# Experiment 5: Heats of Combustion and Solidification

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Name_____Period____

One calorie warms 1g of $H_2O$ 1C°. $\Delta$ = delta which means "a change in"

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

**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:**

a. Stick a candle to a can lid and mass it to 0.01 gram. Record the mass in your data table.

b. Mass an empty can and record it.

c. Fill the can about 1/3 full of water and mass it. Record the mass.

d. 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.

e. Record in the data table the temperature of the water in the can.

f. Light the candle and warm the water to about 40°C.

g. Carefully blow out the candle and record the highest temperature the water attains.

h. Mass the candle and lid and record it.

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## 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:**

a. Borrow a test tube of wax containing 10.0 grams of wax.
b. Mass a styrofoam cup and record it.
c. Fill the cup about 1/3 full of tap water, mass it, and record it.
d. Fill a 250ml beaker 1/2 full of water and place it on a ring stand over a burner.
e. Place the TT of wax into the water in the beaker and heat until the wax completely melts.
f. Take the temperature of the water in the styrofoam cup and record it.
g. Remove the TT of wax from the hot water.
h. As soon as the wax STARTS to solidify (gets cloudy), insert the TT of wax into the water in the cup of cold water.
i. 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:<br>$Q = mc\Delta t$<br>$Q = (\#6)(1 cal/g \cdot C^o)(\#9)$<br>Q = _____ cal<br>Ht. of Combustion:<br>$= Q/g_{(of\ \ candle)}$<br>= Q/#3<br>= _____ cal/g | Finding Heat of Solidification:<br>Total heat:<br>$Q = mc\Delta t$<br>$Q = (\#12)(1 cal/g \cdot C^o)(\#15)$<br>Q = _____ cal<br>Heat of Solidification:<br>$= Q/10.0\ g_{(of\ \ wax)}$<br>= _____ 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

| Finding heat of Combustion: | Finding Heat of Solidification: |
|---|---|
| Find the total number of calories and heat of combustionwhen 200 g of $H_2O$ is warmed from 20°C to 45°C by 0.50 g of candle. This means that Δt is 25C°. | If 200 g of $H_2O$ is warmed by 10.0 g of wax from 20.0°C to 22.4°C. This means that Δt is 2.4C°. |
| Total heat-- | Total heat-- |
| $Q = mc\Delta t$ | $Q = mc\Delta t$ |
| $Q = (200g)(1cal/g\cdot C°)(25C°)$ | $Q = (200g)(1cal/g\cdot C°)(2.4C°)$ |
| Q = 5000 cal | Q = 480 cal |
| Heat of Combustion = Q/g of candle = 5000 cal/0.5 g = 10,000 cal/g | Ht. of Solidification = Q/10.0 g of wax = 480 cal/10.0g = 48 cal/g |

Compare the heats: 10000 cal/g / 48 cal/g = A ratio of 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: