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Introduction

A Little More About Temperature

Thermal conductivity is the ability of a material to convey heat. We know intuitively from human experience that metals are a whole lot better at conducting or conveying heat than nonmetals. All you have to do is put a metal spoon in hot tea and feel how hot the spoon becomes after just a brief amount of time.

This bit of human experience lends itself to some simple experiments that can be performed to get a relative measure of how materials conduct heat. Figure 3 shows a simple apparatus that can be used to determine which materials are best at conducting heat. A Bunsen burner will be the heat source, and various materials of equal length and diameter will be heated at one end. At the other end will be a temperature measuring device and a stopwatch that will time how long it takes for each material to reach a certain temperature. With this setup, we would expect the best conductors to take the least amount of time to reach that temperature. The temperature can be any one of a variety of convenient values such as 90, 100, or 120 degrees F. The materials that can be tested could be lengths of:

- Steel
- Aluminum
- Copper
- Brass
- Bronze
- Glass
- Ceramic
- Any other nonflammable substance that can be obtained

Testing materials for thermal conductivity

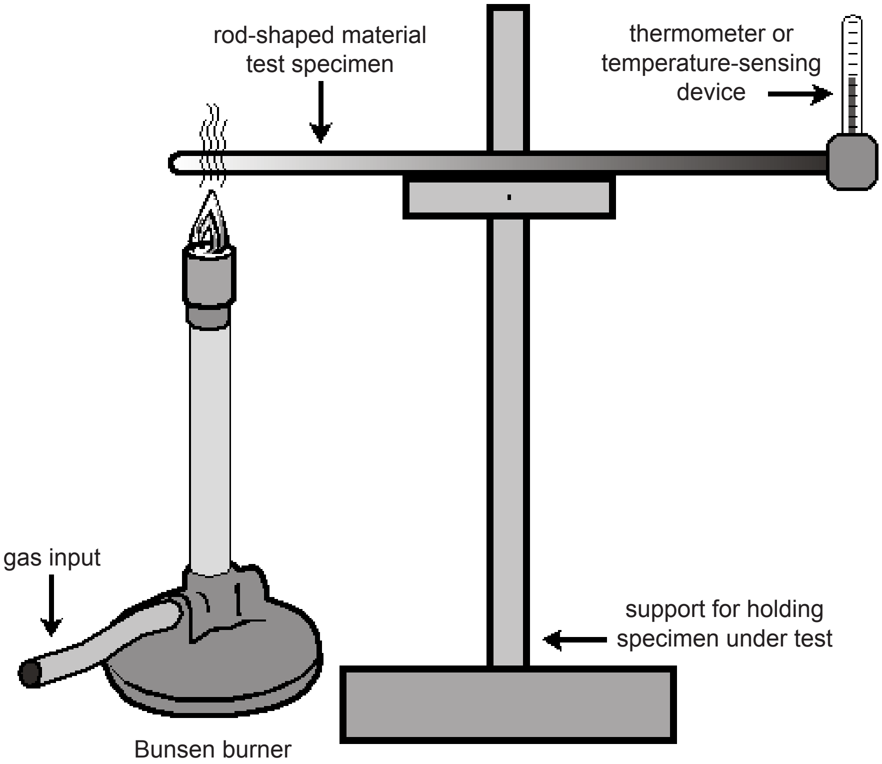

Figure 3

Data recording could be such that a graph of the heat-up time of each material is made, say, in five-degree increments.

Note: Be sure to wear protective gloves when handling the hot substances, and also exercise caution around the open flame. Wear eye protection!

How might the diameter and length of the materials affect their heat-up time? Can this be experimented and verified?

Throughout this series of experiments, make sure the Bunsen burner flame output is constant and unchanged. It is important that the same amount of heat be applied to each test specimen at approximately the same point. Make sure all the test specimens are at the same room temperature. Also, the apparatus that holds the test specimens will absorb some heat, which will inadvertently be transferred to the next specimen placed on it. Let the apparatus cool down a bit before testing each specimen, or use a different one for alternate specimen tests.

Take a convenient length of copper or steel rod and another of similar size, but hollowed out into a tube shape. Using data plots, compare the heat-up times for both. After each one is heated up to its temperature, measure and plot its cool-down rate to a temperature agreed upon by you and the students. Is there a difference between the time for heat-up and cool-down? What affects how fast or slow the rods cool down?

Do the test specimens have to be rod shaped? Could they be of different shapes? How could you test this?

How would you measure the thermal conductivity of water and other liquids?

Engineers often "map" the flow of heat using computer programs. Figure 3a shows how a contour map of surface temperature distribution from a heat source (S) might look. Each ring represents a temperature value that may have been recorded by sensors, or simulated mathematically via a complex computer code. Obviously, the path from S to A is one of high thermal conductivity; and S to B is another path of good thermal conductivity. However, path S to C is not as good. Such maps would be of value for examining the thermal conductivity of soils, metals, and various materials, and might also include a three-dimensional aspect to the flow of heat. These types of representations are also commonly used to show the movement of heat through liquids, such as the thermal discharge into a river from a large power plant or gaseous heat discharge from a chimney or stack.

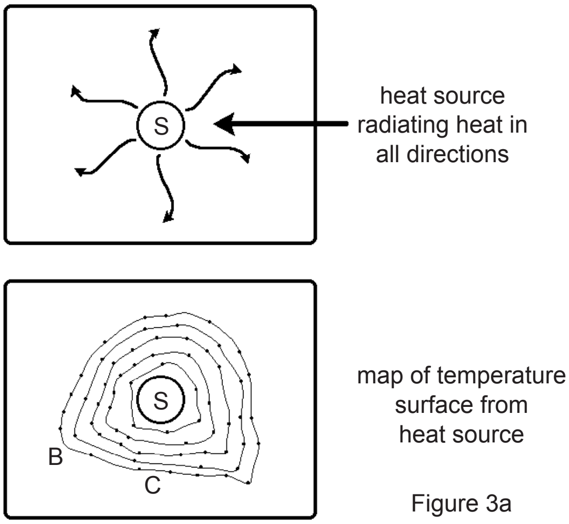

Figure 3a

Some Engineering Activities for Your Students

Here are some activities and questions about engineering that your students can tackle and discuss. There are plenty of engineering references and resources available on the Internet to help with these.

What is a good working definition of engineering?

What is the difference between an engineer and a scientist and how they look at problems and the world in general?

How are engineering and technology education similar?

Based on what you know about engineering, would you consider becoming an engineer? If not, why not?

Can you invite some engineers into the classroom to discuss their work and the technical, social, environmental, and cultural impact it has had?

What is most important for engineers to do: Make the best possible product or make a product that is safe and affordable that people can use?
Discuss and justify your position.

When engineers first designed and built sewage systems to serve cities, it made a tremendous difference in everyone's standard of living. Discuss how this engineering feat impacted the health of city inhabitants.

All engineering accomplishments can have both positive and negative impacts. Make a chart that shows the positive and negative impacts associated with the automobile.

Interview your parents and grandparents to learn how technology has changed their lives. How did computers change their lives?

Speculate what will happen as engineers continue to squeeze more electronics onto a single microchip. Consider how this might impact:

- Medical treatments
- Consumer products
- Personal privacy
- Military activities
- Police activities

How do engineers work with customers who want and need new products?

Why are good communication skills important to what engineers do?

What 36 Years in Engineering Taught Me –

A Slide Presentation with Tips for the Student Interested in Engineering