GCC CHM 107LL
Heat and Energy

Introduction

Energy comes in many forms such as light, heat, electricity, kinetic and potential. Heat is defined as thermal energy flowing from higher temperature to lower temperature. For example, if a chunk of metal at room temperature is placed in a beaker of boiling water, the metal will absorb heat from the water until they both reach the same temperature. Scientists study the heat associated with physical and chemical changes. For example, the burning of gasoline and other fossil fuels can be used to run our automobiles or heat our houses. However, in some cases, the heat associated with some processes is transferred to the environment. For example, traditional incandescent light bulbs use almost as much electricity to produce heat rather than light. So you should buy those new spiral compact fluorescent bulbs that are more efficient and less costly to run.

Most physical and chemical changes are either **exothermic** or **endothermic**. **Exothermic** reactions release energy as a product so those reactions feel hot. Dynamite exploding is an extremely exothermic reaction. **Endothermic** reactions absorb energy as a reactant so they feel cold. Instant cold packs use chemicals that absorb heat when mixed, so the packs feel cold. They absorb heat from your body so you feel colder.

The amount of heat released when food is burned can be used to calculate the calories. The calories are a measure of the energy a person can get from eating the food.

Procedure

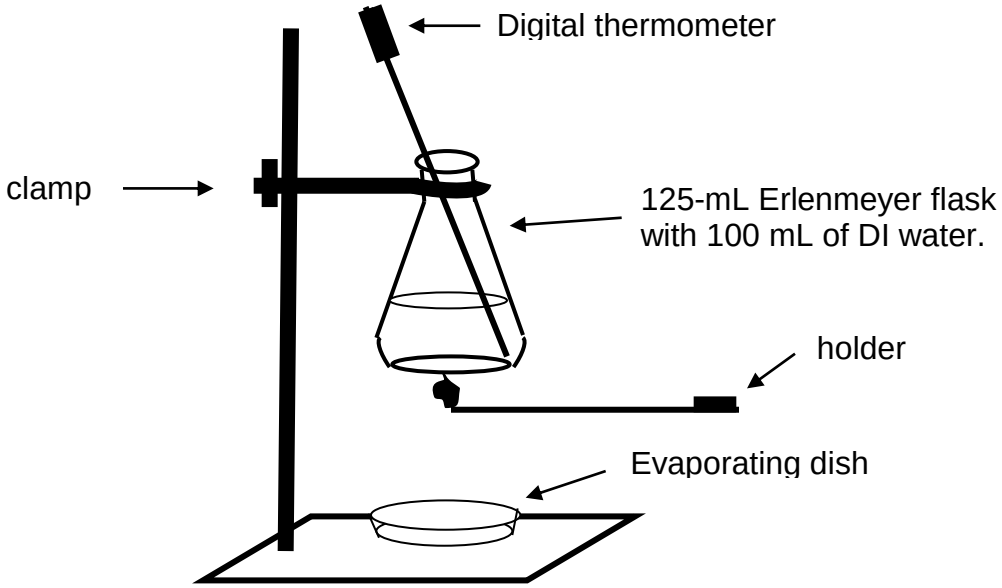
A. Supersaturated solution of sodium acetate, $NaC_2H_3O_2$

1. Check the hotplate cord for any tears exposing wires. If you find any, ask your instructor for another hotplate. Plug in the hot plate. Turn the heat knob, not stir knob, to 5.
2. Use your scoopula to add sodium acetate, $NaC_2H_3O_2$, to the 5 mL mark in a 10-mL Erlenmeyer flask. Use your deionized (DI) water bottle to add water to the 5 mL mark on the Erlenmeyer flask. The water should just cover the solid.
3. Swirl to mix the solution, and then place the Erlenmeyer flask on the hot plate. Heat the resulting slush until the solid has dissolved completely. Do not allow the solution to boil! (If it does, use a paper towel to protect your hand from the hot flask in the next step.)
4. Once all the solid has dissolved carefully put the Erlenmeyer flask onto a piece of paper to cool. (Note: The flask may be a little warm to the touch but not too hot to handle.) **Be careful not to place the flask directly on the lab bench**, which may be cold enough to cause it to crack. Turn off the hotplate. Finish the rest of the lab, and then come back.
5. Make sure the Erlenmeyer flask is completely cool AND the solid is still dissolved or you may have to start over. Use your scoopula to get 3-4 small grains of sodium acetate, $NaC_2H_3O_2$, out of the jar. Without disturbing the flask, drop the crystals into the center of the solution. Pick up the flask and put it on your forearm to feel the temperature change. Look at the flask to see what happens. Record your observations on your Report Sheet.
6. **Waste disposal**: Add water to the $NaC_2H_3O_2$ solid in the flask and heat it up again then pour into the waste jar when it dissolves. Rinse the flask several times with tap water.

B. Heat of Combustion and the Calories in Food

1. Use the markings on a 125-mL Erlenmeyer flask to measure out 100 mL of deionized water.

2. Carefully attach the Erlenmeyer flask to the ring stand using a clamp as shown in the diagram below. Turn on the digital thermometer to degrees Celsius, and place it into the Erlenmeyer flask.



3. Use the digital thermometer to measure the initial temperature of the water. Record the initial temperature in ^{o}C on your report sheet.
4. Get a Bugle and put in your evaporating dish. Weight them together. Write the mass on the report sheet as "mass before burning," and do not round the mass. Place the dish under the flask as shown above.
5. Put the Bugle on the wire holder. Hold the Bugle over a Bunsen burner flame to light the Bugle on fire. Hold the Bugle under the Erlenmeyer flask while it burns about 60 seconds. If it goes out, relight it. Let any liquids dripping from the Bugle fall into the evaporating dish.
6. When the Bugle finishes burning, stir the water in the flask with the thermometer for 30 seconds. Record this as the final temperature in ^{o}C. Subtract the "Initial temperature of water" from the "Final temperature of water" to get the "Temperature change of water" for burning the Bugle.
7. Put any pieces of the Bugle left over from the wire holder into the evaporating dish and go weigh the dish and contents again. Record as "mass after burning" and do not round the mass.
8. Subtract the "mass after burning" from the "mass before burning" to get the "mass burned."
9. Pour the water from the flask into the sink. Clean your Erlenmeyer flask as best you can. Clean your evaporating dish and dry it.
10. Repeat steps 1-9 for a banana chip. Make sure you get the mass of the evaporating dish and banana chip both before AND after burning. The banana chip should burn about 3 minutes. Relight the banana chip if the fire goes out before 3-4 minutes are up.
11. Repeat steps 1-9 for a kernel of popcorn. Make sure you get the mass of the evaporating dish and popcorn both before AND after burning. This will burn just a few seconds.
12. Repeat steps 1-9 for a marshmallow. Make sure you get the mass of the evaporating dish and marshmallow both before AND after burning. This will burn about 30 seconds.

Cleanup and Waste Disposal: Dispose of the burned foods in the waste containers in the hood. Put on a pair of latex gloves before handling the Erlenmeyer flask, which will be covered with soot. Wash in the sink with soap and water using paper towels to remove the soot. Take a wet paper towel and wipe off any soot remaining on the ring stand and clamp. Wipe off your lab bench with a wet paper towel.

GCC CHM 107LL Report: Name: _____

Heat and Energy Partner: _____

A. A supersaturated solution of sodium acetate, $NaC_2H_3O_2$

1. What do you observe and feel when you drop a crystal of sodium acetate, $NaC_2H_3O_2$, into the supersaturated solution?

2. When you drop a crystal of sodium acetate, $NaC_2H_3O_2$, into the solution,

   the temperature _____. (Circle One) increases decreases

   Thus, this process is _____. (Circle One) exothermic endothermic

B. Heat of Combustion and the Calories in Food --- *don't forget units!!!*

	Bugle	**Banana Chip**	**Popcorn**	**Marshmallow**
Mass of dish plus food BEFORE burning				
Mass of dish plus food AFTER burning				
Mass that burned				
Initial temperature of water BEFORE burning				
Final temperature of water AFTER burning				
Change in temperature				

To calculate the calories in the Bugle, nut and marshmallow, you **multiply** 0.100 Cal / 1 ^oC times the **change** in temperature for each.

Calories of Bugle = $\left(\frac{0.100\,\text{Cal}}{1\,^oC}\right)$ (_____ ^oC) = _____ calories

Calories of banana chip = $\left(\frac{0.100\,\text{Cal}}{1\,^oC}\right)$ (_____ ^oC) = _____ calories

Calories of popcorn = $\left(\frac{0.100\,\text{Cal}}{1\,^{\circ}\text{C}}\right)$ (_____ ^{o}C) = _____ calories

Calories of marshmallow = $\left(\frac{0.100\,\text{Cal}}{1\,^{\circ}\text{C}}\right)$ (_____ ^{o}C) = _____ calories

To calculate the calories per gram for the Bugle, nut and marshmallow, you divide the calories you just calculated for each by the **mass that burned** for each.

Calories per gram of Bugle = _____ cal / _____ grams = _____ cal/g

Calories per gram of chip = _____ cal / _____ grams = _____ cal/g

Calories per gram of popcorn = _____ cal / _____ grams = _____ cal/g

Calories per gram of marshmallow = _____ cal / _____ grams = _____ cal/g

Questions

1. Which food has the higher calories per gram? Bugle chip popcorn marshmallow
2. Which food would provide energy for the longest time? Bugle chip popcorn marshmallow
3. Burning food is: (Circle one) exothermic endothermic
4. An instant cold pack used in physical therapy is: (Circle one) exothermic endothermic
5. Now let's consider thermal energy transfer. If you put a piece of hot, glowing iron into a bucket of cool water, the _____ will lose heat and the _____ will gain heat.
6. If you walk on the sidewalk during the Phoenix summer, your feet will get very hot. This is because _____ is losing heat and _____ is gaining heat.
7. When you put an ice cube in your hand it will melt. This is because _____ is losing heat and _____ is gaining heat.
8. When you feel a marble statue it feels cold. This is because _____ is losing heat and _____ is gaining heat.
9. When you sit in a hot tub it feels hot. This is because _____ is losing heat and _____ is gaining heat.