Calculating the Temperature of a Bunsen Burner Flame

This meets Idaho Standard: HS-PSP-2.4 Students who demonstrate understanding can: Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics).

Click here for a video

Heat flows from a hot object to a cooler object until the two objects reach the same temperature, the amount of heat transferred to an object can be determined by measuring the temperature difference before and after heating. In this lab an iron nail will be heated in a Bunsen burner flame. Heat transfer will continue until the temperature of the nail is the same as that of the Bunsen burner flame. The amount of heat stored in the nail can be determined:

$\Delta Q_n = m_n c_n \Delta T_n$

Q_n = heat content of the nail in joules

m_n = mass of the nail in grams

c_n = specific heat of the nail = 0.444 Jg °C

ΔT_n = temperature change of the nail

If both the mass of the nail and its specific heat are known, only the heat difference needs to be determined. If the not nail is immersed in water of a known temperature and mass, the heat change of the water can be determined:

$\Delta Q_w = m_w c_w \Delta T_w$

The specific heat of water is 4.18 Jg °C

Since the heat lost by the nail is equal to the heat gained by the water, the temperature of the nail can be determined.

Safety

Use caution in placing the not nail in the cup of water. Do not put the palm of your hand under the cup. Do not allow the hot nail to touch the cup. Keep your hands away from the nail during the heating process. Wear chemical splash goggles.

Procedure

1. Weigh an empty polystyrene cup and record its mass in the data table.
2. Fill the cup with room temperature water to a level about 1 cm from the top. Record the mass of the cup and water in the data table.
3. Measure the temperature of the water and record it in the data table.
4. Determine the mass of the nail and record it in the data table.
5. Suspend the iron nail from a ring stand using nichrome wire.
6. Place a Bunsen burner under the suspended wire so it looks like the wire will hang in the flame.
7. Light the Bunsen burner.
8. Adjust the iron ring so that the nail is centered in the inner cone of the burner flame.
9. Heat the nail for ten minutes.

   While the nail is heating, open Vizeey on your device and attach the databot with a temperature probe.

10. Turn off the flame and remove the burner.
11. Carefully, but quickly, immerse the nail in the cup. Do not allow the nail to touch the cup.
12. Place the thermometer in the cup.
13. Record the highest temperature the thermometer reaches.
14. Empty the water out of the cup and replace it with room temperature water.
15. Obtain a new nail and repeat the procedure.

Data Table

	Trial 1	Trial 2
Mass of Empty Cup		
Mass of Cup and Water		
Mass of Water		
Mass of Nail		
Initial Temperature of Water		
Final Temperature of Water		
Change in Temperature of Water		

Calculations

1. Calculate the heat absorbed by the water: $Q_w = m_w c_w \Delta T_w$
2. Assuming that no heat is lost to the room, the heat lost by the nail is equal to the heat gained by the water:
   $Q_n = Q_w$
3. Record the heat lost by the nail in the calculations table.
4. Knowing Q_n, c_n, and m_n, you can calculate the ΔT_n.
5. Assuming that initially the nail is at room temperature, add the initial temperature of the nail to the temperature change of the nail and record it in the calculations table.
6. Determine the temperature of the Bunsen burner flame and record it in the calculations table.
7. Determine the average Bunsen burner flame temperature for two trials.

Calculations Table

	Trial 1	Trial 2
Heat gained by water		
Heat lost by nail		
Temperature change of nail		
Temperature of hot nail		
Temperature of Bunsen burner		
Average of two trials		