IB 1 Biology

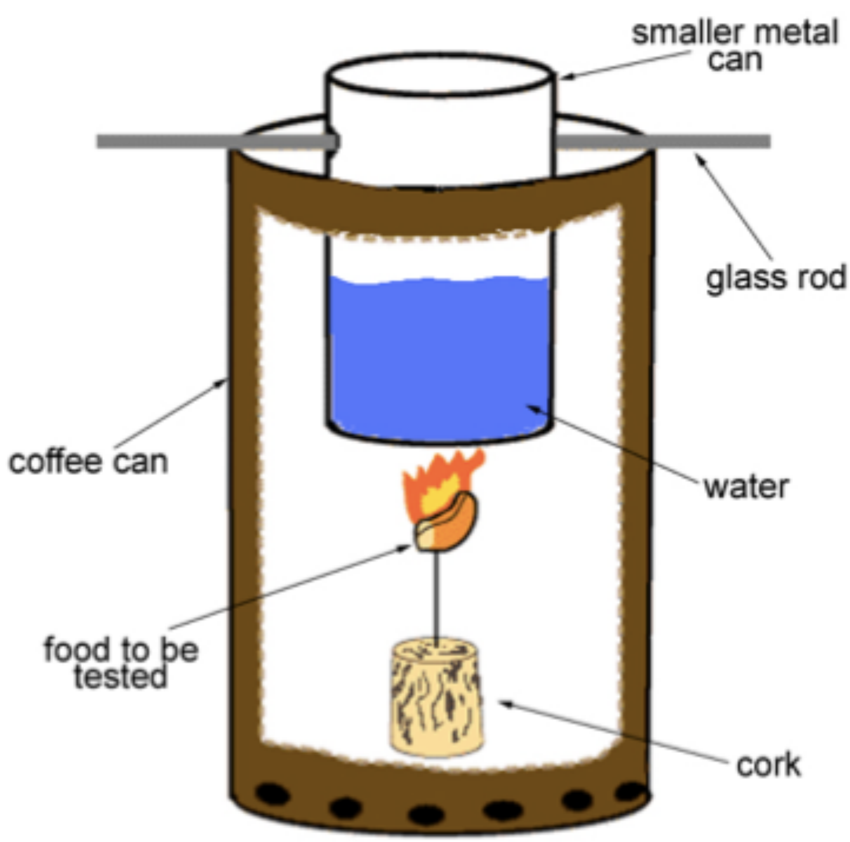
Topic 3: The Chemistry of Life

Practical #3: Burning Calories

Directions: For this practical you will not be planning an experiment, but you will be collecting all data and evaluating your work at the end. Although this is a simple lab, you will want to make sure to look at the **IA Criteria for DCP (Data Collection & Processing)** and **CE (Conclusion & Evaluation)** in order to understand how you will be assessed!

Definitions:

1. *Calorie*: A "calorie is the amount of heat necessary to increase the temperature of 1 g of water 1^{o}C." A calorie is a measure of energy, in this case measuring the energy you get from the food that you eat.
    a. Water's density = 1 g/ml
    b. 1 g of water = 1 ml of water
    c. 1 food Calorie is actually 1,000 calories (1 kilocalorie)
    d. Food with 50 Calories is actually 50 kilocalories = 50,000 calories
2. *Calorimeter*: A calorimeter is a device used to determine the number of calories in a given substance.
    a. A calorimeter allows you to burn food that then heats water in order to determine the caloric value of the food. The greater the change in water temperature, the more calories.
    b. *Figure 1*: Homemade Calorimeter (image from: *www.tutushouse.org/docs/CaloriesExperiment.pdf*)



Homemade calorimeter

    c. For this practical you will need to create your own calorimeter. Yours will look a little different than the one above. You will use the materials available in the lab. Remember that the most important thing is that the calorimeter traps the heat of the burning food in order to allow that heat to be transferred to the water. Unless the heat is effectively transferred, you will not get an accurate calorie count.

Determining calories:
In order to determine the number of calories in a given substance, you will need the following equations:

1. **$Q_{(lost\ by\ food)} = Q_{(gained\ by\ water)}$**
2. **$Q_{water} = (m)(c)(\Delta T)$**
    a. **Q** = heat gained in calories (cal)
    b. **m** = mass of water (g)
    c. **c** = specific heat capacity of water (1 cal/g ^{o}C)
    d. **ΔT** = change in temperature (^{o}C)
3. Remember: the density of water is 1 g/ml, so 1 g of water is equal to 1 ml (this is important when measuring!)
4. To determine **calories per gram of the substances** you are testing, you will need to divide the heat gained in calories by the number of grams of substance burned: **cal/g = (heat gained by water)/(mass of substance lost)**. Remember that these are still **calories**, not **Calories**.

Question: *Which of the following foods (your choice) contains more energy?*

Procedure:
Follow the procedure carefully – remember that you will need to create the calorimeter with the materials available.

Creating the calorimeter:

1. Collect the following materials:
    a. Ring Stand (two clamps – one for small can, one for thermometer)
    b. Larger metal can/beaker
    c. Smaller **metal** can (this must fit inside of the larger)
    d. Thermometer
    e. Cork and wire (to hold food)
    f. Rubber tube (why?)
    g. Lighter (or matches – although lighters might work better)
2. Assemble the calorimeter, making sure that there is room for the food underneath the smaller can, but that there is not too much space for heat to be lost to the surrounding air. Keep in mind that you will need to allow air to get to the substance in the can in order to allow it to burn – this is why you have the rubber tube.
3. Once you are confident with the calorimeter, you can begin the experiment.

Experiment:

1. Make sure that you have an appropriate data table – remember that you are looking at the change in mass of the food as well as the change in temperature of the water. Think about how many trials you will conduct.
2. Equipment:
    a. Calorimeter (instructions above)
    b. Graduated cylinder
    c. Weighing boat/Petri dish
    d. Balance

    e. Forceps

3. Make sure that you weigh the first substance that you will be testing in order to get an initial mass. You will want this to compare to the mass at the end of the experiment!
4. Using the graduated cylinder, pour 50 – 80 ml of water into the smaller metal can.
5. Attach your first substance to the wire on the cork.
6. Get an initial water temperature. Again, this is very important for later comparisons!
7. Using the lighter, light the substance. This may take a while. Be patient.
8. Immediately put the substance attached to the cork into the calorimeter. As quickly as possible, use the ring stand to place the smaller can right above the burning food. You want to let as little heat out into the air as possible.
9. Wait until the substance stops burning. If it goes out early, try reigniting it.
10. Once the substance has finished burning, take another temperature reading.
11. Take the substance out of the calorimeter.
12. Find the mass of the substance.
13. Follow the same procedure with your second substance. Remember to control your variables – don't put new water in a hot can!
14. Do multiple trials with each food – your data is more valid and reliable the more trials you conduct!

Data Collection & Processing:
Collect your data CAREFULLY. You want to make sure to take accurate measurements, and do not introduce any unnecessary errors into the experiment. Be careful to control your variables. Remember that you must include subjective observations as well as taking objective measurements!

When processing the data, think about the question you are trying to answer. What might be the best way to show the data? Tables? Graphs? Charts?

Conclusion & Evaluation
Once you have finished with all of your substances (AND written down all of your data!), compare the two substances. Which contains more energy? Why? How do you know? What are the implications of the caloric values of these two foods? Also, make sure to evaluate the method. Were there any uncontrolled variables? What experimental errors occurred? Were there errors in design, or human error? What might have affected your results? How valid and reliable are your results? What might you do differently in the future? What might be a logical extension of this experiment? Remember that you are not just writing a conclusion, you are **evaluating** the experiment and your results.