Connected Chemistry
Thermodynamics Unit
Lesson 9: Applying Thermodynamics

Student's Lesson at a Glance

Lesson Summary

This lesson is a lab that helps students apply the concept of thermodynamics in a real-world setting. The objective of the lab is to calculate the energy available in selected food items using the calorimetry process. First, in a brief introduction to calorimetry, students are asked to perform a calorimetry experiment on the food items that have been either self-selected or teacher-selected. Specific heat is introduced as a critical component of the lab calculations. Students complete an analysis of the lab that helps to tie together concepts from the thermodynamics unit.

SWBAT (Students Will Be Able To)

- Define the purpose of calorimetry and how it applies to thermodynamics
- Use the scientific method to determine the energy value of selected foods

Essential Vocabulary

Keep a list of all important words from this lesson. This list, in addition to the lists from other lessons, will make studying easier and improve scientific communication skills. The essential vocabulary from the unit is in bold. Additional words that will expand your scientific vocabulary are in italics.

CCC Reminder

- Students and teachers from many different schools helped designed CCC so that the lessons are more helpful and meaningful for all classroom participants.
- Many questions will ask you "what you think" or "to make predictions." The only answer that is wrong is the answer that is left blank.
- Follow lab safety techniques carefully. Inform your teacher if you have any health concerns - such as food allergies or asthma - that may impact your ability to complete the lab.
- Take good notes during your lab to ensure you are able to create a quality lab write-up.
- Use the vocabulary section and note section to take good notes so that studying for tests and quizzes is easier.
- Supporting claims with evidence is not only a skill that scientists use, but a skill that will help you in other classes and everyday life.
- Draw a key when you are sketching. Symbolic keys can help you and others decode your sketches at a later time.
- There is a periodic table and list of common elements used in the back of this book. You will need to refer to the periodic table often.

Notes

Homework

Upcoming Quizzes/Tests

Activity 1: Wet Lab - Calorimetry

Inside your body, a chemical reaction similar to combustion produces the energy your cells need to function. The following lab will help you make connections between thermodynamics and how your body gets the energy it needs to survive.

All foods contain stored energy. The amount of potential energy stored varies depending on the type of food. Athletes may eat high energy foods - such as pasta - to make sure they are ready for the demands of competition. Not all of the stored energy is converted into kinetic energy. As we move, our bodies also produce thermal energy, which is why our body temperature increases. Our bodies convert stored energy in food, known as calories, into chemical energy that allows us to do work. This energy conversion process is called cellular respiration and involves the transformation of chemical potential energy into thermal and kinetic energy.

Combustion reactions are similar to cellular respiration in the body. The similarities include the need for oxygen and sugar (in the form of glucose) as reactants and the production of carbon dioxide and heat as products. A **calorie** is the amount of energy required to raise the temperature of 1 gram (g) of water 1 degree Celsius (°C). The density of water is 1 gram per milliliter (1.00 g/mL); therefore, 1 gram of water is equal to 1 milliliter of water. Caloric values of food are measured in kilocalories (kcal or Calories). There are 1000 calories in a 1 kilocalorie (1 **Calorie**). A food item that is listed as having 90 Calories actually has 90,000 calories. Calories are a way to measure the energy received from the food you eat.

In this wet lab, you will indirectly measure the amount of calories in several food items using a calorimeter. A **calorimeter** is a device that measures the heat generated by a chemical reaction, change of state, or formation of a solution. We will be using a homemade calorimeter that works similarly to a professional calorimeter. A particular food item will be ignited, the calorimeter will trap the heat of the burning food, and the water above will absorb the heat. This heat will cause the temperature (T) of the water to increase. By measuring the change in temperature (ΔT) of a known volume of water, you will be able to calculate the amount of energy in the food tested.

The **specific heat** of water is 1 calorie/gram°C = 4.186 Joule/gram °C which is greater than any other common substance. The specific heat, represented by the symbol "c", is the amount of heat per unit mass required to raise the temperature by one degree Celsius. As a result, water plays a very important role in temperature regulation in biological processes like protein folding.