

STEM *Sims*™

# Calorimetry



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**Do you need an idea for a scientific study?  
Try out one of our ideas or make one of your own.**

**Start right now learning about the basics of calorimetry and how various substances release energy when burned. Take the following brief quiz to see how much you already know about the energy content of common materials. See the bottom of page 4 to check your answers.**

1. A candy bar is labeled as having 450 Calories. If burned, how many calories of heat would the candy bar produce?
  - a. 45
  - b. 450
  - c. 4,500
  - d. 450,000
2. When a chemical bond between two atoms is broken, energy is released.
  - a. true
  - b. false
3. About how long would a 150-pound person have to climb flights of stairs to burn off the energy gained from eating one normal-sized banana?
  - a. 1 minute
  - b. 5 minutes
  - c. 10 minutes
  - d. 30 minutes
4. For a given mass, which food category contains the greatest amount of energy?
  - a. carbohydrates
  - b. proteins
  - c. fats
  - d. all three provide the same amount of energy
5. About what percentage of energy contained in a normal food item is actually gained by a human after respiration has been completed in the body?
  - a. 25%
  - b. 45%
  - c. 60%
  - d. 85%



## A Burning Question

Petroleum is the main ingredient in gasoline. However, gasoline for today's vehicles contains up to 10% of another substance called ethanol. That means that gasoline should really be called "gasohol." Most ethanol is extracted from corn plants. Some people are calling for a higher proportion of ethanol to be present in gasoline since ethanol is a renewable resource. Petroleum, on the other hand, is a nonrenewable, limited resource. So why not go all the way and make all vehicles run solely on ethanol?



**Here are some questions to help you decide on the gasoline/ethanol debate.**

1. Ethanol has a density of 0.79 g/mL, while gasoline's density is 0.70 g/mL.
  - a. Based on this information, which is the better buy to fill your vehicle's fuel tank?
  - b. About how much more fuel (in percentage) is dispensed per fill-up with the "better buy" fuel?
2. Energy is extracted from hydrocarbon fuels, such as gasoline and ethanol, through the process of combustion. The amount of energy released depends on the structure of the molecules that make up the fuels. The more carbon atoms and the more hydrogen atoms per carbon atom, the greater the energy produced by the fuel during combustion. Ethanol produces about 27 units of energy per gram when burned, while gasoline provides about 44 units of energy per gram.
  - a. Which substance, ethanol or gasoline has more carbon-carbon bonds and more hydrogen atoms per carbon atom?
  - b. About how much more energy (in percentage) is produced per gram using the "better fuel?"
3. Based on your answers to the previous questions, should more or less ethanol be added to the current mix of gasohol?

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## Fuel for Machines

Whether an automobile or a person, both machines require fuel to burn. In both cases, carbon-based compounds provide the energy needed to do work when the substance is burned and the chemical bonds in the material are rearranged. Just as gasoline is a more energy rich fuel than ethanol, fats store more energy than carbohydrates or proteins. In fact, fats have about 9 calories per gram compared to only 5 calories per gram for proteins and carbohydrates. This information about the energy content of fats will help you better understand the nutritional value of various food items.



Nutrition Facts	
Serving Size 1 cup (228g)	
Servings Per Container 2	
Amount Per Serving	
<b>Calories</b> 250	Calories from Fat 110
%Daily Value*	
<b>Total Fat</b> 12g	<b>18%</b>
Saturated Fat 3g	<b>15%</b>
Trans Fat 3g	
<b>Cholesterol</b> 30mg	<b>10%</b>
<b>Sodium</b> 470mg	<b>20%</b>
<b>Total Carbohydrate</b> 31g	<b>10%</b>
Dietary Fiber 0g	<b>0%</b>
Sugars 5g	
<b>Protein</b> 5g	
Vitamin A 4%	Vitamin C 2%
Calcium 20%	Iron 4%
* Percent Daily Values are based on a 2,000 calorie diet. Your Daily Values may be higher or lower depending on your calorie needs:	
	Calories: 2,000 2,500
Total Fat	Less than 65g 80g
Sat Fat	Less than 20g 25g
Cholesterol	Less than 300mg 300mg
Sodium	Less than 2,400mg 2,400mg
Total Carb	300g 375g
Dietary Fiber	25g 30g

Please review the food item label shown to the left.

Based on the label, what percent of the food calories in this item comes from fat?

Did you say 18%? Well, let's walk through a calculation that might change your mind about that. First, how many total grams of fat are in the item? 12 grams.

Remember that each gram of fat stores 9 calories of energy, so 9 times 12 equals = 108 calories from fat. 108 calories from fat divided by 250 calories (the total calories in the item) equals 43%. So 43% of the food calories in this item are from fat, not 18%!

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**Answers:** Page 2 Answers: 1) d, 2) b, 3) c, 4) c, 5) d. Page 3, A Burning Question Answers: 1a) Ethanol, 1b) Almost 12% more ethanol per tank that gasoline, 2a) Gasoline, 2b) About 39% more energy per gram from the gasoline, 3) Less ethanol, since it produces fewer miles of vehicle travel per tank than gasoline.

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