**VANDERBILT STUDENT VOLUNTEERS FOR SCIENCE**

**http://studentorgs.vanderbilt.edu/vsvs**

**Refraction of Light and Disappearing Water Gel Balls**

**Elementary 2012**

**Materials**

1 bag containing:

1 laser pen

1 pie pan

1 2oz dropper bottle of flour

8 4-oz jars containing water and a straw

8 styrofoam cups with a penny taped in the center

13 jars of water (4 oz) filled to the marked lines

26 1 oz cups

1 jar containing 13 glass marbles

1 jar containing 13 water gel balls

2 dropper bottles food coloring

13 lasers

**I. Introduction**

Have a VSVS member write the following words on the board: **refraction, visible light,**

Ask students: What are some properties of light?

Light travels in straight lines.

Show students the red laser.

**A. Laser Light – to show students that light travels in a straight line.**

**Materials for Demonstration:**

1 laser pen

1 pie pan

1 2oz dropper bottle of flour

**Safety Note: CAUTION – Be careful not to point the laser at anyone and to keep it pointed away from your eyes.**

* Shine the laser perpendicular to the direction the students are facing. Ask them whether or not they can see the path of the laser beam. *The answer should be no, but they will be able to see the red dot on a wall at the end of the beam.*
* Tell the students that you are going to use the flour to help you see the beam.
* Using the pie pan to catch the flour, continue to shine the laser perpendicular to the students and squirt the flour in small portions onto the beam from above. If you watch carefully, you should be able to see the path of the laser light before it reaches its final destination.



* Point out that the light is travelling in a straight line.
* Light waves can be reflected, refracted, absorbed, scattered, and diffracted.

Tell the students that today’s lesson is going to focus on **refraction .**

Divide the class into 8 groups.

**II. Refraction**

**Materials**

8 4-oz jars containing water and a straw

**A. Water Refracts Light**

* Give each group a jar containing water and a straw lying at an angle in the jar.
* Tell the students to rotate the jar while looking at the straw. Ask them what they observe. *The straw will appear to be bent at the point where it emerges from the water.*
* Tell the students to unscrew the lid and to hold the straw vertically in the center of the jar, so that half is in/out of the water. Look at the straw “straight on” at the center point, and then slowly move it to the side of the glass (do not move your head with the straw). Ask them what they observe.

**Explanation:**

* When light travels from one material to another it changes direction, or refracts.

The speed of light is slower in water than in air. Light is fastest when it is moving in a vacuum (that means that light is moving through nothing, no matter at all, not even air. Outer space is an example of a vacuum. In a vacuum light travels at 300,000,000 meters per second but that’s as fast as it can go.

If it travels in any type of matter, even air, it slows down a little bit.

 As the light wave slows down, it also changes its direction. So the light wave “bends” as it

 enters the water.

* The straw did not appear to be “broken” when viewed in the center of the jar. (When you look at it “straight-on”.)
* The straw becomes more “broken” as it moves across the jar. (When you look at it from different angles.)



Reference: <http://www.physicsclassroom.com/mmedia/optics/bp.html>

**III. The Appearing Coin**

**Materials:**

8 styrofoam cups with a penny taped in the center

Tell students that the next activity involves the property of refraction and may be used as a magic trick to try on their family.

Have students in each group do the following:

* Place the styrofoam cup with the penny on the desk.
* Select one student in each group to pour the water.
* Have the students in the group stand so they can easily see the coin.
* Now have the students back up slowly and stop when the coin has just disappeared from sight. (Tell the students that they may not stop at the same point as other students because they are different heights and have different lines of vision. They should stop just as soon as the coin disappears from sight and should not go back too far.)
* Tell the designated student to slowly pour water in the cup. The other students should raise a hand as soon as they can see the coin again.
* Continue to pour the water into the cup until all the students raise their hands. (If they cannot see the coin, they went back too far.)

**Explanation**: **Refraction** causes this effect. When water is added, the light is bent so that the coin becomes visible. This experiment shows that light is bent as it travels at an angle through one medium (water) into another (air). As light rays from the coin cross the water/air boundary, they speed up and bend. Our brains are programmed to assume that light rays travel straight from an object to our eyes. Therefore we see the coin straight in front of our eyes.



**IV. Disappearing crystals.**

The Water Gel balls are made from a polymer that absorbs water. Materials of this type are said to be hydrophilic, water loving, just as a dry sponge might if dropped into a pail of water. When placed into water, the crystals will absorb water and swell to several hundred times their original size.

Show the students the small dehydrated crystal, and tell them that the ball grew from this when it was put into water for 1 day.

Give each pair a water gel ball and a glass marble (in a 1oz cup) and a jar of water.

Ask students to describe the water gel ball and the marble.

Tell students to put **the marble** into the jar of water.

Ask students if they can see the marble? (yes)

Explain – refractive index of water and glass are different so that the light waves are bent when they enter the marble.

Now put the water gel ball into the water. Can you see it? (No)

Explain – these gel balls are made up almost entirely of water (99%). So the refractive index of water and the ball is the same. It is difficult to see the spheres in water because light rays are not bent when they travel between two substances with the same indices of refraction.

Ask students what they could do to make the water gel ball appear visible?

What happens when you put a beam of laser light thru the water plus water gel ball? (the laser shows a path through the gel).

What happens when you put food coloring into the water? Add a single drop of red food coloring, swirl the water around, and show the students that you can now see the water gel ball.