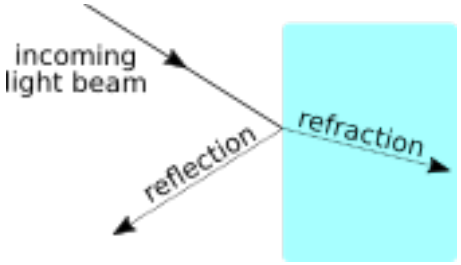
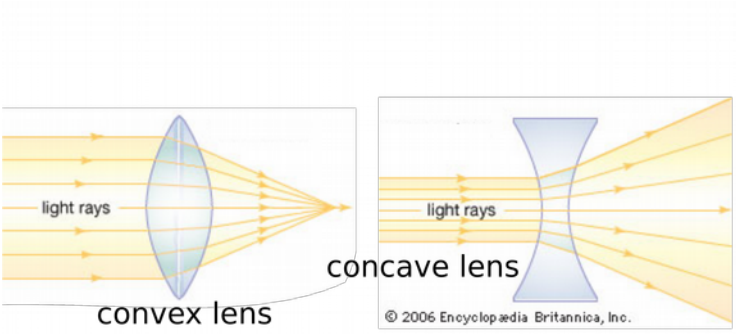
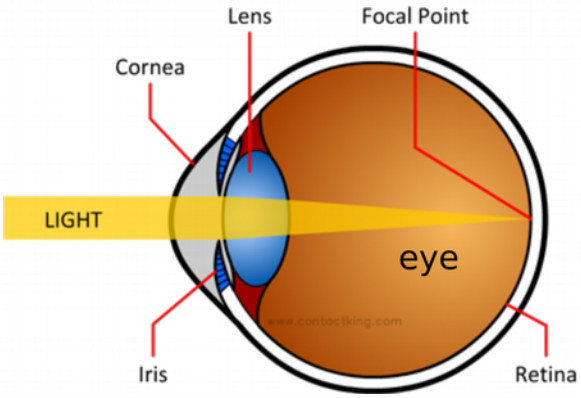
# Refraction and Lenses

## 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.

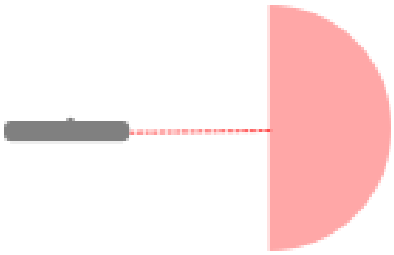
Be careful how you cut, as there isn't much extra jello!

## Exploring Refraction

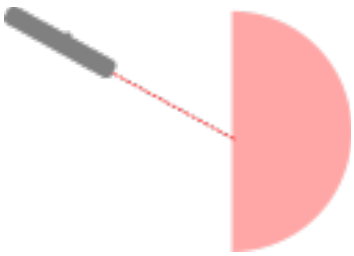
1. Cut out a circle of jello (use the cup) and split it in half with a ruler or knife to make a smooth flat edge. Put the jello on a white sheet of paper.

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)**

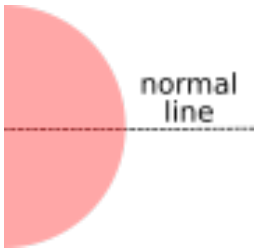


**Shining straight at the flat side**



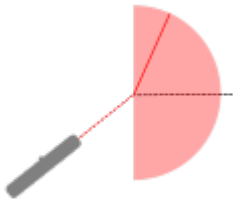
**Shining at an angle to the flat side**

Draw a "normal line" on your paper, passing through the center of the flat side and perpendicular to it.



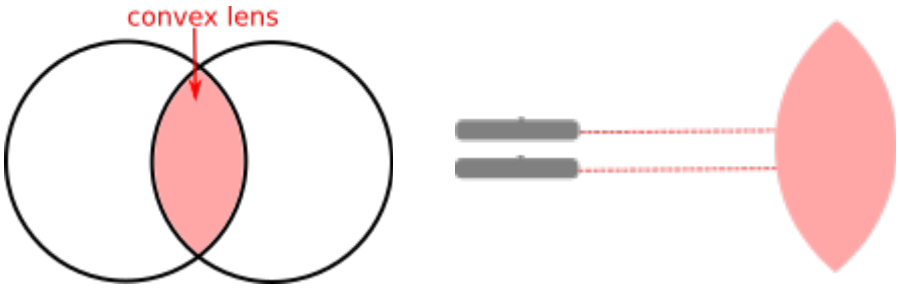

**Does the laser beam bend towards the normal line or away from it when it goes into the jello? Circle one:**


towards normal


away from normal

## Jello Lenses

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




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?**

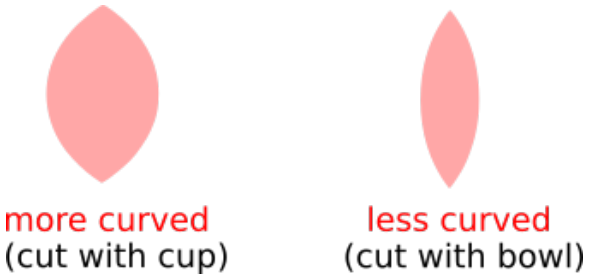
Measure the distance from the lens to the focus point: _____

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.

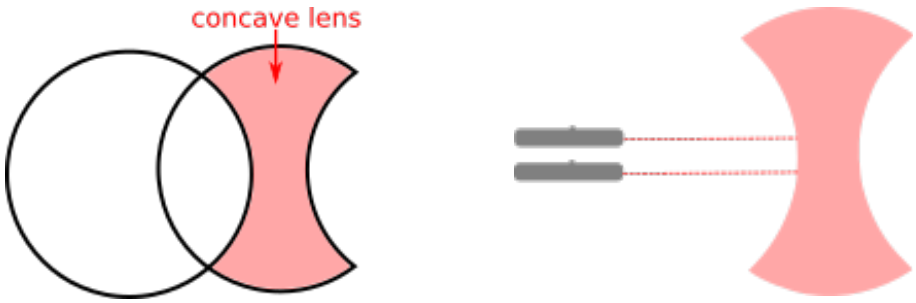
Focal length for less curved lens: _____

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




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!