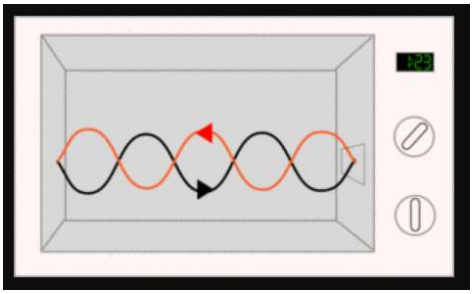
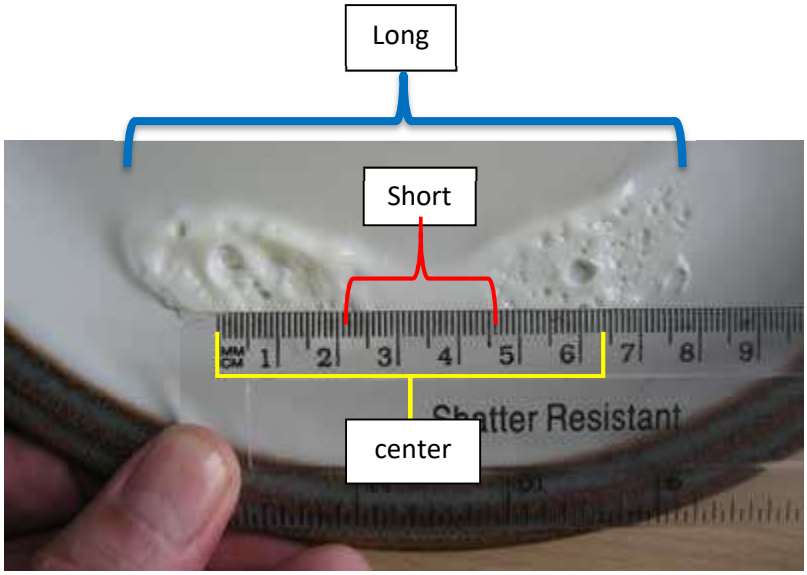
Dr. Duick

2012 Measuring the Speed of Light with Egg Whites and a Microwave (30pts)



- The smaller the microwave, the better for doing this experiment.
- If you have a microwave that has a fan at the top, you may get different results.
- (15pts) You must take a pictures of your results
  - 5 pictures showing your data for the experiment (the platter with the egg whites
  - ***YOU MUST BE IN ONE OF THE PICTURES!***

1. You will use the microwave rotating platter, remove it. You will cover the rotator on the bottom with a small bowl and rest the plate on top.
2. Using egg whites, pour a thin layer across the rotator plate (allow the white to drain into a bowl so it can be used on additional trials).
3. Put the plate in the oven (on top of the bowl), close the oven door, and cook the egg whites approximately 10-15secs.
   a. You'll probably need to experiment to find the ideal cooking time for your particular oven. 13 seconds may be a good starting point. If the egg is completely cooked, start over and decrease the time. If the egg is still totally uncooked, increase the time. If you don't disturb the plate, you can simply add more time. If the plate moves, you'll need to start over with a fresh plate of uncooked egg white.
   b. The ideal result is to have egg white that is partially cooked in some places.
4. Remove the plate from the oven. Be careful not to move the egg on the plate.
5. Measure the spacing between the cooked portions of the egg. Notes:
   a. The centers of the cooked portions will not be clearly defined.
   b. Your goal in making this measurement is to find:
      - the average distance between the cooked portions, *and*
      - an estimate for the error of your measurement.



c. Measuring the "center-to-center" distance between adjacent cooked portions will give you the average spacing of the hot spots.

d. Measuring the "edge-to-edge" distances (both shortest and longest) between adjacent cooked portions will give you upper and lower bounds on the error of your measurement.

e. Calculate length of a wavelength by adding the short edge to the long edge.

6. Clean and dry the plate, and repeat the experiment at least three times.

7. Look at the label on the back of the microwave (sometimes the inside door) to find the frequency of the microwave radiation the oven produces (see the illustration below). Alternatively, you may find this information in the user's manual for the oven.

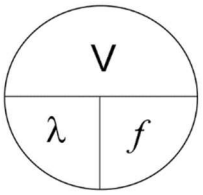
Example of a microwave oven label, showing the frequency of the microwave radiation: 2450 MHz. (Hood, 2007)

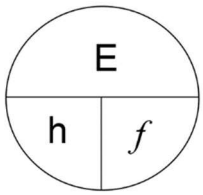
Dr. Duick

8. (5pts) Calculate the speed of the microwaves using the wavelength (measured) and frequency (from the oven label). Remember to use your upper and lower boundary measurements to put error limits on your measurement.
9. (5pts) How closely does your calculation agree with published values for the speed of light? What is your percent error for your trials (1-5) (true value = 299,792,458 m/s?
10. (5pts) What is the energy of these wavelengths?

- f = Hz frequency
- V = wave speed
- λ = wavelength
- E = energy in joules
- h = Planck's constant 6.626 x 10^{-34} J . s

$$\text{Percent error} = \frac{(\text{observed value} - \text{true value})}{\text{true value}} \times 100$$





Region	Distance between **short** boarders (red)	distance between **long** boarders (blue)	Center (yellow) X2 = wavelength	**short+long** **total wavelength**	Experimental Speed of microwave	% Error	Energy Joules
1							
2							
3							
4							
5							
average							