a WOW Lab BLUEPRINT

'c' is for Chocolate

Inquiry Approaches

Initial Inquiry

How do microwaves work?

A microwave uses standing electromagnetic waves to excite polar molecules, mainly the water and fat present in food.

Why do microwaves have turntables?

Microwaves heat unevenly because the standing waves only emit heat at the points where they pass through the food or drink (the antinodes). A turntable is used to ensure that more of the food or drink encounters an antinode during the cooking process.

Experimental Procedure Inquiry

What type of chocolate (dark or milk chocolate) works best in this activity and why?

Dark chocolate is best because the higher cocoa butter content results in a higher melting point. In milk chocolate, the heat dissipates through the bars very quickly by conduction and the bars melt entirely before any distinct antinodes can be observed.

Why is it important to refrigerate the chocolate before performing the activity?

If the bar is cooled beforehand, more heat is needed to achieve melting by convection. Refrigeration improves the odds of observing the antinodes in the chocolate before the entire bar melts.

In-Depth Inquiry

What is an electromagnetic wave and how does it melt the chocolate?

Electromagnetic waves have an electric and a magnetic component. A microwave is an example of such a wave. Electromagnetic waves carry both energy and momentum. In this activity, the energy of the microwaves is greatest at the antinodes. This provides the heat which melts the chocolate at the location of the antinodes.

When calculating the speed of light using the measured wavelength, why are there discrepancies between the calculated value and the actual value? Calculate the percent error compared to the known value of the speed of light (the constant *c*).

The formula for the percent error is: [(calculated value - actual value)/(actual value)]*100. The actual value for the speed of light is that of speed of light in a vacuum; light travels a little bit slower in air. The value calculated in this activity will vary depending on the points students use as an estimate of the melted antinodes. The frequency of the microwave also includes some margin of error.

Calculate the wavelength of the microwave using the known speed of light ($3x10^8$ m/s) and the frequency of the microwave (2.45 GHz). Is there a discrepancy between the calculated and measured wavelength? Why?

Measurements using the chocolate will never be completely precise because the antinodes of melted chocolate are at least 2 cm in diameter, leading to variations in data. Also, the speed of light calculation assumes a vacuum medium, but the medium inside the microwave is air.