Name:_____Date:_____Class:_____

Student Worksheet

Jell-O® Waveguide and Power Loss

Safety
Never shine laser light or reflected laser light into anyone's eyes—it will harm a person's retina and can cause permanent blindness. Boiling water and water vapor can cause serious burns.

As you do the procedure, write 3 of your own questions.

Materials
- pan with Jell-O®
- photodetector on an index card
- laser light pen
- multimeter with wires
- 2 wires with alligator clips at each end
- 4 sheets of graph paper
- protractor
- metric ruler
- pencil
- stirring rod
- sugar or salt
- masking tape

Question #1: _____

_____

_____

Question #2: _____

_____

_____

Question #3: _____

_____

_____

What do you think are the answers to your questions? Write your predictions below.

<u>Remember</u>: A prediction has the form: I think _____ will happen because _____.

Prediction #1: _____

_____

_____

NNIN Document: NNIN-1217

Prediction #2: _____

_____

_____

Prediction #3: _____

_____

_____

Procedure

1. Attach the alligator clips to the photo detector wires and plug the other ends into the multimeter. The photo detector wires should NOT touch each other. Set the multimeter to measure resistance (Ohms, Ω). Turn the knob on the meter to 20 kΩ.

2. Cover the photodetector. On the data table on the next page, record the resistance with no light on the detector.

3. Record the result while **NOT** covered.

4. Shine the laser directly on the detector. Record the result.

5. Place one section of Jell-O**®** on paper. Hold the photodetector at one end. Shine laser through the long length of one piece of Jell-O**®** and record the result.

6. Put two Jell-O**®** pieces end-to-end to make a length of about 14 inches. Shine laser through and record the resistance. Try three pieces end-to-end. Repeat. How long can you make the Jell-O**®** waveguide until you can't get a reading anymore?

7. Now repeat steps 5 and 6 but through the short side (the narrow width) and measure its thickness and resistance, then try two and then three. Record your measurements in the table below.

8. Draw an *x*-axis and *y*-axis on graph paper. Place a straight section of waveguide along the *x*-axis with the line along its edge.

9. Shine the laser into the intersection of these lines. Trace the path of the incident light beam. Mark where the refracted beam comes out of the Jell-O**®** waveguide on the other side.

10. Use a protractor to measure the incident angle, θ_1, and the refracted angle, θ_2, and record.

Record Your Observations
The numbers below are possible readings which will differ depending on the intensity of the ambient light and the laser.

No light	Ambient light	Direct laser light
140 kΩ	*40 kΩ*	*600 Ω*

	One long side of Jell-O®	**Two long pieces of Jell-O®**	**Three long pieces of Jell-O®**
Resistance	*1500 Ω*	*6000 Ω*	*12,000 Ω*
Length	*17.5 cm*	*35 cm*	*52.5 cm*
	One short side of Jell-O®	**Two short pieces of Jell-O®**	**Three short pieces of Jell-O®**
Resistance	*600–900 Ω*	*600–900 Ω*	*600–900 Ω*
Length	*3.75 cm*	*7.5 cm*	*11.25 cm*

Incident angle, θ_1 _____   Refracted angle, θ_2 _____

Analyze the Results

1. On a sheet of graph paper, graph your answers in the second data table to show how the resistance changes in relationship to the length of the Jell-O**®**.

2. What happened to the beam of light as the Jell-O**®** waveguide got longer?

   The beam of light dimmed as the Jell-O® waveguide got longer. _____

   _____

3. Calculate the index of refraction of the Jell-O**®** n_2, using Snell's law:

$$n_1 sin\theta_1 = n_2 sin\theta_2$$

$$n_1 = 1 \text{ for air}$$

4. When did the resistance seem to change the most?

   The resistance changed the most when we added longer pieces of Jell-O®. _____

   _____

5. When did the resistance seem not to change much at all?

   The resistance changed the least when we read the light through the short pieces of Jell-O®.

   _____

   _____

6. When does the graph seem to rise in resistance?

When the length of the Jell-O® increases, the resistance quickly rises. When the length of the Jell-O® doesn't change much, the resistance doesn't change very much, either.

Draw Conclusions

Can you suggest other ideas about how beams of light can be used to make the internet work?

NNIN Document: NNIN-1217