frac{|Accepted - Experimental|}{Accepted} x100$$

$$\%E = \frac{|130J/kgK - 124J/kgK|}{130J/kgK} x100 = 4.6\%$$

Lab Questions

Some labs will have a number of laboratory questions that must be answered in addition to your normal analysis of the lab. You must first write out the question and then answer it in a complete sentence. It is not necessary to recopy the original question word for word; paraphrasing is sufficient. Your answer, however, must be in complete sentences. One word answers such as 'yes' or 'no' are not acceptable and will not receive credit. Be sure to explain yourself thoroughly.