

Radio waves to gamma rays: uses and risks

Physics grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · Lab

Name: _____ Date: _____ Class: _____

Can a microwave oven and a chocolate bar help you measure the speed of light? In this lab the pattern of melted spots reveals the wavelength of the microwaves, and the frequency on the oven label gives you the speed with $c = f \times \lambda$.

Level: Physics grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · **Curriculum:** HS-PS4-4, HS-PS4-5

Aim

To measure the speed of light by finding the wavelength of microwaves in a microwave oven and using the frequency printed on its label.

Equipment

- Microwave oven (the frequency is printed on the back or inside the door, usually 2.45 GHz)
- Flat microwave-safe plate with the turntable removed
- Bar of chocolate or a slice of cheese spread flat
- Ruler in centimetres
- Oven gloves
- Pencil and notebook

Safety

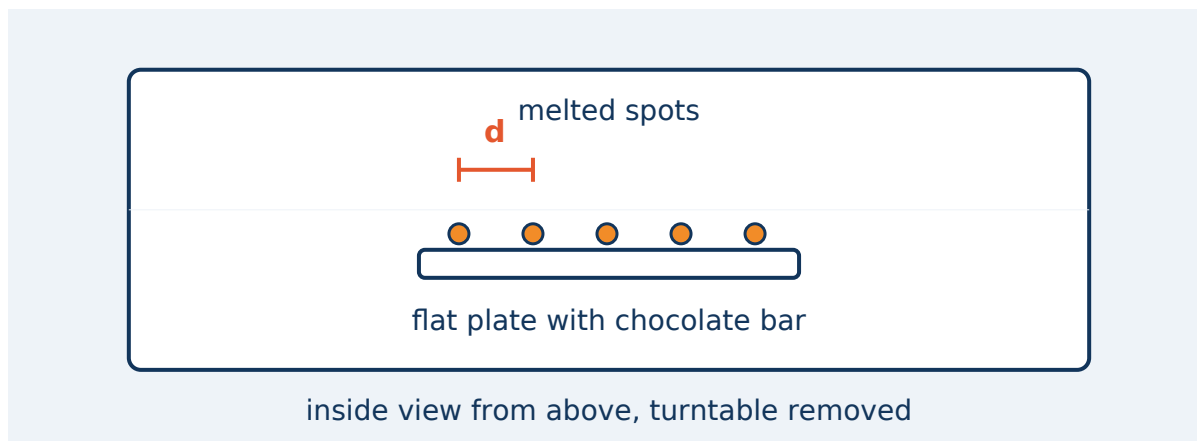
Safety

Never run a microwave oven empty. Heat for 15-20 seconds at a time, use oven gloves because the plate and melted food are hot, and do not eat the food afterwards. Ask an adult to supervise.

Method

1. Take out the rotating turntable so the food stays still, and note the frequency printed on the oven.
2. Place the chocolate bar on the flat plate, on a fixed spot.
3. Heat for 20 seconds, then stop and look. Repeat in 10-second bursts until several melted spots appear.

- Measure from the centre of the first melted spot to the centre of the last visible one in a row, and count the gaps between spots.
- Calculate the mean spacing d between neighbouring spots, then double it to get the wavelength.
- Repeat with a fresh piece of chocolate for each trial.



The melted spots mark where the microwaves are strongest. d is the distance between neighbouring spots.

Results

Sample measurements (oven frequency 2.45 GHz):

Trial	Number of gaps	Distance first to last spot (cm)	Spacing d (cm)
1	4	24.0	6.00
2	3	18.6	6.20
3	4	24.6	6.15
4	3	18.3	6.10

Analysis questions

Question 1 Mean spacing

Calculate the mean spacing d from the table to 3 significant figures.

Question 2 Wavelength

Explain why the wavelength is twice the spacing between melted spots, then calculate it.

Question 3 Speed of light

Use $c = f \times \lambda$ to calculate the speed of light from your results.

Question 4 Percentage difference

Compare your value with 3.00×10^8 m/s and calculate the percentage difference.

Question 5 Turntable

Explain why the turntable must be removed.

Question 6 Uncertainty

Estimate the range of the spacings and say which source of error is largest.

Question 7 Improvement

Suggest two improvements to give a more reliable value.