6

Conductors of Heat Energy

Kitchen Conductors

Scientific Inventions in Your Kitchen!

In science class you noticed that heat energy travels through some materials better than others. Materials that transfer heat easily are called **conductors**. Materials that slow the transfer of heat are called **insulators**.

Why is it important to know whether something is a conductor or an insulator? Step into your kitchen the next time someone is baking and you will find an answer to this question. Most likely, you will notice a lot of different items made up of a lot of different materials—metal pans, rubber spatulas, cloth oven mitts, wooden spoons. Think about how each of these items is used. Do they need heat to travel through them easily or are they meant to keep heat from transferring? What are each of these things made of? Do the materials they are made from help them do their "jobs"?

Each tool we use in the kitchen serves a unique role in the preparation of food. There are some things that we want heat energy to transfer through easily, such as pots and pans and baking sheets. Most of these things are made of materials that conduct heat energy easily—aluminum, stainless steel, or copper.

Then again, there are other things in the kitchen that we definitely don't want to get hot. Imagine oven mitts made of metal. Instead of protecting your hands, they'd cause you to get burned! You also wouldn't want cooking spoons, spatulas, and even pot handles to get hot. Many of these things are made of insulators that limit the transfer of heat—plastic, wood, rubber, and cloth.

During Lesson 6 you discovered that slices of butter fell rapidly from the aluminum and copper rods, but not from the brass, bamboo, and plastic rods. This is because the heat energy in the water transferred quickly through the aluminum and copper rods, but more slowly through the brass, plastic, and bamboo rods. Let's explore how each of these materials are used in kitchens, and why.

Copper is an excellent conductor of heat energy. Pots and pans made of copper transfer heat energy quickly and evenly to all sides of the pan—this helps food get cooked evenly throughout. When the pan is removed from its source of heat energy (the burner), it immediately transfers its heat energy to the surrounding air and cools down. This keeps food from getting overcooked.

Aluminum is also a good conductor of heat energy. When heat energy is applied to an aluminum pan, the pan transfers the heat energy quickly and evenly to all sides, just like copper.

Brass is an alloy (a mixture) of copper and zinc. Even though brass is a metal like copper and aluminum, it does not conduct heat energy nearly as well as copper and aluminum. Chances are you will not find too many brass pots in your kitchen!

Bamboo, like all wood, is a poor conductor of heat energy. Because they do not transfer heat energy well, bamboo and wood are used to make cutting boards, spoons, and serving

Think About It!

Since we know that copper is an excellent conductor and you found in Lesson 6 that brass is a poor conductor, do you think zinc is a good or poor conductor of heat energy?

dishes. But you need to be careful when using bamboo around heat! If enough heat energy is applied, bamboo will burn. Think of a log thrown on a fire…the same thing can happen if a wooden spoon is placed in an oven, or left unattended on a stovetop.

Energy Fact

Bamboo is a woody grass. Some types can grow to a height of 18 m (60 ft) in about 3–5 years. They can grow as much as 61 cm (2 ft) per day! Because bamboo grows so quickly, it is a better choice than wood for many kitchen items.

Plastic is a poor conductor of heat energy. Plastics make good cooking utensils, such as spoons to stir sauces and soups, or storage containers for food. Even though plastic does not transfer heat energy well, if enough heat energy is applied to some types of plastic, they melt. Only certain plastics are designed to handle high temperatures. So be careful about how you use plastics around heat.

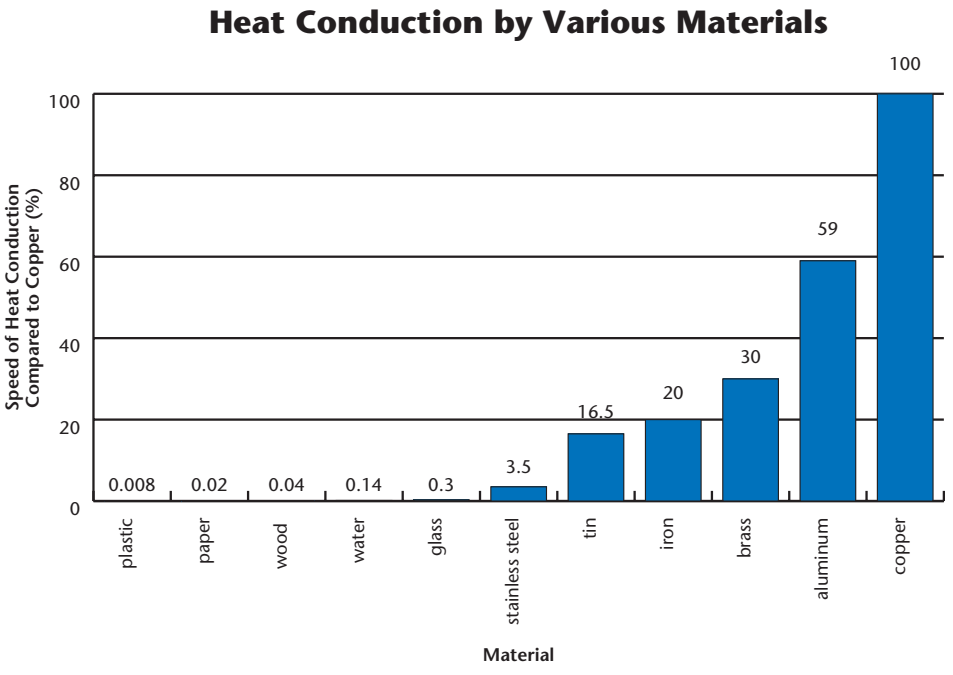
Combinations of Materials—Many types of cookware and kitchen utensils are made from a combination of materials. What is the advantage of having a copper pot with a plastic handle? You can heat the pot quickly on a stovetop, but still be able to pick it up without an oven mitt. Many types of pots, pans, and utensils are made of a combination of materials—some that are good conductors of heat energy and others that are poor conductors. Using a combination of materials makes these tools even easier to use in the kitchen.

Cooking—Harnessing Heat Energy Transfers to Meet Our Needs

How does heat energy transfer to cook the food you eat? In the case of stovetops, heat energy flows from the burner on your stove to the pan resting on it, and then to the food it contains. In an oven, the heat comes from electricity or gas and is transferred through the air to the food baking, roasting, or broiling inside the oven.

How Well Do Materials Conduct Heat Energy?

How well do the pots and pans in your kitchen conduct heat energy? The bar graph below shows how well a variety of materials conduct heat energy compared to copper.



Think About It!

Use the bar graph, "Heat Conduction by Various Materials" to answer the following questions:

- What material would you want a teapot that you boil water in to be made of?
- What material would you use when you want to cook something very slowly over a long time without burning it?

As you can see from the bar graph, kitchen tools made from plastic, paper, wood, and glass do not conduct heat energy very well compared to copper. That is why these materials are more often used in kitchenware that protect us from heat energy, such as drinking mugs, serving dishes, spatulas, and pot handles. Pots and pans are made from materials that conduct heat energy well. These materials include copper, aluminum, iron, and stainless steel.

Each type of kitchenware has different characteristics that make it unique. No one type of kitchenware is perfect for all jobs—but each one might be perfect for a particular job. So the next time your family is preparing dinner, ask if you can help them—and share with them what you've learned about heat energy!

History and Biographies

Harnessing Heat Energy—Kitchen Appliances

Refer to the timeline "A Walk Through Energy History" on pages 129–146. Several of the milestones listed are related to kitchen appliances and cooking:

1913—The first refrigerators for home use are produced in Chicago.

The first refrigerators looked very different than the one in your home today! For one thing, they did not have a freezer compartment. Refrigerators with freezers were not made until the 1920's and '30s. Refrigeration technology did not improve much until the 1950's and '60s. It was during this time that inventions like automatic defrosters and automatic ice makers first appeared.

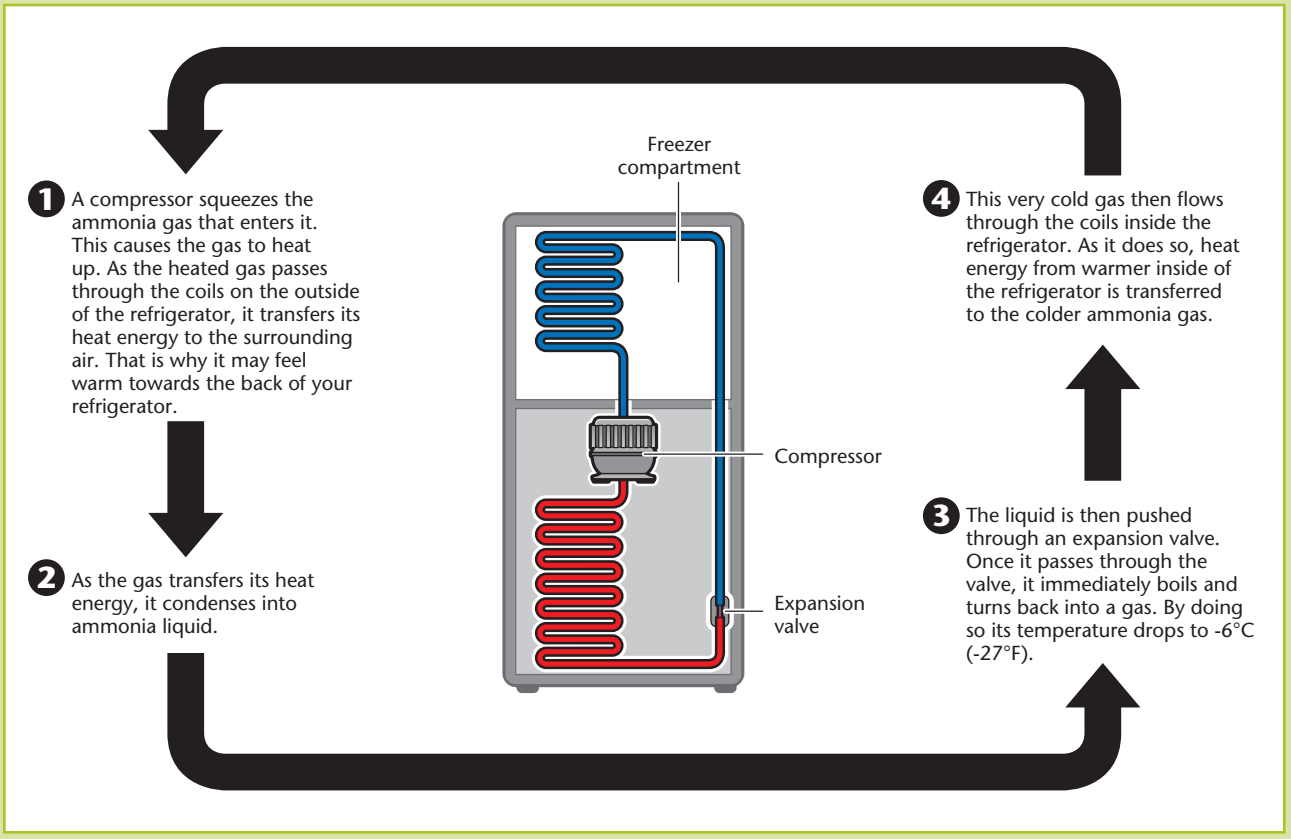
The first refrigerators were not very friendly to the environment. From the 1930's through the 1980's a gas, called Freon, was used in refrigerators to help keep food cool. In the 1970's and '80s people became more concerned about the environment. In the late 1980's scientists confirmed that Freon helped cause what's called the Antarctic Ozone Hole. This knowledge led to the development of refrigerators that use ammonia gas, instead of Freon, which is more environmentally friendly.

Think About It!

Studies by scientists in the 1970's found that gases released into the atmosphere, such as Freon, accumulate in the **stratosphere**. This is the layer of the atmosphere where the ozone layer is located. The ozone layer protects living organisms from the harmful effects of the sun's ultraviolet radiation. A small decrease in the ozone layer can result in an increased rate of skin cancer in humans.

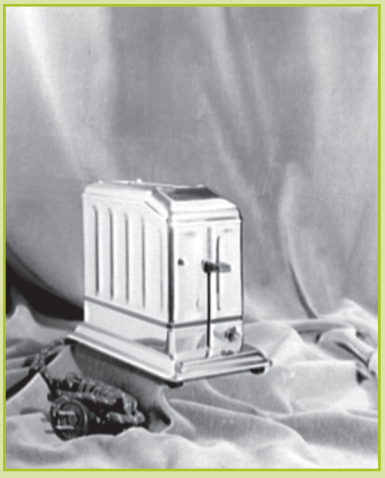
How Does a Modern Refrigerator Work?

A refrigerator contains a system of coils, a compressor, and an expansion valve. Ammonia gas flows through these pieces, as Freon once did, in a continuous cycle. This transfers heat energy from the inside to the outside of the refrigerator, so the refrigerator is constantly getting rid of heat energy. Let's explore the process more closely and see the role that heat energy transfer plays in cooling your food.



1919—The pop-up toaster is invented.

Toasting bread began as a method of making bread last longer. It was a very common activity in Roman times. "Tostum" is the Latin word for scorching or burning. The first electric toaster was invented in 1893 in Great Britain and reinvented in 1909 in the United States. It only toasted one side of the bread at a time and it required a person to stand by and turn it off when the toast looked done. Charles Strite invented the modern pop-up toaster in 1919.



1947—Raytheon introduces the first microwave oven.

In 1947, Percy Spencer was touring one of his laboratories at the Raytheon Company. He stopped in front of a magnetron tube—a device that makes microwave energy. Feeling a sudden strange sensation, Spencer noticed that the chocolate bar in his pocket had begun to melt. He then held a bag of unpopped popcorn next to the magnetron tube—only to see the kernels explode into popcorn.

From this simple experiment, Spencer and Raytheon developed the microwave oven. The first microwave oven weighed a hefty 340 kg (750 lbs) and was as tall as an average adult. That is very different than today's microwave ovens!

How Does a Microwave Oven Work?

Microwave ovens cook food in an amazingly short amount of time. They use **microwave energy** to cook food. When you start a microwave oven, a magnetron tube inside the microwave produces and releases microwave energy. The water, fats, and sugars in foods absorb the microwave energy. As the microwave energy is absorbed, it is transferred to heat energy which cooks the food. Most plastics, glass, or ceramic materials do not absorb microwave energy. This is why it is safe to use these dishes in a microwave oven. Microwave energy reflects—or bounces—off metals, which is why you cannot put metal pans or aluminum foil in a microwave oven.