

## 2011 Light and Optics 2

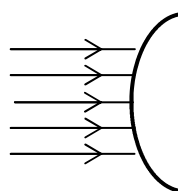
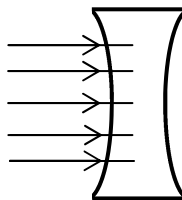
Yellow light



- Yellow light is incident on a patch of magenta paint.
  - Break up the yellow light into its constituent colors (next to the incoming arrow write the letters of the two colors that make up yellow)
  - What colors are reflected off of magenta?
  - What color is absorbed by magenta?
  - What color the magenta patch looks like?

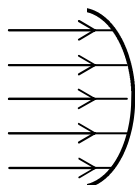
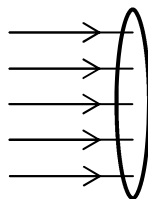
From the lab OR double check your "Optics Basics" notes.

- Use the **lens** at the right to answer the following.
  - Is it concave or convex?
  - Draw what will happen to the parallel light rays.
  - Is it convergent or divergent?
  - Does it have a real or virtual focal point?



- Use the **mirror** at the left to answer the following.
  - Is it concave or convex?
  - Draw what will happen to the parallel light rays.
  - Is it convergent or divergent?
  - Does it have a real or virtual focal point?

- Use the **lens** at the right to answer the following.
  - Is it concave or convex?
  - Draw what will happen to the parallel light rays.
  - Is it convergent or divergent?
  - Does it have a real or virtual focal point?



- Use the **mirror** at the left to answer the following.
  - Is it concave or convex?
  - Draw what will happen to the parallel light rays.
  - Is it convergent or divergent?
  - Does it have a real or virtual focal point?

- Does light reflect from or go thru a mirror?
  - Does light reflect from or go thru a lens?
- The light rays shine from a light on the left side of a mirror or lens.
  - The light rays will end up on which side of a mirror: left or right?
  - The light rays will end up on which side of a lens: left or right?
  - \* So, which side of a mirror is real?
  - \* Which side of a lens is real?
- Concave mirror (CCM), convex mirror (CVM), concave lens (CCL), or convex lens (CVL)?
 

A. ___ * Is divergent and reflects.	D. ___ Is convergent and the right side is real.
B. ___ * The middle is thicker than the ends and refracts.	E. ___ Has a real focal point and reflects.
C. ___ Has a virtual focal point and the left side is real.	F. ___ Is divergent and the right side is real.

Here's why we care about the real and virtual sides and focal points: we are going to use equations that have focal length ( $f$ ) and the distance to the object ( $q$ ).  $f$  is + if the focal point is real.  $f$  is - if the focal point is virtual. Also, if the image is virtual, then  $q$  is - and will be found on the virtual side of the device. If you don't put in the + or - when appropriate, you will calculate incorrectly. As for the object ( $p$ ) (what we are looking at), it will ALWAYS be real and positive.

- + or -?
 

A. ___ $f$ for a convergent device.	E. ___ $q$ if the image is on the right side of a mirror.
B. ___ * $q$ for an image on the left side of a mirror.	F. ___ $q$ if on the right side of a lens.
C. ___ $f$ for a concave mirror.	G. ___ $p$ for a convergent mirror.
D. ___ $f$ for a concave lens.	H. ___ $f$ for a convex mirror.

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*Thinking back to harmonic motion.*

10. \* If a string vibrates back and forth 10 times each second, how many times does the air around it vibrate each second?
11. So, what stays the same as a wave (or energy) passes from one material to another (as it crosses a boundary)?
12. A 350nm light wave is traveling thru air.
  - A. What is its speed?
  - B. \* What is its frequency in air?

The light wave then passes into glass. Light travels in glass at a speed of  $1.97 \times 10^8$  m/s.

- C. \* What is the frequency of the light after it has passed into the glass?
- D. Calculate the wavelength of the light in glass.

*You will need your "Refraction Notes"...*

13. Why does light bend as it travels from one material to another?
14. What is the index of refraction for air? For water?
15. Noticing the arrow on the left side of the index of refraction table, in which substance is light faster:
  - A. Ice or glass?
  - B. Glass or air?
16. After studying the index of refraction example problem, calculate the speed of light in water.
17. A new substance is found with an index of refraction of 2.22.
  - A. Will light travel faster or slower in the new substance when compared to in air?
  - B. \* What is speed of light in the new substance?

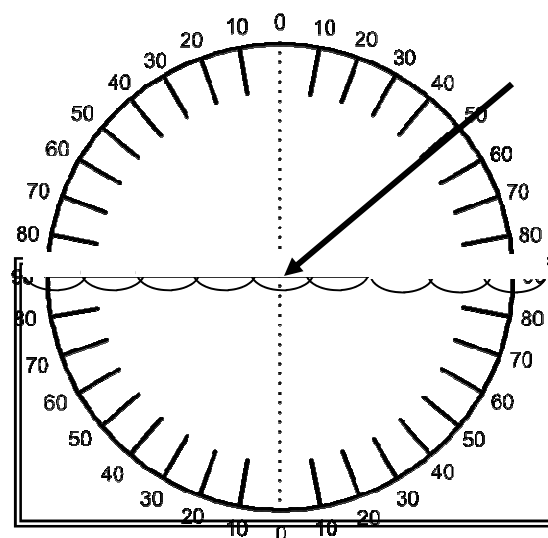
- D. \* If the incident light has a wavelength of 20 nm in air, what is its wavelength in the new substance?

*After studying the Snell's Law section and example problem...*

18. All angles must be measured from where?
19. Light is traveling at  $35^\circ$  in air. It passes into glass.
  - A. Substance 1 is air or glass?
  - B. So,  $n_1 = \underline{\hspace{2cm}}$
  - C. Substance 2 is air or glass?
  - D. So,  $n_1 = \underline{\hspace{2cm}}$
  - E. \* Calculate its angle in the glass.

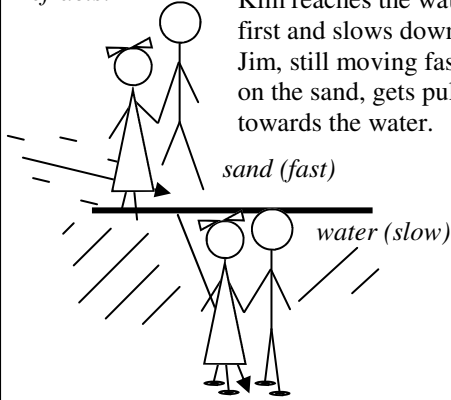
20. Light passes from air into glass as shown at the right.
  - A. Substance 1 is air or glass?
  - B. So,  $n_1 = \underline{\hspace{2cm}}$
  - C. Substance 2 is air or glass?
  - D. So,  $n_1 = \underline{\hspace{2cm}}$
  - E. Calculate its angle in the water.

- F. Draw its path in the water.
- G. Did the light bend toward or away from the normal?



An analogy for why light refracts:

Slim Jim and Kim are running on the beach. Kim reaches the water first and slows down. Jim, still moving fast on the sand, gets pulled towards the water.



The right side (circles) of the light ray hits the slower substance first. The left (x's) side continues moving fast, takes another "big step" and gets pulled toward the normal. When both are in slower substance they move again in a straight line.

Faster substance, like air (lower index of refraction)

Incident (incoming) ray

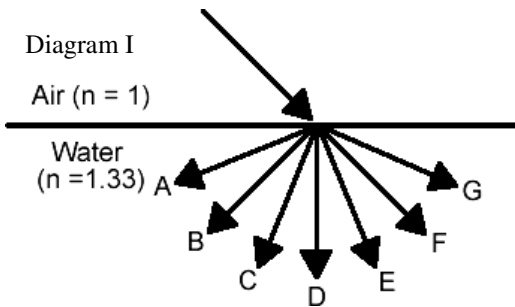
Straight path (never happens)

Refracted ray

normal

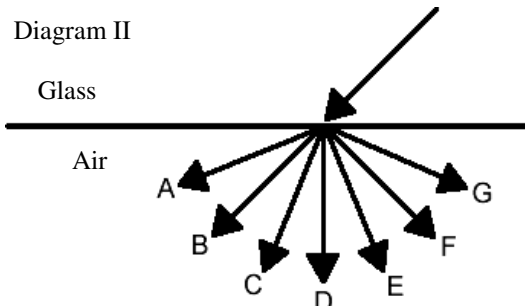
Slower substance, like water or glass (higher index of refraction)

Diagram I



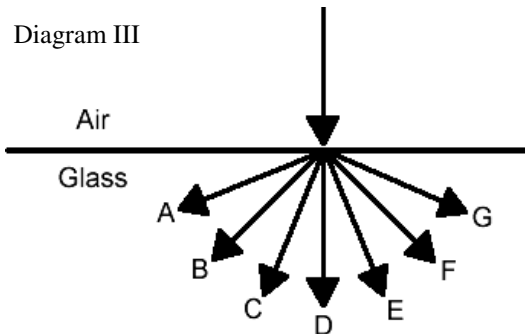
21. \* In the first diagram, light travels from air to water.
  - A. In which substance does light travel faster?
  - B. Looking from light rays point of view, which side of the light ray hits the water first: left or right?
  - C. Label the "straight path" as "SP".
  - D. Label the normal with "N".
  - E. What path with the light ray follow in the water?

Diagram II



22. In the second diagram, light travels from glass to air.
  - A. In which substance does light travel faster?
  - B. Looking from light rays point of view, which side of the light ray hits the water first: left or right?
  - C. Label the "straight path" as "SP".
  - D. Label the normal with "N".
  - E. What path with the light ray follow in the air?

Diagram III



23. What path will the light ray take in the glass?

7C) left side; 7D) right side 8) A. CVM. B. Thicker in middle is convex, CVL;  
 9B) +, since left side of mirror is real. 10. 10 times. 12B.  $V = f\lambda$ .  $3E8/(350E-9) = 8.57E14\text{Hz}$  12C) same freq.  
 17C)  $1.35E8 \text{ m/s}$ . 17D) since  $f_{\text{air}} = f_{\text{new}}$ , you could calculate  $f_{\text{air}}$ , then use it to calculate  $\lambda_{\text{new}}$  OR just use  $f_{\text{air}} = f_{\text{new}}$ , and put  $v/\lambda$  into each side.

19)  $22.2^\circ$ . 21) A. Air; B. Right side; C. path F is the SP; D. path D is the normal; E. Path E (toward the normal)