Refraction and Lenses
Bending Light with Jello

• Light beams go in a straight line until they hit a boundary between two different materials
• At the boundary, the beam can bounce back (reflection) or bend to enter the new material (refraction)
• Lenses bend light beams so that they cross (focus) at a distant point
• Your eye is a lens that focuses all the beams coming from a distant object, allowing you to see a sharp image.

Work with a partner.
Be careful how you cut, as there isn’t much extra jello!

Exploring Refraction
1. Cut out a circle of jello (use the cup) and split it in half with a ruler or knife to make a smooth flat edge. Put the jello on a white sheet of paper.

2. Shine your laser pointer at the flat edge of the jello half-circle. Try different angles.

When does the beam bend more? (circle one)

- Shining straight at the flat side
- Shining at an angle to the flat side
Draw a “normal line” on your paper, passing through the center of the flat side and perpendicular to it.

Does the laser beam bend towards the normal line or away from it when it goes into the jello? Circle one:

![towards normal](image1) ![away from normal](image2)

**Jello Lenses**

1. Make a convex lens from jello, by cutting two intersecting circles with a cup:

![convex lens](image3)

2. Together with your partner, place 2 laser pointers next to each other and shine them both at the lens.  
**Do the rays get bent towards each other or away from each other?**

3. Set up a vertical piece of cardstock as a screen behind the jello (where the laser beams come out). If you move the paper too close, you will see 2 laser spots. If you move it too far, you will again see 2 laser spots.

**Can you find where the two laser beams focus (cross each other) and there is only one spot on your screen?**

Measure the distance from the lens to the focus point: ________________

This is called the “focal length” of the lens. Your eye has a focal length that’s just as long as your eyeball, to focus far-away images on the retina (screen) at the back.
4. Now try cutting a **less curved convex lens**, using the plastic bowls. Try to measure the focal length again.

Focal length for less curved lens: _________________________

Which lens has a longer focal length? (circle one)

- more curved (cut with cup)
- less curved (cut with bowl)

Your eyeballs change their curvature to adjust the focal length when you look at objects nearby or far away.

5. Cut out a concave lens by using the crescent-shaped jello that remained from your intersecting (cup-cut) circles.

6. Again, with a partner shine 2 parallel laser beams at it.

**Do the rays get bent towards each other or away from each other?**

Near-sighted people have eyes that bend light beams too much (the focal length is too short). **Glasses** with concave lenses help compensate by spreading the light beams apart.
Jello “Fiberoptics”

1. Use the ruler to cut a long thin slice of jello with smooth sides.

2. Try shining the laser beam into the sides of this slice, at an angle. Can you make the beam bounce?

   How many bounces could you manage?

3. By bending the jello slice, can you get the laser beam to turn around a corner?

   This bouncing of the beam inside a fiber is called total internal reflection. It is the principle behind fiberoptics!