



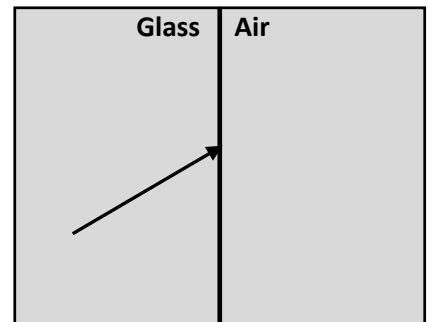
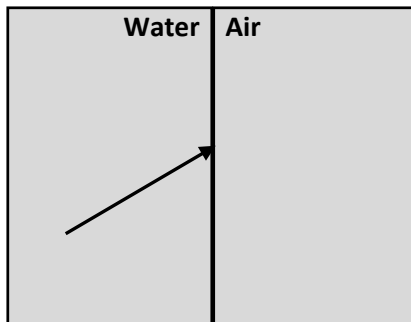
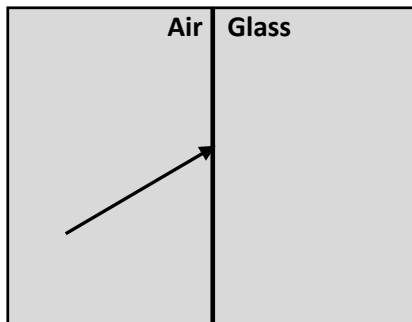
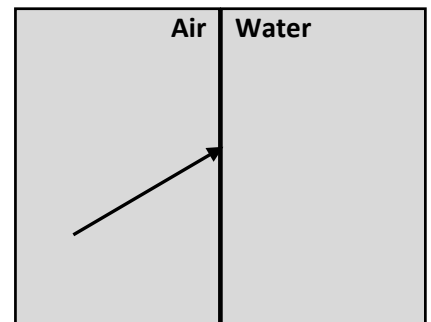
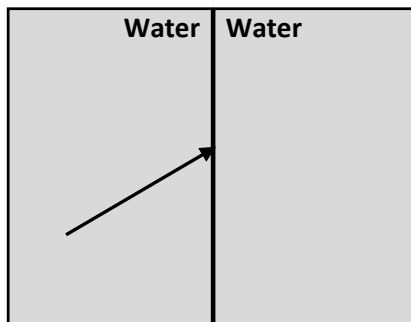
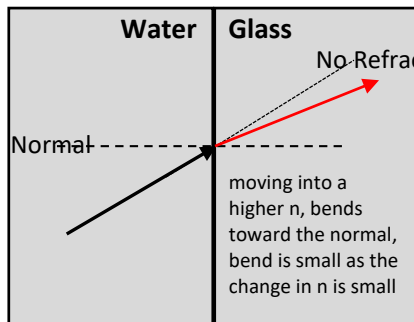
Astronomy Demonstration Video – Optics 2: Refraction – Worksheet
 (to follow the video at: https://www.youtube.com/watch?v=n9_bgMKvAYQ)



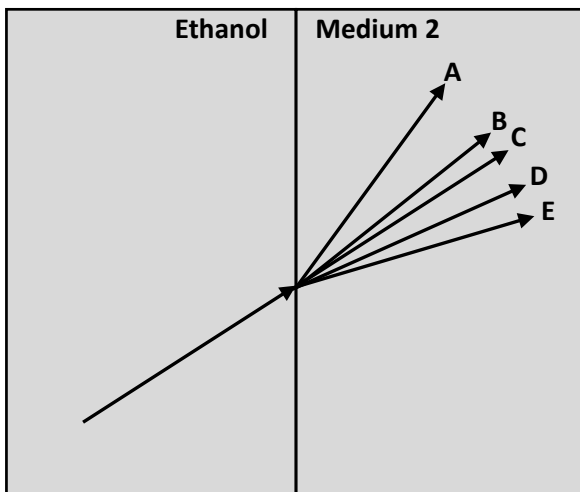
Part 1: Each graphic below represents a ray of light about to traverse the boundary between two media. The indices of refraction for these media are given in the table to the right. For each graphic:

- Draw in the normal (as a dotted line) at the location where the ray of light traverses the media boundary
- Draw in the estimated direction of the refracted ray in the second media (it may help you to first draw in the transmitted ray as it if were unrefracted).
- Provide a short explanation (in any empty space) describing your thinking. The first is done for you.

Medium	Index of Refraction n
Air	~ 1
Water	1.33
Glass	1.5



Part 2: The diagram below represents a sequence of rays of light about to traverse the boundary between ethanol and several possible media. The n values are given for the substances that could be medium 2.

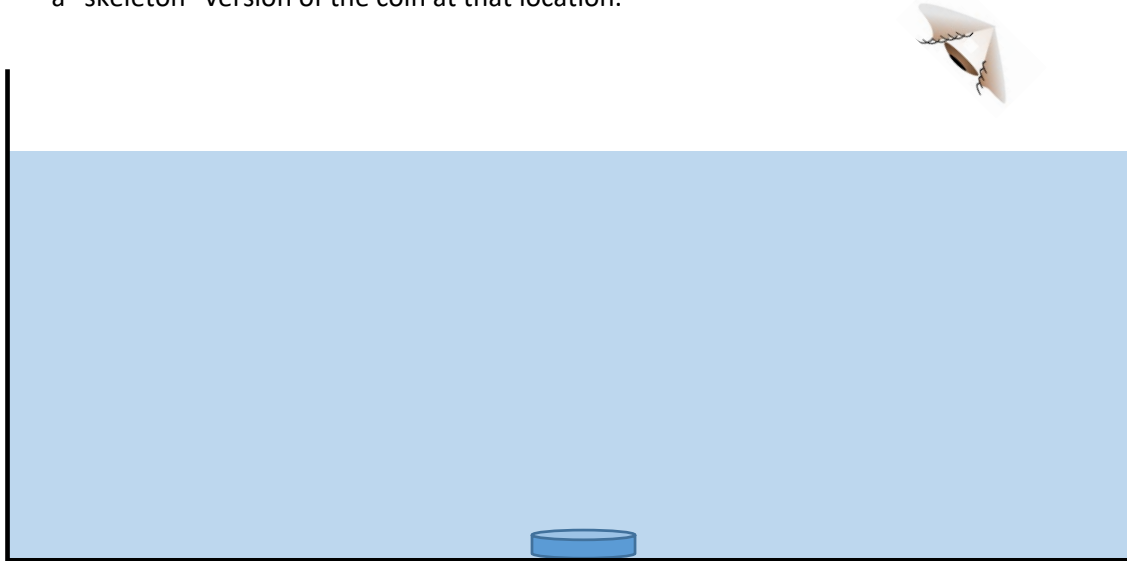


Indicate which lettered transmitted ray corresponds to each possible substance for medium 2.

- Water ($n = 1.33$) _____
- Ethanol ($n = 1.36$) _____
- Benzene ($n = 1.50$) _____
- Glass ($n = 1.50$) _____
- Bromine ($n = 1.66$) _____

Part 3: Let's revisit the concepts of the apparent and true locations of an object in the water. The diagram below shows a coin at the bottom of a large pool (its true location).

- a) Draw in a straight line coming from the center of the coin to the center of the eye.
- b) Draw in a ray of light coming from the coin to the eye that takes into account refraction.
- c) Use this refracted ray to estimate the apparent location of the coin on the bottom of the pool. Draw in a "skeleton" version of the coin at that location.



d) Can you write out a general rule regarding how one estimates the true position for an object in water from its apparent position?

(Although not covered in this video/worksheet, the coin will also appear closer to the observer than it really is. In fact, the entire bottom of the pool will appear closer.)

e) Two students scheme to determine the exact position of the coin. Comment upon each student's thinking.

--**Student A** says: "I'd get a high-powered laser pointer. I would hold it next to my head (aligned with my eye) and point it at the coin. So I would learn its true location when the laser hits it."

-- **Student B** says: "I'd get in a raft and row out directly over the coin. Since light from the coin along the normal will not be refracted at the water-air boundary, I'll know its location when I am looking straight down and get directly over it."
