By Amy Gilbert, Ph.D., and Megan O'Keeffe, STEM Cobb

ENERGY AND COMBUSTION: BACKGROUND INFORMATION

In previous Fire Forensics investigations, we learned that only gases burn, solids do not burn. When a solid is heated, it gives off fuel gases, which are flammable. This process is called **pyrolysis**. We also learned that synthetic materials burn a lot faster than organic materials. We learned that the mass and density of materials may enable them to ignite and burn at different rates – meaning that we can change how easy it is (or how much energy is required) to ignite a material, like wood, based on the shape and size of the wood, or the form that it is in. This is called the **surface-to-mass ratio.**

Now, we want to investigate the heat released when different fuels burn, and measure the heat released by household materials and foods using a process and calculation for the heat of combustion.

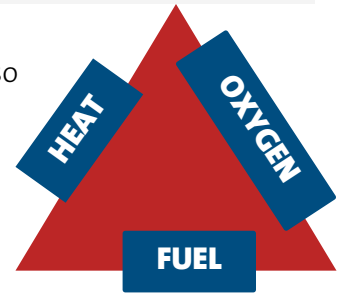
HEAT OF COMBUSTION

What's the difference between temperature and heat? According to the National Fire Protection Association (NFPA):

> **Temperature:** The degree of sensible heat of a body as measured by a thermometer or similar instrument.
>
> **Heat:** A form of energy characterized by vibration of molecules and capable of initiating and supporting chemical changes and changes of state.

Heat of combustion is the energy released from a fuel while it is burning with oxygen at standard temperature and pressure. This is a primary difference between heat and temperature. For example, think of a candle flame and a campfire flame. The flames of different sizes may be the same temperature, but the energy released is different. In addition to the potential energy of the material, the amount of energy released is also based on the oxygen consumed during combustion.

Consider: Why might the heat released by the candle and campfire be different?



Here's another way of thinking about it. When you eat food, your body breaks down the calories – or the chemical potential energy stored in the food. You also breathe in oxygen, then oxidize and digest the food you consumed. You do this to transform the potential energy to mechanical energy that your body uses to move around. Sometimes you move around so much you will sweat because you are generating heat and burning the calories you consumed.

If you think about it, you also know that some foods are more efficient fuel than others. Have you ever eaten a bunch of candy at one time? What happens? Were you super hyper for a little while and then really tired once the candy metabolized?

Consider: How might the way our bodies burn calories in food connect to the different fuel sources found at the fire scene?

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HOW DOES A CALORIMETER PROVIDE DATA ABOUT THE AMOUNT OF ENERGY RELEASED DURING COMBUSTION?

A **calorimeter** is a tool used to measure heat released by burning objects – both food and common objects found in homes and buildings. Calorimeters can measure energy released during a chemical reaction (fire) or even phase changes.

To build a simple calorimeter, we will burn objects under a can of water. In this experiment we will assume the heat released by the object is equivalent to the heat absorbed by the water. The temperature change in the water provides a rough measurement of the heat released by the object during combustion and transferred to the water in the can. We will record the temperature change in the water to calculate the heat released by the object.

Before we observe the calorimeter at work, let's review the methods of thermal energy transfer: conduction, convection, and radiation.

Consider: The object being burned is the fuel. The fuel is releasing energy as it burns under the can. The transfer of energy from the object to the can is mostly due to _____.

Consider: The can transfers energy to the water and we can measure the temperature change of the water. The transfer of thermal energy from the can to the water is due to _____.

Consider: The light energy is transferred from the flames to the can is due to _____.

Everything burned in this investigation is found in homes, including wood and food. Fire investigators need to know how different common household items burn so when they arrive at a fire scene and enter a room where everything is rubble, they can sift through the debris and determine what was on fire, how it burned, and understand the patterns of the burn scene around them. When fire investigators investigate the evidence left behind from different fuels, they have to know how the fuels reacted in the fire, the energy they release, if they were insulators or conductors of heat. They can use this information to trace back to what the fuel was that burned.