Experiment 13 ENERGY OF CHEMICAL AND PHYSICAL CHANGES

Chem 110 Lab

I. INTRODUCTION

In this experiment, the heat energy produced when a peanut is burned (a chemical change) is used to change the temperature (a physical change) of water. The amou nt of energy, E, required to change the temperature of a sample of liquid water may be calculated as follows:

$$E = m \bullet C \bullet \Delta T$$

m = mass of the water sample (in grams)
ΔT = change in temperature ($T_{final} - T_{initial}$) of the water, in °C
C = specific heat (or heat capacity) of liquid water, a constant:

$$\frac{1.00 \text{ calorie}}{\text{gram} \quad °C} \quad \text{or} \quad 1.00 \text{ cal/g °C}$$

If we assume that all of the energy liberated when the peanut reacts is in the form of heat, and that none of it escapes, then the heat energy absorbed by the water and used to raise its temperature is a rough measure of the caloric content of the peanut.

II. EXPERIMENT

A. Place a half peanut on an "apparatus"—a foil-wrapped cork with a paper clip attached to it. Weigh the apparatus with peanut and record this as the INITIAL mass of the apparatus plus peanut in Table 13.1.

B. Carefully measure 25 mL of deionized water and pour it into a clean, d ry 100 or 150-mL beaker. Measure the temperature of the water and record this INITIAL temperature of water in Table 13.1 We will assume that the density of liquid water at this temperature is 1.00 g/mL, therefore 25.0 mL of water is equivalent to 25.0 g water.

C. Ignite the peanut with a match, and once the peanut is lit, quickly lift the beaker of water with your beaker tongs and hold it over the flaming peanut. The goal is to get as much heat into the water as possible. If the water begins to boil, blow out the flame.

D. Swirl the water in the beaker briefly to equalize the water temperature throughout, then measure the temperature. Record this temperature as the FINAL temperatue of water in Table 13.1.

E. Weigh the apparatus with the remaining peanut on it (be sure to pick up any peanut crumbs that have fallen off the paper clip) and record this as the FINAL mass of the apparatus plus peanut in Table 13.1.

F. Repeat this procedure two more times.

Table 13.1

TRIAL #	MASS OF APPARATUS + PEANUT		MASS OF PEANUT REACTED	TEMPERATURE OF WATER		Water Temperature Change, ΔT	MASS OF WATER m
	INITIAL	FINAL		INITIAL	FINAL		
1							25.0 g
2							25.0 g
3							25.0 g

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CALCULATIONS

- Report your answers to the following calculations in Table 13.2.
- For items 1-3, give the set-up of the calculation for Trial 1 ONLY.

1. For each trial, calculate the amount of heat energy, in calories (cal), absorbed by the water and report your answers in Table 13.2. Set up of calculation for Trial 1:

2. The heat energy lost by the peanut is egual to that absorbed by the water, calculated in 1 above. How much heat energy is that in kilocalories or "food calories", Cal? Report your answers in Table 13.2. Set up of calculation for Trial 1:

3. Calculate the experimental heat-loss-per-gram-peanut, in Cal/gram, by dividing the heat energy lost by the peanut, Cal, by the mass of peanut reacted. Set up of calculation for Trial 1:

4. Calculate the average experimental heat-loss-per-gram-peanut.

5. What is the theoretical heat-loss-per-gram-peanut, in Cal/gram? You will find this on the peanut container.

6. Calculate the % efficiency, which is calculated in a manner similar to percent yield: divide the average experimental heat-loss-per-gram-peanut by the theoretical heat-loss-per-gram-peanut, then multiply by 100.

Table 13.2

TRIAL #	MASS OF PEANUT REACTED (g)	Water Temperature Change (°C) ΔT	MASS OF WATER (g) m	EXPERIMENTAL				THEORETICAL HEAT LOSS PER GRAM PEANUT (Cal/g)	% EFFICIENCY
				HEAT ABSORBED BY WATER (cal)	HEAT LOST BY PEANUT (Cal)	HEAT LOSS PER GRAM PEANUT (Cal/g)	AVERAGEHEAT LOSS PER GRAM PEANUT (Cal/g)		
1			25.0 g						
2			25.0 g						
3			25.0 g						

QUESTIONS

1. Why was your % efficiency so low? Give three (3) reasons.

   a. _____

   _____

   b. _____

   _____

   c. _____

   _____

2. How could you improve your % efficiency?

   _____

   _____

   _____

   _____

   _____

   _____

3. While the peanut reacted, energy was liberated at the same t ime that mass was decreased. Does this mean that matter was changed into energy? Explain.

4. What happened to the atoms & molecules in the peanut when you burned it?