Our senses

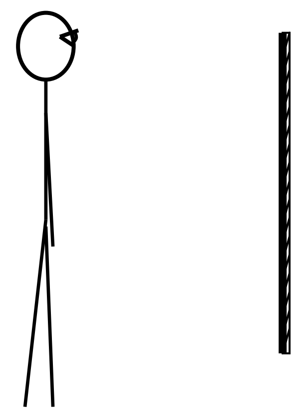
What we see

Light entering our eyes

Question: How Tall does a mirror have to be to see your body from head to toe?

Prediction

A plane mirror is affixed to the wall. What do you think the minimum length of the mirror must be for you to see your entire body from head to toe (just as tall, ¾ as tall, ½ as tall etc…)?



At what height does a mirror of this length need to be mounted to allow you to see your entire body from head to toe? Why is this?

Procedure

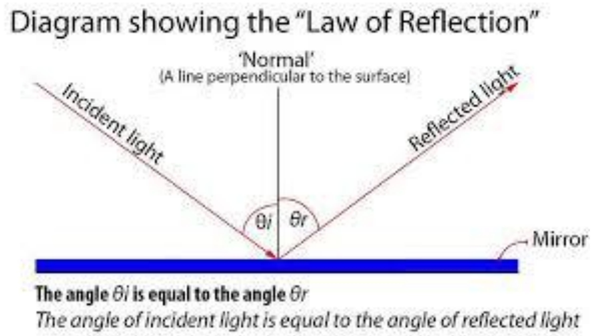
Materials: Plane mirror mounted to the wall, meter stick, dry erase marker.

Note: While you're waiting your turn for the mirror, skip to page 5 and start on one of the activities listed on pages 5, 6 or 7.

1. Choose your two most extreme group members, the tallest and the shortest.
   A. Have the shortest member, known as the object, stand in front of the plane mirror. Another group member will mark on the mirror with a dry erase marker where the object sees the top of their head. Then mark where the object sees their feet. Cover the unused areas of the mirror to verify that they are not needed for the object to see themselves from head to foot.
   B. Now have the object test to see how distance from the mirror affects the necessary size of mirror. The object should stand very close and very far from the mirror the entire time checking to see how the original head and feet marks align with their head and feet respectively.
   C. Measure the distance between the head and the feet marks.

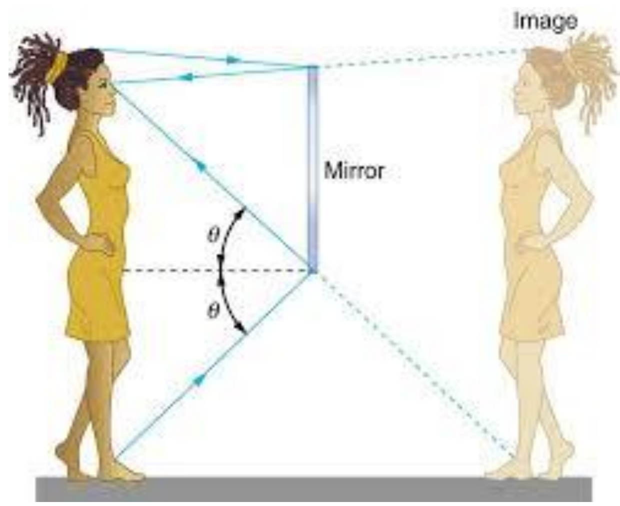
   D. Repeat procedures A-C for your tallest member.

2. Using the results from your two extreme group members, determine what fraction of the object's height the mirror has to be to show them from head to toe.

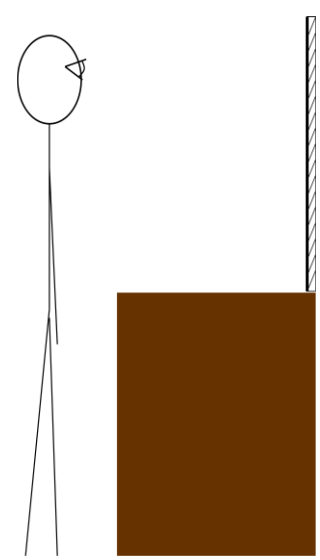


Law of Reflection: The Law of reflection tells us that when light reflects off of a mirror, it reflects at the same angle that it hits the mirror. You can see in the diagram above that the two angles θ_i and θ_r are equal. θ_i is in the incident angle (the i subscript is for incident) and θ_r is the reflected angle.

3. Use the diagram on the right of the lady standing in front of the mirror.
   A. What fraction of her body height is the mirror's height? You must describe how you use the two rays of light shown to figure this out. One ray goes from her ankle to her eyes and the other goes from the top of her head into her eyes.



4. Slim is standing in front of the bathroom mirror. He learned at school that he should be able to see his whole body, including his feet, when he stands in front of a mirror half his height. He's mad because the bathroom mirror is more than half his height and he cannot even see his knees. Can you help slim understand why it's not working? *Draw light rays on the diagram to illustrate your explanation.*



Line of Sight

Question: Can Johnny sneak a peak at Josephine's beautiful blue eyes in a small mirror without Josephine being able to see his eyes peaking at her from the mirror?

Prediction

If a small mirror is sitting flat in the middle of a table, where do two people have to stand so that person A can see person B's eyes in the mirror?

If person A stands so that they can see person B's eyes in the mirror, does that mean that B can also see A's eyes in the mirror?

Procedure

Materials: very small mirror (no more than 2" square), meter stick, 3 people and a table.

1. A. Place a mirror in the middle of your table. One person in your group will be the "object" and the other the "observer". The object should find a position that they can comfortably maintain without moving their head. Now the observer moves until they find a location from which they can see the object's eyes in the mirror.

   B. Describe what the Object sees in the mirror when the observer is looking at their eyes in the mirror.

2. The object remains in the **<u>same position</u>** they were in for part 1.

   A. Now the observer finds a different, <u>2nd,</u> position that allows the observer to see the object's eyes in the mirror.

   B. Describe what the Object sees in the mirror when the observer is looking at their eyes in the mirror.

3. Now the observer will try to find a location where they can see the object's eyes in the mirror but the object cannot see the observer's eyes in the mirror? Describe your findings.

4. The object remains in a comfortable position; however, this time with their arms crossed in front of them.

   A. Now the observer should find a position where they can see the object's hand in the mirror.

   B. Describe what the object sees in the mirror while the observer sees the object's hand.

   C. Why is this result different from #1 -3 above where the observers looked at the objects eyes in the mirror?

   D. Draw a diagram that shows a light ray from the object's hand to the observer's eye. Be sure that the incident angle and the reflected angle are equal.

   E. Using your diagram in D, figure out what the object's eye will see in the mirror? *Show a light ray in the diagram and explain here.*

Questions

1. Explain why it is that when the observer can see the object's eyes in the mirror, the object can also see the observer's eyes in the mirror without exception.

2. Consider the case when the observer can see the object's hand in the mirror. Why is it *not* the case that the object can also see the observer's hand in the mirror?

Touch and Smell

For this section of the lab two group members will volunteer to be the "sensors" and the other lab members will be the guides. The sensors must be blindfolded. After they are blindfolded, the guides will take them to the supply room. On the grey cart you will find twelve beakers with different items in them. The front six will have a label under them that says "TOUCH", the back six will have a label that says "SMELL".

What we sense with touch

1. Have the sensors each touch the items in the beakers one beaker at a time in the order that they have been labeled 1 – 6. The guide should hand each beaker to the sensors, one at a time. Enter each sensor's guess in the table below. ***No peeking!!***

Please be careful **not to mix** any of the items.

Item	**Sensor 1 name:**	**Sensor 2 Name:**
1		
2		
3		
4		
5		
6		

What we sense with smell

2. Have the sensors smell each item in the beakers from the SMELL row, one beaker at a time, in the order that they have been labeled 1 – 6. The guides should hand a beaker, one at a time to the sensors. Enter each sensor's guess in the table below. ***No peeking!!***

Item	**Sensor 1 name:**	**Sensor 2 Name:**
1		
2		
3		
4		
5		
6		

3. A. Please place all the beakers back in the correct rows in numerical order.

   B. Once both the tables are complete, the "sensors" may remove their blindfolds and look.

Taste

Skittles Taste Test

Here is what you do:
Each student should take one Skittle or more of the *same flavor*
Everyone should pinch their nose.
Eat the Skittle.
Discuss your observations together (still pinching your noses!)
After a few seconds, release your nose, and keep eating.

1. Explain what you tasted and felt while your nose was pinched.

2. Explain how the taste and/or feel changed after you unplugged your nose.

Explanation :
Though at a glance the procedures seem easy, students (and you!) shouldn't be able to actually taste the flavor of the Skittle with your nose pinched. Observations may be about texture, but not much else. Once you release your nose, you should be able to taste the flavor of the Skittle. This is because your tongue can only taste or sense sweet, bitter, salty, sour, and umami. The receptors in your nose are much more complicated, and "fill in the blanks" of what you're tasting. This also explains why when someone is sick and their nose is congested, food can taste very different!
For more information, this article is very helpful, and is more detailed:
http://www.brainfacts.org/sensing-thinking-behaving/senses-and-perception/articles/2012/taste-and-smell/

Tips :
▪ Make sure students have their noses *completely* sealed. This makes for the most drastic change.
▪ Lemon flavor tends to have the strongest reaction out of all the flavors.
▪ I have tried this with other foods such as chocolate, and it works pretty well with that too. Experiment with other foods as well!
Safety : Be wary of any food allergies students may have. You may have to change the food based on that.

Information Processing

Our brains have to process the information coming from our senses to help us understand what we are seeing, hearing, touching, smelling and tasting.

1. Have you ever entered an area that had a strong smell and then after you'd been there for a while, you didn't notice the smell anymore? Provide an example.

This happens because your nerves get tired of sending that signal to your brain and /or your brain decides that this signal is not important anymore. The nerves are over stimulated.

Floating arms.

Stand next to the wall and push on it very very hard with the back of your hand as shown in the diagram. Do this for 30 seconds. Then move away from the wall. What happens to your arm?

After Images

1. Stare at the dot in the center of the squares for at least 30 seconds. After you're done, look at a blank white sheet of paper (back of this sheet). What do you see? Describe or draw what you saw. *If you don't see a fairly clear color image, you probably need to stare for 45 seconds and make sure you never let your eyes stray from the dot.*

2. Now stare at the circles page for 30- 45 seconds and then look at the blank sheet and describe or draw what you see.

3. Stare at the rectangle with three circles for 30-45 seconds and then describe or draw what you see.

4. Create an American flag that will show the after image in red, white and blue. (use a clean sheet of white sheet of paper.)

5. Read the description of why after images work. Now reword it in a way that an elementary student can understand it. It is written at a fairly high level so may take several readings to sort through. *Note*: This is something you'll find yourself having to do as a teacher all the time and it's not an easy skill!

Negative afterimages

Negative afterimages are caused when the eye's photoreceptors, primarily known as rods and cones, adapt to overstimulation and lose sensitivity. Newer evidence suggests there is cortical contribution as well.[3] Normally, the overstimulating image is moved to a fresh area of the retina with small eye movements known as microsaccades. However, if the image is large or the eye remains too steady, these small movements are not enough to keep the image constantly moving to fresh parts of the retina. The photoreceptors that are constantly exposed to the same stimulus will eventually exhaust their supply of photopigment, resulting in a decrease in signal to the brain. This phenomenon can be seen when moving from a bright environment to a dim one, like walking indoors on a bright snowy day. These effects are accompanied by neural adaptations in the occipital lobe of the brain that function similar to color balance adjustments in photography. These adaptations attempt to keep vision consistent in dynamic lighting. Viewing a uniform background while these adaptations are still occurring will allow an individual to see the after image because localized areas of vision are still being processed by the brain using adaptations that are no longer needed.

"When all wavelengths stimulate the retinal region adapted to green light, the M and L cones contribute less to the resulting percept because their photopigments absorb less light than the S cones. Thus, trichromatic theory can not explain all afterimage phenomena, indicating the need for an opponent-process theory such as that articulated by Ewald Hering (1878) and further developed by Hurvich and Jameson (1957). Afterimages are the complementary hue of the adapting stimulus and trichromatic theory fails to account for this fact." (David T. Horner, Demonstrations of Color Perception and the Importance of Contours, Handbook for Teaching Introductory Psychology, Volume 2, page 217. Psychology Press, Texas, 2000)[4]

Ewald Hering explained how the brain sees afterimages, in terms of three pairs of primary colors. This opponent process theory states that the human visual system interprets color information by processing signals from cones and rods in an antagonistic manner. The opponent color theory suggests that there are three opponent channels: red versus green, blue versus yellow, and black versus white. Responses to one color of an opponent channel are antagonistic to those to the other color. Therefore, a green image will produce a magenta afterimage. The green color fatigues the green photoreceptors, so they produce a weaker signal. Anything resulting in less green, is interpreted as its paired primary color, which is magenta

6. Compose a drawing of your choice (maybe a car or flowers) that looks best as an afterimage.