Lasers, Jell-O and Trigonometry

Overview: If you're scratching your head during math class, wondering what you'll ever use this stuff for, here's a cool experiment that shows you how scientists use math to figure out the optical density of objects, called the "index of refraction".

Materials:

- Paper
- Laser
- Pencil
- Protractor
- Ruler
- Gelatin (1 box)
- 1/2 cup sugar
- 2 containers
- Hot (boiling) water with adult help
- Knife with adult help

Experiment:

1. Mix two packets of gelatin with one cup of boiling water and stir well.
2. To one of the containers, add 1/2 cup sugar. Label this one as “sugar” and put the lid on and store it in the fridge.
3. Label the other as “plain” and also store it in the fridge. It takes about 2 hours to solidify. Wait, and then:
4. Cut out a 3”x3” piece of gelatin from the plain container.
5. On your sheet of paper, mark a long line across the horizontal, and then another line across the vertical (the “**normal**” line) as shown in the video.
6. Mark the **angle of incidence** of 40^{o}. This is the path your laser is going to travel on.
7. Lay down the gelatin so the bottom part is aligned with the horizontal line.
8. Shine your laser along the 40^{o} angle of incidence. Make sure it intersects the origin.
9. Measure the **angle of refraction** as the angle between the bent light in the gelatin and the normal line. (It’s 32^{o} in the video.)
10. Use Snell’s Law to determine the index of refraction of the gelatin: $n_1 \sin q_1 = n_2 \sin q_2$
11. Repeat steps 4-10 with the sugar gelatin. Did you expect the index of refraction to be greater or less than the plain version, and why?

What’s Going On? How much light bends as it goes through one medium to another depends on the index of refraction (refractive index) of the substances. There are lots of examples of devices that use the index of refraction, including fiber optics. Fiber optic cables are made out of a transparent material that has a higher index of refraction than the material around it (like air), so the waves stay trapped inside the cable and travel along it, bouncing internally along its length. Eyeglasses use lenses that bend and distort the light to make images appear closer than they really are.

Questions to Ask:

1. Does reflection or refraction occur when light bounces off an object?
2. Does reflection or refraction occur when light is bent?
3. What type of material is used in a lens?
4. What would happen if light goes from air to clear oil?