Burn a Nut Activity

Objectives

- Understand the similarities and differences from stored energy in a variety of fuel sources.
- Understand that biofuels can be used as alternative fuels.
- Understand how agricultural crops can be used to create fuel.
- Understand how energy is neither created nor destroyed but transferred from one form to another.

Skill Level: High school	**Class time:** 45 minutes **Set up:** 15 minutes

Materials (per group)

- 1 nut (pecan, almond, or brazil nut)
- 1-2 soybeans
- 1 wood pellet
- 2 large paperclips
- Stopwatch
- Empty aluminum can
- Small glass dish
- Masking tape
- Thermometer
- Ring stand
- Food or balance scale
- Safety glasses
- Grill lighter
- Copy of Burn a Nut Observation Log (below)

Next Generation Science Standards

Disciplinary Core Idea:
HS-PS3.B Conservation of Energy and Energy Transfer

Performance Expectations:
HS-PS3-1 Produce written and illustrated texts or oral presentations about how scientific discoveries about the conversion of energy from one form to another have affected human

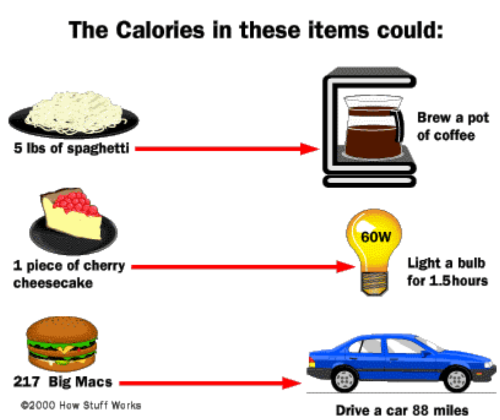
civilization, including the further development of science and technology.

Practices	**Crosscutting Concepts**
☐ Asking questions / defining problems	☐ Patterns
☐ Developing / using models	☐ Cause and effect: Mechanism / explanation
☒ Planning / carrying out investigations	☐ Scale, proportion, and quantity
☐ Analyzing / interpreting data	☐ Systems and system models
☒ Math / computational thinking	☒ Energy / matter: Flows, cycles, conservation
☐ Constructing explanations / design solutions	☐ Structure and function
☐ Engaging in argument from evidence	☐ Stability and change
☐ Obtaining / evaluate / communicate	

Background Information

Background

As Webster's dictionary defines it a calorie is: "the amount of heat required at a pressure of one atmosphere to raise the temperature of one gram of water one degree Celsius", but what does this mean. This means at a set pressure and a set weight of water, we should be able to raise the temperature of water by a degree Celsius. How much heat it takes to raise the water by one degree Celsius determines how many calories are needed.



Calories also tell us how much energy a particular substance has. As you may know already from Newton's First Law of Thermodynamics, energy cannot be created nor destroyed and therefore can only be transferred. In the process of consuming a calorie energy transfers from food to the consumer. The consumer does not always have to be a human being. As this graphic shows, energy transferred from food can even be used to power a car. Alternative fuels such as food are even being discussed because food (like corn based ethanol) can be regrown. This would be considered a renewable energy source, which can be a better fuel source than gasoline because there is a finite amount of fossil fuels on the planet. When a renewable energy source is used as a fuel it is considered a biofuel.

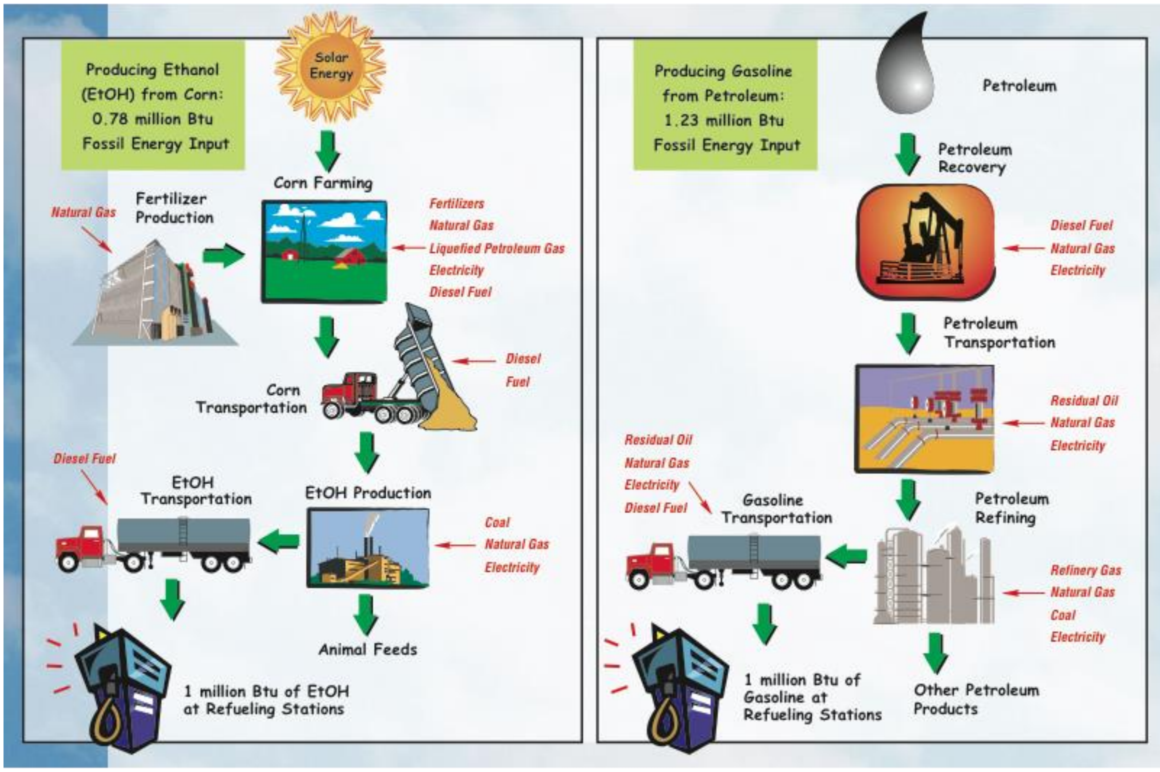


Figure 1. Life cycle of ethanol as compared to gasoline. Reference

When measuring the efficiency of any fuel, scientists (in the United States) often use a measurement called British thermal units (BTUs). Like a calorie, a BTU is the amount of energy used to heat or cool one pound of water by one degree Fahrenheit. This unit is useful when comparing how much a biofuel burns compared to gasoline. As the graphic shows, ethanol fuel does have a lower BTU meaning ethanol's energy input is lower than that of gas. Therefore a car that can run on ethanol would have to have a larger tank to be able to go the same distance as a gasoline car could on a normal tank. With biofuels there are always trade-offs; you can have a cleaner fuel source, but may be at the pump more often, depending on the energy content of the fuel.

In this activity students will explore the transfer of energy from food to fuel source. By taking a nut and measuring its temperature, students should be able to figure out how much energy the nut has and how much energy is consumed in the process of burning. Students will also compare this to other fuel sources and decide which is the better biofuel.

Engage

• What is energy? How is it created? Where do we get most of our current energy that we use in our homes and transportation? How do we use energy? Is there a limitation to this resource?

• Which source contained the most "stored energy"?

• What are the benefits to finding alternative resources? What are the limitations?

• Important concept: One of the major limitations that biofuels have is scaling the production to industrial scale. Help students understand the differences between private and small-scale productions and large industrial scale productions, and the impacts these have on society. The Industrial Revolution and its impact on society could be a good source of reference.

• How could we expand the use of biofuels in the future?

Explore

Experiment Questions:

- How much energy is stored in a nut?
- Do different nuts contain the same amount of energy?

Procedure:

1. Gather the materials.

2. Arrange a nut on the unfolded paperclip. Tape to the bottom of the dish (see Figure 1). Measure the mass of the fuel, (nut or soybean), fuel holder (paperclip) and glass dish. Add this data to the Observation Log.

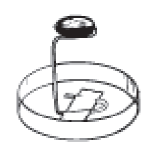


Figure 1

3. Pour 50 mL of water into the aluminum can. Record the temperature. Suspend from the ring clamp using an unfolded paper clip (see Figure 2).

4. Ignite the nut or bean by holding a flame on it until it begins to burn on its own. Start the stopwatch when you apply the flame.

5. Adjust the can to hang directly over the burning fuel source. Do not extinguish the flame! If the nut/soybean stops burning before it is completely consumed, try to relight.

6. Monitor the temperature of the water, but do not allow the thermometer to touch the bottom of the can.

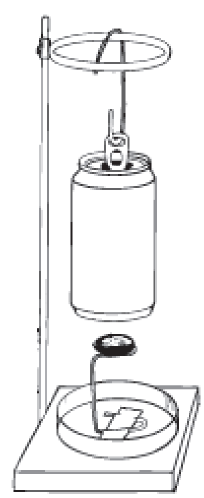


Figure 2

7. Allow the fuel to burn until it is consumed. Record both the burning time and the temperature of the water on the Observation Log. Measure the mass of the glass dish, paperclip and any ashes.

8. Calculate the change in time, temperature and mass and record on the Observation Log.

9. Repeat steps 1-8 using the soybean. Record your data. Repeat again using the wood pellet. Record your data.

10. Calculate the change in temperature over the change in mass. Which fuel produced the greatest change in temperature compared to the mass? Which fuel has the most stored energy?

Explain

Following are questions for guiding the discussion:

- What is energy? How is it created? Where do we get most of our current energy that we use in our homes and transportation? How do we use energy? Is there a limitation to this resource?
- Which source contained the most "stored energy"?
- What are the benefits to finding alternative resources? What are the limitations?
- Important concept: One of the major limitations that biofuels have is scaling the production to industrial scale. Help students understand the differences between private and small-scale productions and large industrial scale productions, and the impacts these have on society. The Industrial Revolution and its impact on society could be a good source of reference.
- How could a machine be designed to burn nuts as a fuel source?
- How could we expand the use of biofuels in the future?

Elaborate

- Test other nuts or food sources. In addition, try using a glass fuel burner containing lamp oil. Allow the lamp oil to burn for exactly 3 minutes.
- Make predictions about how much stored energy there is in some of your favorite foods.
- Are there sources of biofuels in your community? If so, what are they and how could you adapt them for use? Students can develop a written or oral presentation on biofuels to emphasize the performance standard.

Resources

Additional Resources:

- Biofuels Calorific Value
- BTU Comparison

Resources Used:

- Biomass to Biofuel Activity
- Alternative Fuels Data Center
- Ethanol Life Cycle