Calculating the Speed of Light

Name: _____ Date: _____

James Clerk Maxwell proved mathematically that light is an electromagnetic wave. This substantiated Michael Faraday's claims that this was the case shortly before Faraday's death. The speed of light has been calculated in many ways; one of the first was attempted by Galileo using campfires on distance hilltops. More recently it has been determined experimentally to a high degree of accuracy.

In this lab you will be calculating the speed of light using some simple household materials. You will also compare your value of the speed of light to the actual value and calculate the percent error.

Materials

- Large milk chocolate bar
- Microwave oven (remove the rotating base)
- Ruler and calculator

Review

Since light is an electromagnetic wave it follows the wave equation and will also create standing waves when reflected back on itself.

- **Wave equation** – look this up and write out the equation. _____
- **Standing Waves** – microwave ovens produce light waves at a very specific frequency; the waves are a constant frequency and since they reflect back and forth inside the oven they interfere with themselves and a standing wave is produced. This means there are regions of nodes and antinodes within the oven. This is why ovens now have rotating bases; this moves the food round so that one particular section of it is not in a node the whole time.

Procedure

1. Look at the back of the microwave oven to get the **frequency** of the light used within it. It will be in the Megahertz range:

$$f = \_\_\_\_\_$$

2. Place the unwrapped chocolate bar in the oven.
3. Shut the door and turn on the oven for a short period of time only. Not too long or else the whole chocolate will melt. Observe until two distinctly melted areas are created. **Stop it as soon as you see them appear**.

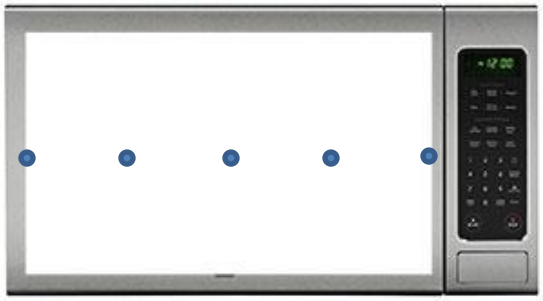
4. Remove the chocolate bar. Measure the **distance between the centre of the melted spots** (convert this to metres).

d = _____

5. Enjoy the chocolate treat!!

Calculations

1. In the microwave box below draw a standing wave at the fourth harmonic. It is closed at both ends.
2. The melted areas of the chocolate bar represent the **antinodes (maximums)**. Using the diagram to aid you and the measurement from one antinode to the other **calculate the wavelength** of the light.



3. Using the frequency from the microwave and your calculated wavelength; use the wave equation to **calculate the speed of light**.

$c \approx$

Percent Error

1. Calculate the percent error:

2. Comment on the accuracy of your measurements and results. Discuss some possible sources of error.