Refraction and Standing Waves

Lab #7

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Objective

Measure the wavelength of a microwave by creating a standing wave and demonstrate Snell's law using a prism mold.

1 Introduction

1.1 Standing waves

A standing wave is a wave whose energy density at every point remains constant, or a wave that does not propagate. The points at which the energy density is zero are called the nodes of the wave, and the points where the energy density is a maximum are called the antinodes.

A standing wave is generated by resonance when a traveling plane wave of wavelength λ reflects back on itself from a wall that is some integer multiple of $\lambda/2$ away from the source and interferes with itself. The horns of the microwave receiver reflect some radiation, so the transmitter and receiver can be placed facing each other at a distance $n\lambda/2$ apart (for any natural number n) to create a standing wave. When this happens, the intensity reading will be at a maximum.

1.2 Refraction

An electromagnetic wave is refracted, or bent, when it passes from one medium to another medium with a different index of refraction. Snell's law, named after Dutch astronomer Willebrord Snellius, relates the indices of refraction of the materials the light passes through and the angles at which it enters and leaves the boundary. If θ_1 is the angle between the direction of the light before crossing and the surface normal of the boundary, θ_2 is the angle between the direction after crossing and the surface normal, and n_1 are the indices of refraction of the first and second materials the light passes through, then

$$n_1 \sin\theta_1 = n_2 \sin\theta_2. \tag{1}$$

2 Procedures and Results

2.1 Standing waves

We set up the microwave system so that the transmitter and receiver diodes were approximately 70 cm and then slid them a few centimeters farther apart to get a maximum intensity reading. Then, we slid them farther apart, counting the times that the intensity reading hit a local minimum, stopping at a local maximum. We recorded the initial and final positions of the units and the number of minima passed.

Table 1: My caption

Initial position	Number of minima passed	Final position
74.9 cm	10	90 cm
73.3 cm	11	88.3 cm

2.2 Refraction

3 Discussion

3.1 Standing waves

3.2 Refraction

4 Conclusion

Today