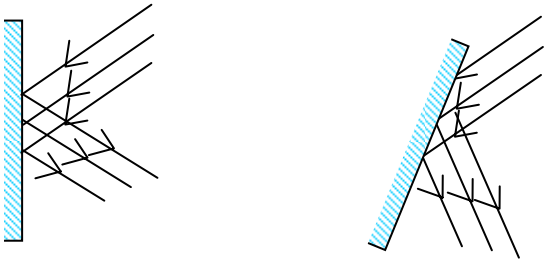
REFLECTION and REFRACTION QUESTIONS AND ANSWERS

1. To reduce glare of the surroundings, the windows of some department stores, rather than being vertical, slant inward at the bottom. How does this reduce glare?
This slant reflects the sunlight further down toward the ground than would have happened if they were vertical.



2. A person in a dark room looking through a window can clearly see a person outside in the daylight, whereas the person outside cannot see the person inside.
There is usually *some* reflection that occurs at an interface between two materials, but often most light passes through. Imagine you are inside in the dark. A person outside in bright sunlight is sending out (reflecting) lots of light, most of which would come through the window to you, so you see them clearly. Since it is so bright outside, there is also a good amount of that light which reflects back toward them. This can distract them from the *little* bit of light from *you* that is going toward them (which would be hard to notice anyway), so they have a much harder time seeing you.

3. A pulse of red light and a pulse of blue light enter a glass block normal to its surface at the same time. Strictly speaking, after passing through the block, which pulse exits first?
Higher frequencies travel slightly *slower* in materials, so the red light would exit first.

4. If, while standing on a bank, you wish to spear a fish beneath the water surface in front of you, should you aim above, below, or directly at the observed fish to make a direct hit?
You should aim slightly below where you see the fish because the refraction of light coming from the fish makes it appear closer to the surface than it really should.

5. Two observers standing apart from one another do not see the “same” rainbow.
The correct geometry to see a rainbow always puts you in line with the center of the arc of the rainbow that you see. So someone next to you is lined up with the center of *their* rainbow, which comes from raindrops lightly to the side of the drops that send you the light that you see.

6. How is a rainbow similar to the halo sometimes seen around the Moon on a frosty night? How do rainbows and halos differ?
Rainbows and halos both occur because of the “dispersion” of light due to the slightly different speeds of the different colors, which leads to slightly different bending, and hence the “spreading” of the colors. But with a rainbow there is also *reflection* of the light from the back of the raindrop in addition to the refraction entering and leaving the water. The halos don’t have that reflection, and so the light comes straight to you through the droplets or ice crystals. So, a rainbow is always opposite the direction of the Sun, and it has red on the outside of the arc, but the halos are *in* the direction of Moon (or Sun) and they have blue/violet on the outside.

7. Does a diamond under water sparkle more or less than in air? Defend your answer.
The sparkling of a diamond actually occurs because of repeated “total internal reflection”. When light enters a diamond, it is difficult for it to leave because of the high index of refraction so it tends to totally internally reflect inside the diamond (especially if it is cut with many facets, giving even more surfaces for reflection). All the bouncing means that light leaves the diamond in many different directions, leading to the sparkle. Putting a diamond underwater means that the difference in speeds (or index of refraction) is much *less* which leads to *less* total internal reflection, and therefore, *less* sparkling!

8. In terms of focal length, how far behind the camera lens is the film located when very distant objects are being photographed?
Very distant objects have light the reaches the camera pretty much parallel, so that light will be focused right at the focal point of the lens – and that’s where you want your film. Anything closer will have rays that are not quite parallel (they will be diverging a little) and so they will not be focused until *after* the focal length (that is, at a distance further from the lens than the lens’ focal point). The film/CCD chip must be placed where the image is focused in order to record a sharp image.

9. The image produced by a converging lens is upside down. Our eyes have converging lenses. Does this mean the images we see are upside down on our retinas? Explain.
The images that form on the cornea *are* upside down, just as happens with other converging lens images. But the retinal cells send the information to our brain, and our brain knows that if the cells detect an “upside-down” image, it corresponds to a correctly oriented object in the real world.

10. Describe the two different types of mirage and how they form.
Superior mirage – appears above the object, when hot air is above cold air.
Inferior mirage – appears below the object, when hot air is below cold air (desert mirages).

11. What is happening in the near-sighted eye?
The near-sighted eye cannot focus the light from distant objects onto the retina because the eye bends and focuses the light *too quickly*. In effect, the eye is “too strong”.

12. What is happening in the far-sighted eye?
The far-sighted eye cannot focus the light from near objects onto the retina because the eye bends and focuses the light *too slowly*. In effect, the eye is “too weak”.

13. A house has its lights on at night. A person outside can see in through the windows easily, but a person inside the house cannot see out through the windows very well. Why?
See Question 2, but reverse the location of the person who is sending out more light.