Name:________________________________Date:_______________Class:________________

Student Worksheet

Gelatin Waveguides: Guided Inquiry

Safety
Never shine a laser into anyone's eyes. It can cause permanent blindness.

Before you begin: Make sure you and your parents have read and signed the laboratory safety contract.

Introduction

Now that you understand how light can be contained and guided, you will be describing and designing your own optical waveguide that will bend a ray of light 180°!

Part I: Design Your Own Optical Waveguide

Materials
- gelatin square
- laser pointer
- graph paper
- protractor
- plastic knife
- 1/2 teaspoon of sugar
- 1 in. square of sandpaper

Question

What factors affect how well light can be contained and guided in a material?

Make a Prediction

*Example prediction: Factors that affect total internal reflection of light within the material will determine how well light is contained and guided.*____

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Procedure

1. Place your piece of gelatin on your graph paper.
2. Shine your laser beam through the piece of gelatin parallel to the graph paper. Use the graph paper and protractor to measure angles of incidence and refraction as the beam enters the gelatin from air.
3. Use the sandpaper to roughen one side of the gelatin piece to examine the effect of roughness on the total internal reflection of the laser beam.
4. Sprinkle a few crystals of sugar on the roughened site and observe the effect of large particles on the total internal reflection of the laser beam.
5. Use the plastic knife to create vertical grooves along the side of the gelatin and observe the effect of the grooves on the total internal reflection of the laser beam.

Record Your Observations

Material: *Gelatin*		**Effect of sandpaper**	**Effect of sugar crystals**	**Effect of grooves**
Angle of Incidence	*20°*	*Side of gelatin glows brighter showing that light is leaving the waveguide.*	*Sugar crystals on the side of the gelatin glow brightly representing points at which light is leaving the waveguide.*	*Side of gelatin glows brighter showing that light is leaving the waveguide.*
Angle of refraction	*15°*			

1. Experiment with your piece of gelatin and describe at least two more ways to positively or negatively affect the total internal reflection or light containment.
   a. *Example answer: Pieces of gelatin placed next to each other will allow light to pass through the interface between the pieces. Light can still be contained.*
   b. *Example answer: Corners on the gelatin will not guide the beam of light very well. Light is poorly contained.*

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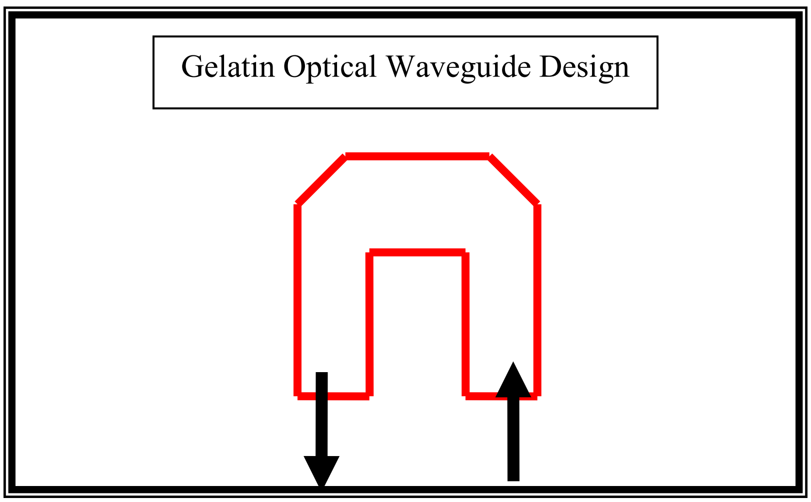
Analyze the Results

1. Small optical waveguides are beneficial for they take up less space, thereby increasing the number of waveguides that can be placed on a computer chip. What is the surface area called that an optical waveguide occupies? ____*footprint*__________________
2. Using the observations you have made, design a gelatin optical waveguide that will:
   a. turn a beam of light 180°
   b. occupy the smallest footprint possible
3. Draw your design below and describe at least two aspects of your design that you feel will allow you to meet the above criteria.



<u>Design Features</u>:

a. *Example answer: We will use a cake slicer with a flat blade to get smooth sides on the gelatin for better total internal reflection.*______________________________

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b. *Example answer: We will use one single piece of gelatin to keep down the number of interfaces the light will need to pass through.*____________________________

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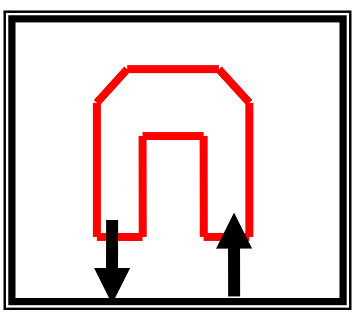
Part II: Making and Testing Your Optical Waveguide

Materials
- 4" × 5" gelatin piece
- laser pointer
- graph paper

Procedure
1. Place your piece of gelatin on your graph paper.
2. Using the design that you developed, create an optical waveguide. You may use the laser pointer to test the waveguide as you make it.
3. Demonstrate your optical waveguide to your teacher.
4. When approved, calculate your optical waveguide's footprint.

Record Your Observations
1. Sketch a diagram of your working gelatin optical waveguide.



2. Calculate the footprint of your gelatin optical waveguide.

   Total length (cm) *Example answer: 9 cm* Total width (cm) *Example answer: 6 cm*___

   Footprint *Example answer: 54 cm²*_____

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3. Review the design features that you described yesterday. Describe how well or poorly each design feature worked. If you discovered new features today, describe those as well.

Design Features:

a. *Example answer: Smoother sides helped increase total internal reflection.*

b. *Example answer: Carving from one piece of gelatin was difficult. We made lots of errors and finally had to piece together 3 sections to complete the design.*

c. *Example answer: The sides did not have to be completely curved; small angles seemed to work just as well.*

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