Bizarre behavior with light

I have observed people with cameras undergoing some strange behavior.

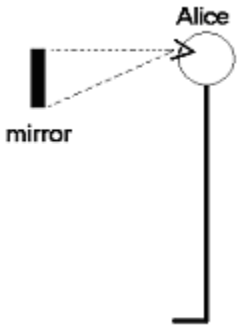
a. When I was at a conference in North Carolina, one of the physics graduate students (who should have known better!) was trying to take a picture of the overheads projected on a white screen. Since the room was darkened, he used a flash. Explain why this is a bad idea and what his pictures are likely to show.
b. I mentioned to him that he probably should not be using his flash so he turned it off. He then proceeded to try and take pictures of the participants in the darkened room! Explain why this is a bad idea and what his pictures are likely to show.
c. I once observed a woman on an airplane at night with a camera. As we flew low over Washington DC she was impressed with the view of the city lights in the dark. She stood back in the aisle and tried to take a picture through the window using her flash. Explain why this is a bad idea and what her pictures are likely to show.

Alice and the looking-glass

Alice faces a looking glass (mirror) and is standing at a level so that her eyes appear to her to be right at the top of the mirror as shown in the figure. At the position she is standing, she can just see her belt buckle at the bottom of the mirror. If she steps back far enough

a. she will be eventually able to see all of herself in the mirror at the same time.
b. she will see no change in how much of herself she can see.
c. she will see less of herself as she steps back.
d. some other result (explain)

Put the letter of the choice that completes the sentence correctly in the box at the right below and explain why you think so with a few sentences and some rays on the diagram.

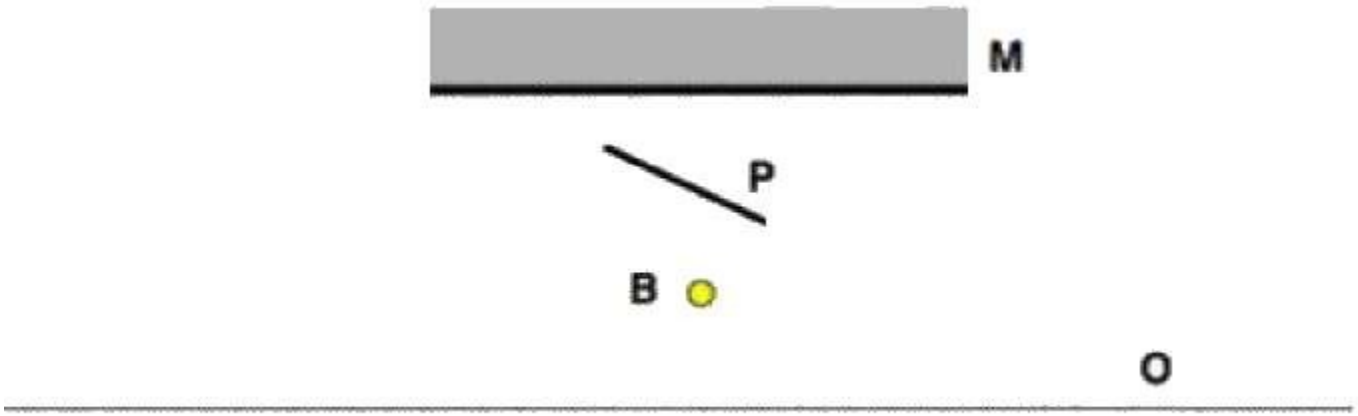


On the mirror

While doing a tutorial lesson on "How to find out where something is by looking," two students, Ethelred and Guinivere, answered the question, "Where does the image [in the mirror] appear to be located?" by saying "On the mirror." Do you agree with them or not? If you disagree, where would you say the image is and how would you justify your answer to them? If you agree, propose a different plausible position for the image in the mirror and explain why you prefer Ethelred and Guinivere's answer.

One more mirror

In the diagram below, M is a plane mirror, B is a very small bulb that can be treated as a point source, and P is an opaque plate that does not transmit light. O is a line anywhere along which an observer can stand to try to see the image of the light bulb in the mirror. By using relevant rays of light, determine the locations along line O from which the image of B is visible in the mirror and the locations from which it is not visible. Mark these regions accordingly along line O and explain your reasoning.



Bending Light – *PhET Simulation*

In the PhET sim *Bending Light*, there are two mystery materials, Mystery A and Mystery B. These materials appear in both the "Intro" and the "Prism Break" tabs. Determine what the index of refraction is for each of these materials and propose substances that fit these values. Describe clearly how you determined the two values of n including all calculations.

Mirror Mirror in the Halls

Sheila is standing in wide mirrored hallway. The hall is 2 meters wide and has mirrors covering both walls. If Sheila stands 0.5 a meter from the right hand side of the hall, find the distance from Sheila to the first three images in the mirror on the left side of the hall.

Snell's law for ultrasound

a. Snell's law correctly predicts the refraction (bending) of light as it moves from one homogeneous medium into another where the speed of light differs from the speed in the first medium. Discuss what has been assumed about the speed of light in a more dense medium in order to describe experimental observations.

b. We typically deal with sound that has wavelengths comparable to the objects it interacts with (on the order of a few centimeters to a few meters) so we don't usually talk about "sound rays" or Snell's law for sound. But if we are working with high frequency ultrasound, as is used currently in many medical probes, it would be appropriate to consider it. We are pretty certain of a couple of relevant facts about sound:
    - Sound propagates as a wave.
    - The speed of sound is greater in a dense medium.

    Discuss what this would mean for Snell's law for sound. Do you expect a ray of sound coming onto a denser medium to bend towards the normal (like light) or away from the normal? Explain your reasoning.

c. Can we have the analog of total internal reflection for sound? If so, this could have severe implications for imaging using ultrasound. The speed of sound for some relevant media are given below. Determine which boundaries between two media could lead to total reflection of sound rays. Describe the configuration (entering from which medium) and find the angle above which total reflection occurs.*

Material	*Speed of Sound*
Air	330 m/s
Muscle	1600 m/s
Bone	4000 m/s

* Data taken from J. R. Cameron and J. G. Skofronick, *Medical Physics* (John Wiley & Sons, Inc., 1978) p. 255.