

**QUESTIONS**

Sometimes, when you stick your hand in a pool of water, your arm seems to bend at impossible angles! Certainly, you didn't break your arm sticking it in the water, so there must be another explanation. Refraction causes this optical illusion.

Refraction happens when light changes the material that it travels through. In the example above, light is going through the air, and when it hits the surface of the pool, it travels through water instead. When that change happens, the light is refracted and slightly changes its path.

Refraction and reflection are related to each other! You are likely familiar with your own reflection. Anytime you look into a mirror or a dark window, you see a reflection of yourself. The light bounces off the surface and comes back to your eyes, showing you a mirror image of what's around.

Because the speed of light is so fast (over 670 million miles per hour), light is a great way to send a message to someone. One Energy does this with a special kind cable: a fiber optic cable! These delicate cables are made from glass, and when we ricochet light through them, someone on the other end can see that light. The light bounces through the cable (using reflection) and leaves the cable at the other end (using refraction). We create messages with how we blink this light to tell people all sorts of things!

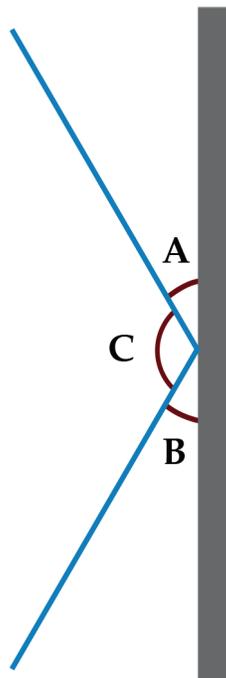
**Level 1:** When light refracts, it changes the direction that it was moving. A refraction also causes a change in the speed of the light! The amount of that change depends on the material. Some materials alter the speed of light dramatically while other materials only cause a small difference. Below is a table where the first column lists the material that light can travel through; the second column is a decimal. When you multiply the decimal by the true speed of light, you get the speed of light through that material.

SPEEDS OF LIGHT	
MATERIAL	FRACTION OF THE "TRUE" SPEED OF LIGHT
Vacuum	1 <small>* The true speed of light is <math>3 \times 10^8</math> meters / second (m/s)</small>
Air	0.999
Water	0.75
Windows	0.66
Diamond	0.41

Fill out the table below with the speeds of light in meters per second. You should be able to use the table above to help!

SPEEDS OF LIGHT	
MATERIAL	SPEED OF LIGHT THROUGH MATERIALS
Vacuum	
Air	
Water	
Windows	
Diamond	

**Level 2:** When light reflects off a surface, it bounces off at the same angle that it hit the surface.



In the diagram above, angle *A* and angle *B* are the same angle! This is a fundamental law of reflections.

For this question, we'll say that angle *A* is equal to  $30^\circ$ . What is the value of angle *C* as it bounces off a flat, vertical surface?