Thermodynamics Calorimeter Lab

Names _____

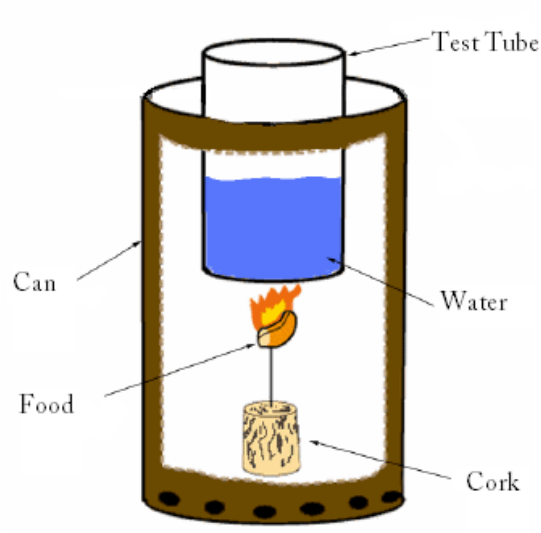
As new Biology graduates, you've been hired by Titan Food Labs Ltd. to work in the Calorimetry Department. Your job is to determine the energy contained in various food products (Alcohol, Cheerios, Peanuts, Known Chip, and Mystery Chip).

Calorimeter

A calorimeter is a device used for measuring the heat released during a chemical reaction. The burning of the food item releases the heat stored in the bonds contained within them. The heat is absorbed by water.

Food Calories vs. scientific calories

Scientific calorie = Amount of energy required to warm 1g of water by 1°C.



Scientific calories and Food Calories are different.
On food labels, energy is written as Calories with an upper case "C".
1 dietary "Food **C**alorie" = 1000 scientific calories = 1 kilocalorie

(Amount of energy needed to warm 1000 ml of water by 1°C)

When a label reports that food contains 450 **C**alories, the food actually contains 450,000 scientific calories or 450 Kcal.

Assumptions and Formulas

We will assume that the energy or calories contained in the food is proportionate to the heat (H) released when the food is burned which in turn is proportionate to the increase in water temperature.

Calories = $mc\Delta t$

m = mass of water in grams (1 ml = 1 g)
C = Specific Heat Capacity of water (1 cal/g°C)
Δt = change in temperature of water

CAUTION: Calorimeters will get HOT! Lift only by the base.

Part 1: Ethanol

Purpose: To determine if there is actual food calories in pure 100% alcohol (ethanol).

Hypothesis: Alcohol has been said to contain "empty calories". Circle whether you think pure alcohol contains calories.

Yes or No

Procedure:

1. Pour 1.0 gram of ethanol in the watch glass provided.
2. In a graduated cylinder, measure 100 ml of water. Pour water into flask.
3. Record initial temperature in **observation table**.
4. Ignite ethanol inside calorimeter.
5. Record final temperature in observation table.

Initial Temperature of Water (°C)	Trial 1 Trial 2 Trial 3
Final Temperature of Water (°C)	Trial 1 Trial 2 Trial 3
(Δt) Change in Temperature of Water (°C)	
AVERAGE (Δt) Change in Temperature of Water (°C)	
Total Scientific calories (cal) calories = $M_{H2O}\, C_{H2O}\, \Delta T_{H2O}$	**calories=**
Convert scientific calories into Food Calories (**C**al)	**Calories=**

Question:

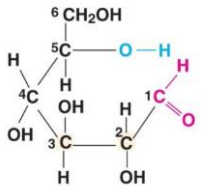
1. Tequila is only 40% pure alcohol. If a shot is 1 ounce (30 grams), calculate how many food Calories are in a shot.

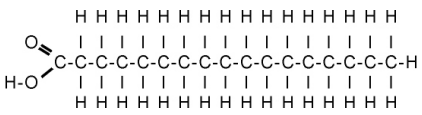
Part 2: Carbohydrates vs. Lipids

Purpose: To determine which food group contains more energy, carbohydrates (cheerios) or lipids (nut).

Hypothesis: Circle which you think contains more energy: **LIPIDS or CARBOHYDRATES**.

To help you with your hypothesis – the structural formulas of a lipid (a fatty acid) and a carbohydrate (glucose) are shown below. **Identify which is which!!!!**





Procedure:

1. Mass 0.5g cheerios and nut on the balance.
2. In a graduated cylinder, measure 100 ml of water. Pour water into flask.
3. Record initial temperature in observation table.
4. Ignite food and place immediately inside calorimeter.

Observations and Calculations for PART 2: Carbohydrates vs. Lipids

	Carbohydrate (0.5 g cheerios)			**Lipid (About 0.5 g of nut)**		
Initial Temperature of Water (°C)	Trial 1	Trial 2	Trial 3	Trial 1	Trial 2	Trial 3
Final Temperature of Water (°C)	Trial 1	Trial 2	Trial 3	Trial 1	Trial 2	Trial 3
(Δt) Change in Temperature of Water (°C)						
AVERAGE (Δt) Change in Temperature of Water (°C)						
Total Scientific calories (cal) calories = $M_{H2O}\, C_{H2O}\, \Delta T_{H2O}$	**calories=**			**calories=**		
Convert scientific calories into Food Calories (**C**al)	**Calories=**			**Calories=**		
Food Calories per gram of food burned (Cal/g) (Food Calories per gram = Food Calories ÷ Mass of food burned)						

Questions: Carbohydrates vs. Lipids

1. List three factors you kept constant to make a fair comparison between carbs vs. fats.

   1.

   2.

   3.

2. When using the formula calories = mcΔt, why did we use the 100g as the mass as opposed to the mass of our food sample?

3. A fellow classmate tells you they found there to be 2000 calories in 1 tic-tac. Does this seem possible/logical? **Explain how it could be true**!

4. Calculate the carb to lipid calorie ratio using your lab data. Ex) If carb cals = 20 and Lipid cals = 10, then carb:lipid ratio =20:10 or 2:1. Simplify your ratio completely by dividing your larger number by the smaller one. Show your work.

THIS IS FOR MARKS!

_____ : _____
Carbs **Lipids**

(one of the numbers above should be a "1")

Part 3: Percent Accuracy of Calorimeter

Purpose: To determine the percent accuracy of your calorimeter.

Hypothesis: Estimate the accuracy of your calorimeter: _____ %. (Consider how much heat you think escaped the calorimeter)

Procedure:

1. Mass **1.0 g** of chip on balance.
2. In a graduated cylinder, measure 100 ml of water. Pour water into flask.
3. Record initial temperature in observation table.
4. Ignite food and place immediately inside calorimeter.
5. Burn food completely. Relight quickly if it goes out.
6. Record final temperature in **observation table**.
7. Clean blackened flask if necessary.

Initial Temperature of Water (°C)	Trial 1 Trial 2 Trail 3
Final Temperature of Water (°C)	Trial 1 Trial 2 Trail 3
(Δt) Change in Temperature of Water (°C)	
AVERAGE (Δt) Change in Temperature of Water (°C)	
Total Scientific calories (cal) calories = $M_{H2O}\, C_{H2O}\, \Delta T_{H2O}$	**calories=**
Convert scientific calories into Food Calories (**C**al)	**Calories=**
Use **food label on the chip bag:** What is the **ACTUAL** food Calories per gram for these chips? (Cal/g)	
% Accuracy of Calorimeter $\frac{\text{Calories/g determined with calorimeter}}{\text{Actual Calories/g from food label}} \times 100$	

Part 4: Finding the Calories in the "Mystery Chip"

Purpose: To determine the actual calories in a given food sample.

Hypothesis: How many food calories per gram will our mystery chip contain factoring in our % error.

_____ Calories per gram

Procedure:

1. Mass **1.0 g** of mystery chip on balance.
2. In a graduated cylinder, measure 100 ml of water. Pour water into flask.
3. Record initial temperature in observation table.
4. Ignite food and place immediately inside calorimeter.
5. Burn food completely. Relight quickly if it goes out.
6. Record final temperature in **observation table**.
7. Clean blackened flask if necessary.

Initial Temperature of Water (°C)	Trial 1 Trial 2 Trial 3
Final Temperature of Water (°C)	Trial 1 Trial 2 Trial 3
(Δt) Change in Temperature of Water (°C)	
AVERAGE (Δt) Change in Temperature of Water (°C)	
Total Scientific calories (cal) Calories = $M_{H2O}\, C_{H2O}\, \Delta T_{H2O}$	**calories=**
Convert scientific calories into Food Calories (**C**al)	**Calories=**
% Accuracy of Calorimeter (**from Part 3 of the lab**)	
Account for Calorimeter's lack of accuracy. Find the ACTUAL Food Cal per gram of chip. Use this formula: Food Cal/gram (found with calorimeter) % Accuracy of Calorimeter (**as a decimal**)	**THIS IS FOR MARKS!!!!!**

Part 5: The Titan Burger

Hypothesis: How many Calories do you predict are in one Titan Burger _____ Cal

Calories per gram determined
by your calorimeter:

Bun 3
Burger 3
Cheese 4
Ketchup 1
Mustard 1
Mayonnaise 6
Bacon 5
Tomato 0.5
Lettuce 0.5
Onions Rings 3
Avocado 2
Pickles 0.5

Your Titan burger weights are as follows:

Item	Grams per Titan Burger	Calories per Titan Burger
Bun	110	
Burger	300	
Cheese	50	
Ketchup	40	
Mustard	20	
Mayonnaise	60	
Bacon	125	
Tomato	40	
Lettuce	25	
Onions Rings	80	
Avocado	75	
Pickles	20	
	TOTAL	

Part 6: Finding the Calories in a Few Other Foods

Purpose: To determine the actual calories in various other food samples. Use 0.5 gram for all samples.

TIP: To help the foods burn better slice them into thin strips before weighing and burning.

Food			
Initial Temperature of Water (°C)	Trial 1	Trial 2	Trial 3
Final Temperature of Water (°C)	Trial 1	Trial 2	Trial 3
AVERAGE (Δt) Change in Temperature of Water (°C)			
Scientific calories = $M_{H2O}\, C_{H2O}\, \Delta T_{H2O}$			
Convert scientific calories into Food Calories (**C**al)			
% Accuracy of Calorimeter (**from Part 3 of the lab**)			
Account for Calorimeter's lack of accuracy. Food Cal (found with calorimeter) % Accuracy of Calorimeter (**as a decimal**)			

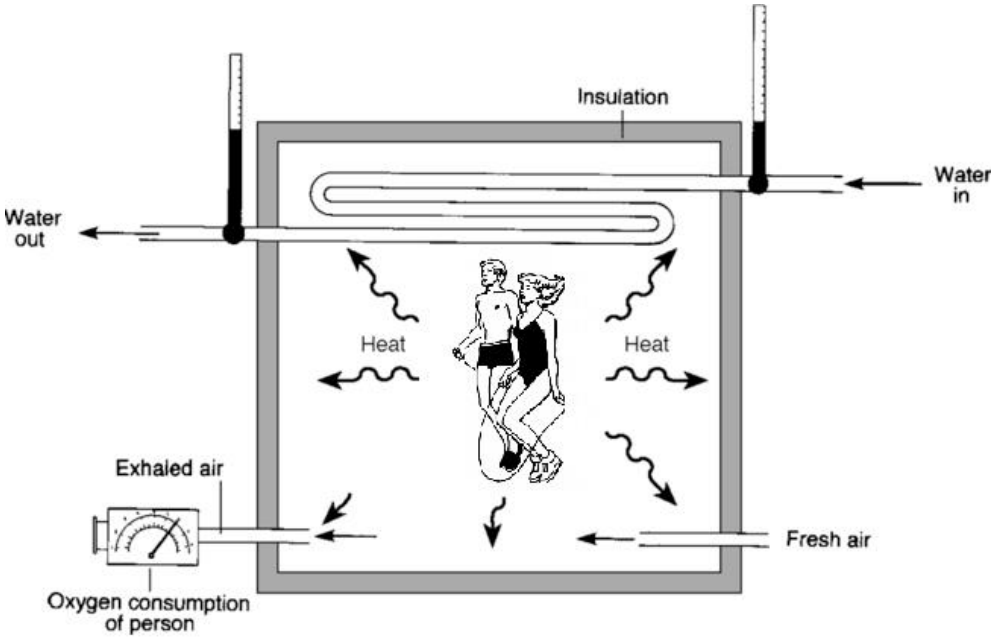
Food:			
Initial Temperature of Water (°C)	Trial 1	Trial 2	Trial 3
Final Temperature of Water (°C)	Trial 1	Trial 2	Trial 3
AVERAGE (Δt) Change in Temperature of Water (°C)			
Scientific calories = $M_{H2O}\, C_{H2O}\, \Delta T_{H2O}$			
Convert scientific calories into Food Calories (**C**al)			
% Accuracy of Calorimeter (**from Part 3 of the lab**)			
Account for Calorimeter's lack of accuracy. Food Cal (found with calorimeter) % Accuracy of Calorimeter (**as a decimal**)			

Food:			
Initial Temperature of Water (°C)	Trial 1	Trial 2	Trial 3
Final Temperature of Water (°C)	Trial 1	Trial 2	Trial 3
AVERAGE (Δt) Change in Temperature of Water (°C)			
Scientific calories = $M_{H2O}\, C_{H2O}\, \Delta T_{H2O}$			
Convert scientific calories into Food Calories (**C**al)			
% Accuracy of Calorimeter (**from Part 3 of the lab**)			
Account for Calorimeter's lack of accuracy. Food Cal (found with calorimeter) % Accuracy of Calorimeter (**as a decimal**)			

Part 7: The Human Calorimeter

Purpose: To determine how many calories **you** burn when skipping rope intensely for a given period of time.

If we had a human calorimeter chamber, we could measure the heat given off during skipping to calculate exactly how many calories were burned during the exercise. We assume the amount of heat given off by the person is proportionate to the calories burned during exercise.



With no human calorimeter chamber available ☹, we'll use the following formula to approximate how many calories you burn during your **intense skipping**.

Calories = body weight (lbs) x time skipped (minutes) x 0.10

1. Have members of your group skip intensely for as long as you'd like and record the time on data sheet.
2. Use the formula to approximate how many calories you burned as a group.
3. Bring the data sheet to the front Candy Counter to collect the Booty you've "earned"!!! If you ask nicely, we might even triple the calories you've earned!!!

Your **Approximate** Average Weight (lbs)	
Total Time ~~you're~~your group Skipped (in minutes)	
Calories burned = Weight (lbs) x Time (min) x 0.10	
Carbs contain 4 cal/gram. So to calculate your grams of candy so the following: Grams of candy = Calories burned / 4	

Eat to replenish the calories you burned!!!