

Experiment 5: Heats of Combustion and Solidification

Name _____ Period _____

One calorie warms 1g of H₂O 1C°. Δ = delta which means "a change in"

$$Q = mc\Delta t, \text{ where } c = 1 \text{ cal/g}\cdot\text{C}^\circ$$

Purpose: Find Heats of Combustion and Solidification for wax and compare their values.

Part I Heat of Combustion:

Finding the heat of combustion for wax. That is how many calories are released per gram of wax burned.

Procedure:

- Stick a candle to a can lid and mass it to 0.01 gram. Record the mass in your data table.
- Mass an empty can and record it.
- Fill the can about 1/3 full of water and mass it. Record the mass.
- REMOVE the wire screen from your ring stand. Suspend the can of water inside the ring by hanging it with a spatula through the holes. Adjust the can to about 5 cm above the unlit candle.



- Record in the data table the temperature of the water in the can.
- Light the candle and warm the water to about 40°C.
- Carefully blow out the candle and record the highest temperature the water attains.
- Mass the candle and lid and record it.

Data Table:

1	Mass of candle before burn	g
2	Mass of candle after burn	g
3	Mass of candle burned #1 - #2	g
4	Mass of empty can	g
5	Mass of can 1/3 full of water	g
6	Mass of water in can #5-#4	g
7	Temp of water before heating	°C
8	Temp of water after heating	°C
9	Change in temp, Δt , #8-#7	C°

Part II Heat of Solidification

Finding the heat of solidification for wax. That is the number of calories liberated per gram of wax that freezes.

Procedure:

- Borrow a test tube of wax containing 10.0 grams of wax.
- Mass a styrofoam cup and record it.
- Fill the cup about 1/3 full of tap water, mass it, and record it.
- Fill a 250ml beaker 1/2 full of water and place it on a ring stand over a burner.
- Place the TT of wax into the water in the beaker and heat until the wax completely melts.
- Take the temperature of the water in the styrofoam cup and record it.
- Remove the TT of wax from the hot water.
- As soon as the wax STARTS to solidify (gets cloudy), insert the TT of wax into the water in the cup of cold water.
- Stir with the thermometer and record the highest temperature attained.

**Data Table:**

10	Mass of empty cup	g
11	Mass of cup + 1/3 full of water	g
12	Mass of water in cup #11-#10	g
13	Temp of water before heating	°C
14	Temp of water after heating	°C
15	Change in temp, Δt , #14-#13	C°
16	Mass of wax in test tube	10.0 g

*There are sample calculations on page 4 to show how it is done**

Calculations Part I	Calculations Part II
Total heat in calories:	Finding Heat of Solidification:
$Q = mc\Delta t$	Total heat:
$Q = (\#6)(1\text{cal/g}\cdot\text{C}^\circ)(\#9)$	$Q = mc\Delta t$
$Q = \underline{\hspace{2cm}} \text{ cal}$	$Q = (\#12)(1\text{cal/g}\cdot\text{C}^\circ)(\#15)$
Ht. of Combustion:	Heat of Solidification:
$= Q/g_{(\text{of candle})}$	$Q = \underline{\hspace{2cm}} \text{ cal}$
$= Q/\#3$	$= Q/10.0 \text{ g}_{(\text{of wax})}$
$= \underline{\hspace{2cm}} \text{ cal/g}$	$= \underline{\hspace{2cm}} \text{ cal/g}$

ON THE BACK, SHOW YOUR HUP, TWO, THREE, FOUR CALCULATIONS!

Compare the heats:

Heat of combustion in cal/g / Heat of solidification in cal/g = _____ a ratio

Questions & Critique:

1. What experimental error would cause your value for the Heat of Combustion to be higher or lower than the accepted value?

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2. What experimental error would cause your value for the Heat of Solidification to be higher or lower than the accepted value?

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3. Why do you think there is such a vast difference between the Heat of Combustion and the Heat of Solidification?

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*** Sample Calorie Calculations**

<p>Finding heat of Combustion:</p> <p>Find the total number of calories and heat of combustion when 200 g of H₂O is warmed from 20°C to 45°C by 0.50 g of candle. This means that Δt is 25°C.</p> <p>Total heat--</p> $Q = mc \Delta t$ $Q = (200\text{g})(1\text{cal/g}\cdot\text{C}^\circ)(25\text{C}^\circ)$ $Q = 5000 \text{ cal}$ <p>Heat of Combustion</p> $= Q/\text{g of candle}$ $= 5000 \text{ cal}/0.5 \text{ g}$ $= 10,000 \text{ cal/g}$	<p>Finding Heat of Solidification:</p> <p>If 200 g of H₂O is warmed by 10.0 g of wax from 20.0°C to 22.4°C. This means that Δt is 2.4°C.</p> <p>Total heat--</p> $Q = mc \Delta t$ $Q = (200\text{g})(1\text{cal/g}\cdot\text{C}^\circ)(2.4\text{C}^\circ)$ $Q = 480 \text{ cal}$ <p>Ht. of Solidification</p> $= Q/10.0 \text{ g of wax}$ $= 480 \text{ cal}/10.0\text{g}$ $= 48 \text{ cal/g}$
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Compare the heats: $10000 \text{ cal/g} / 48 \text{ cal/g} = \text{A ratio of } \underline{200}$

So the chemical change (burning) takes over 200 times the energy of the physical change (freezing)!

And a nuclear change takes over a million times the energy of a chemical change! **WOW!**

The Grand Critique: