

# MELTING MARSHMALLOWS

## INTRODUCTION

In Melting Marshmallows, students, with supervision, estimate the speed of light and discuss the difference between the speeds of light and sound using other more common examples, like fireworks and lightning.

## MATERIALS

For Melting Marshmallows, you need a microwave oven, a microwave-safe casserole dish, a ruler, and a bunch of marshmallows. Because you are unlikely to have more than one microwave in your classroom, or near it, you might plan stations or do this once as a demonstration.

## STANDARDS

### NGSS MS PS4-1

Use mathematical representations to describe a simple model for waves that includes how the amplitude of a wave is related to the energy in a wave.

### NGSS MS PS4-2

Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.

### NGSS MS PS3-5

Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object.

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*In this activity students use the conversion of electromagnetic radiation into kinetic energy, and the pattern resulting, to calculate the speed of light. The point is not the accuracy of their calculation, but to show then how different forms of energy are related, and can be changed in form, and to see the relationship between the characteristics of waves. Also to understand how microwave ovens work. Developing and Using Models, and Using Mathematics and Computational Thinking are the Science and Engineering Practices they use in this activity. They will have a chance to explore the Crosscutting Concept of Pattern.*

NAME:

DATE:

## MELTING MARSHMALLOWS

You know that equation that made Einstein famous?  $E=mc^2$

The  $c$  represents the speed of light. Red light, UV light, radio waves—they all go the same speed, which is  $c$ . But how fast is  $c$ ? You are going to estimate  $c$  by melting marshmallows in a microwave oven.

**Complete the following steps:**

1. Put a plate covered with marshmallows in the microwave and heat them up. Because microwaves do not heat things evenly, some spots will melt faster than others. Watch it carefully, and stop it before all the marshmallows have melted.
2. Turn off the microwave and remove the marshmallows when some marshmallows begin to melt. Measure the distance between melted areas. They should all be about the same distance from each other. Record that distance in centimeters. Divide that measurement by 100 to convert it to meters.
3. Distance = \_\_\_\_\_ m
4. That distance is about half of one wavelength of the microwaves used in the oven:
5. \_\_\_\_\_ x 2 = \_\_\_\_\_ = wavelength in meters
6. Most microwave ovens make microwaves that have a frequency of 2450 MHz. That means they make 2,450,000 waves every second.
7. Calculate how fast a wave goes. To do this, multiply its frequency times its wavelength.
8. 2,450,000 waves per second x \_\_\_\_\_ meters = \_\_\_\_\_ speed of microwaves meters per second.

The speed of a microwave, and any electromagnetic wave, should be about 300,000,000 meters every second.

How close was your calculation? Where do you think the error comes from?