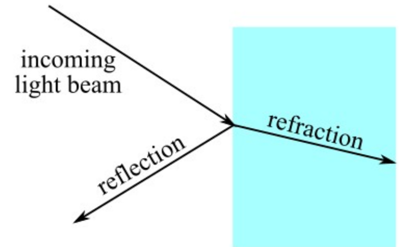
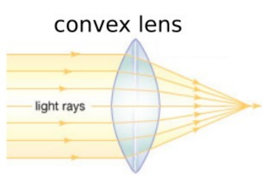
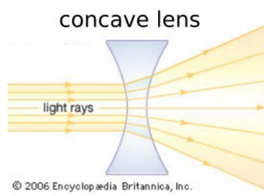
Refraction and Lenses

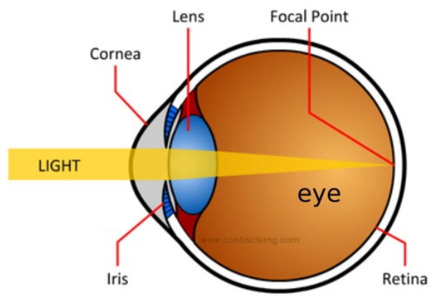
Bending Light with Jello



- 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 come together (or split apart from) a point called the **focus**
- Your eye has a lens that focuses all the beams coming from a distant object onto the light-sensitive cells in your **retina**, allowing you to see a sharp image.







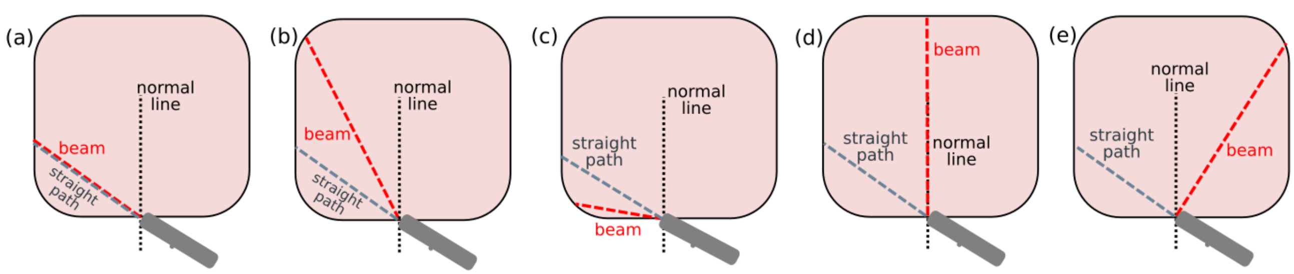
Exploring Refraction

1. A **normal line** is a line that is perpendicular to the surface. Direct a light beam into the jello along the normal line.

What happens to the beam when it enters the jello?
(a) It goes straight (b) it bends away from the normal line
(c) it is completely absorbed (d) it is completely reflected

2. Now try directing the laser at an angle to the normal line, as shown below.

When going <u>from air into jello</u>, the light beam ________________________
(a) Keeps going straight
(b) Bends towards the normal line
(c) Bends away from the normal line
(d) Bends onto the normal line
(e) Bends across the normal line

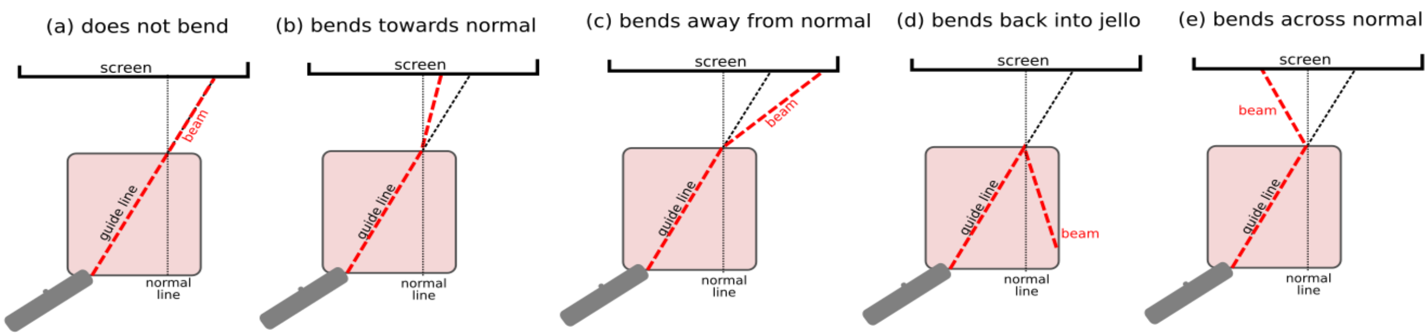


3. Use the template to place your container of jello and a vertical cardstock screen, as shown below. There will be a diagonal guide line going from the container to the screen.

Adjust your laser so that the beam inside the juice is directly along the guide line.

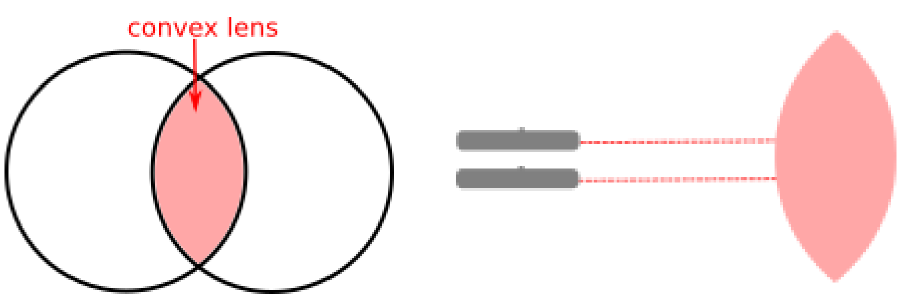
When going <u>from jello into air</u>, the light beam ________________________

(a) Keeps going straight
(b) Bends towards the normal line
(c) Bends away from the normal line
(d) Bends back into the jello
(e) Bends across the normal line



Jello Lenses

1. Cut out a circle of jello from your dish, using a cup. Make a **convex lens** by using the cup to cut off a piece of the circle (see picture).



2. Together with your partner, place 2 laser pointers next to each other and shine them both at the lens.

How do the rays get bent?: converge together diverge apart

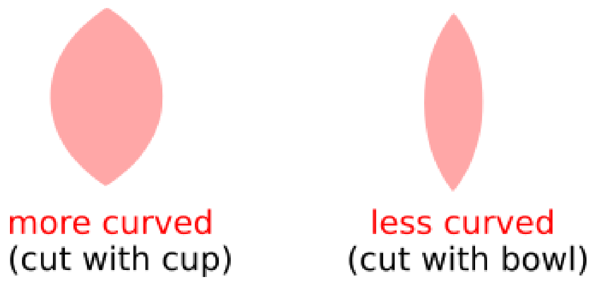
3. Set up a vertical piece of cardstock as a screen behind the jello (where the laser beams come out). If you move the paper too close, you will see 2 laser spots. If you move it further out you will find a point where the two rays come together to make the narrowest spot.

Can you find where the two laser beams focus and you have the narrowest spot on your screen?

Measure the distance from the lens to the focus point: _______________ cm

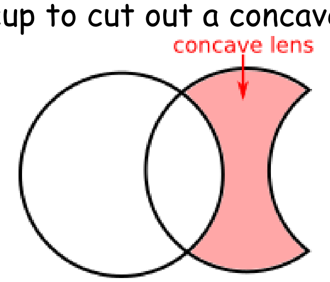
This is called the "focal length" of the lens. Your eye has a focal length that's just as long as your eyeball, to focus far-away images on the retina (screen) at the back.

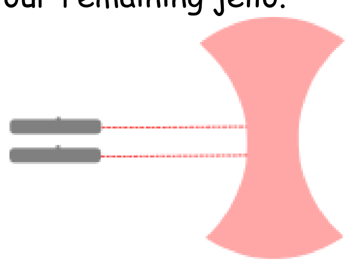
4. Now try cutting a less curved convex lens, using a bowl to cut a piece off the remainder of your circle. Try to measure the focal length again.
Focal length for less curved lens: _________________________ cm
Which lens has a longer focal length? (circle one)



Your lenses in your eyes change their curvature to adjust the focal length when you look at objects nearby or far away.

5. Use a cup to cut out a concave lens from your remaining jello.





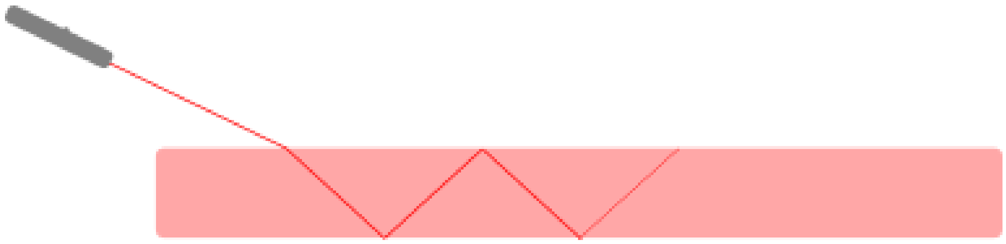
6. Again, with a partner shine 2 parallel laser beams at it.
How do the rays get bent?: converge together diverge apart

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.

If someone in your group has glasses, try shining 2 laser pointers through them to see what happens to the beams.

Jello "Fiberoptics"
(if you have time)

1. Take 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 can you manage? _____________

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

When a ray hits a boundary from jello to air at a very large angle, it cannot be refracted out, and only bounces back. This is called **total internal reflection**. It allows fiberoptic cables to carry light over long distances and into hard-to-reach places, like the inside of your body during surgery.