Phys122
HW 9: Due Thursday, April 20, 2006

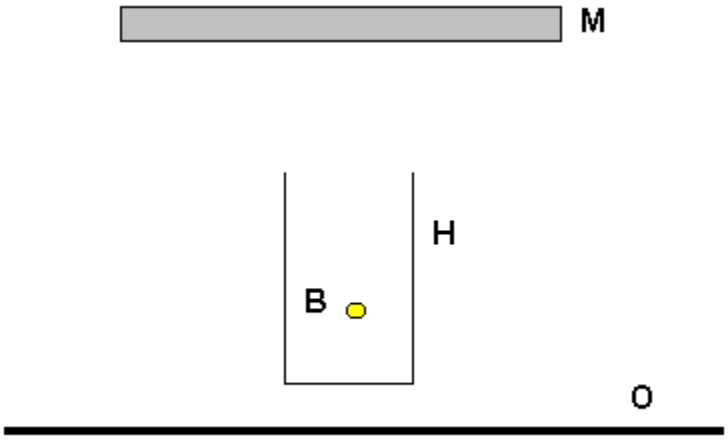
Closer than they may appear

When a *T. rex* pursues a jeep in the movie *Jurassic Park*, we see a reflected image of the (very large) *T. rex* via a side-view mirror, on which is printed the (then darkly humorous) warning: "Objects in mirror are closer than they appear." Is the mirror flat, convex, or concave? Why do you think so?

Where can you see the bulb?

In the following diagram, M is a plane mirror; B is a very small bright light bulb that can be treated as a point source of light; and H is an opaque housing that does not transmit light. An observer can stand anywhere along a line O to try to see the image of the light bulb in the mirror.

By using relevant rays of light, determine those locations along the line O from which the image of B is visible and those locations from which it is not visible. Marke the regions along line O accordingly and explain the reasoning you used in drawing the rays.



Applying the Mirror Equation

A concave spherical mirror has a radius of curvature of 40cm. Draw the rays needed to locate the image, and find the image distance for object distances of a) 60cm b) 40cm c) 10 cm. In each case state whether the image is real or virtual, upright or inverted, and find the magnification.

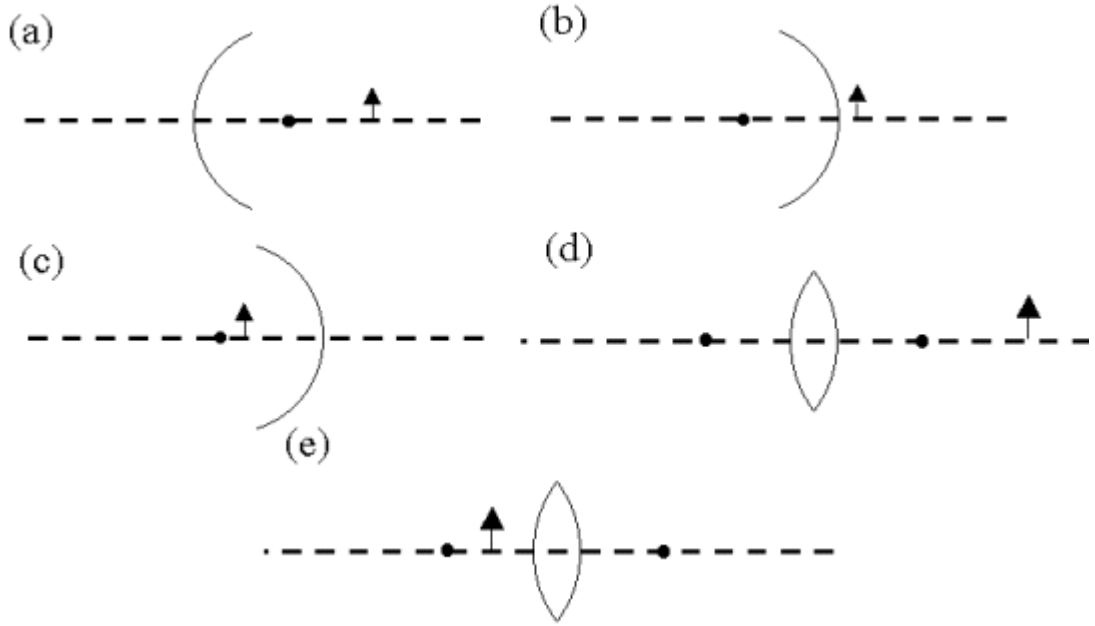
Mirrors and lenses

Each of the problems in this part has a description of an object and an optical device (lens or mirror). A sketch is shown below. For each case, specify whether

- the image is real (R), virtual (V), or no image is formed (N) ;
- the image is on the same side of the device as the object (S) or the opposite side (O). If there is no image put a null mark (ϕ)
- if an image is formed, on which side of the system must the observer be in order to see it, left (-) or right (+)?

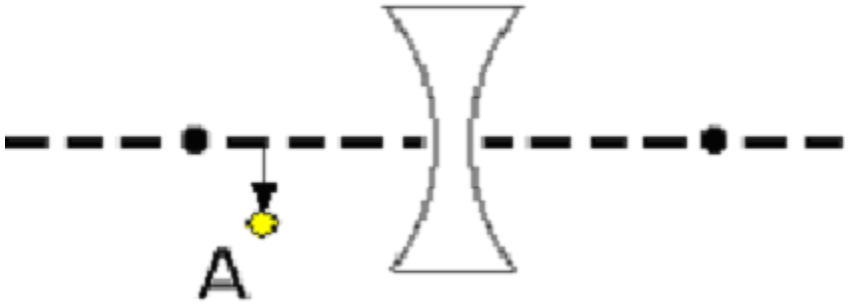
For each problem you should therefore give three answers (for example : V O +). For the mirrors the center is shown. For the lenses, the focal points are shown. The radius of curvature of the mirrors is R, the focal length of the lenses is f.

a. An object on the right side of a spherical mirror, a distance $s > R$ from the mirror. The mirror is concave towards the object.
b. An object on the right side of a spherical mirror, a distance $s < R/2$ from the mirror. The mirror is convex towards the object.
c. An object on the left side of a spherical mirror, a distance $R > s > R/2$ from the mirror. The mirror is concave towards the object.
d. An object on the right side of a convex lens, a distance $s > f$ from the lens.
e. An object on the left side of a convex lens, a distance $s < f$ from the lens



The diverging lens

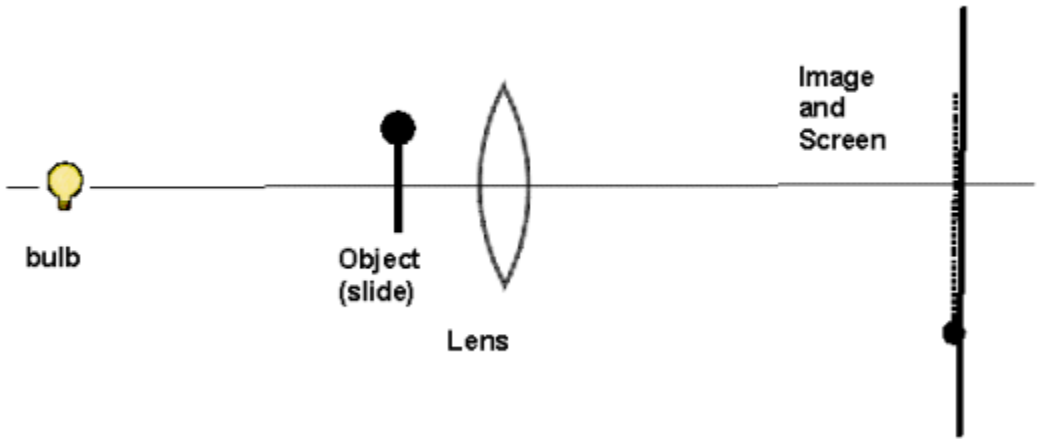
. In the figure shown below, point A (marked by a circle) is the top of a small object (indicated as an arrow). Near it, is a concave lens, as shown. The focal points of the lens are marked with black dots.



A. Using a ray diagram, show where an image of point A would be formed.
B. If the focal length of the lens is 8 cm and the object is 6 cm from the lens, where will the image be?
C. If the object is 1 cm tall, how tall will the image be?
D. Will the image created by the lens be real or virtual?
E. Where will you have to be to see the image?

The half lens

A projector has an arrangement of lenses as shown in the figure below. A bulb illuminates and object (a slide) and the light then passes through a lens that creates an image on a distant screen as shown.



When a cardboard is brought up to cover the lower half of the lens, what happens to the image on the screen?

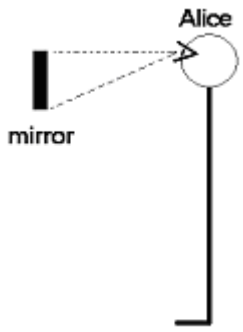
a. The top half of the image disappears.
b. The bottom half of the image disappears.
c. The image remains but is weaker (not as bright).
d. The image remains unchanged.
e. The bottom half of the image becomes weaker, the top is unchanged.
f. The top half of the image becomes weaker, the bottomis unchanged.
g. Something else happens. (Tell what it is.)

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

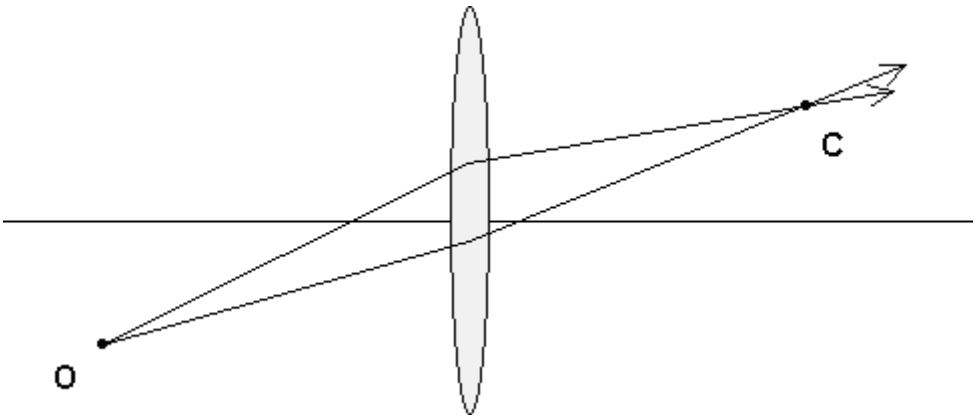
a. she will be eventually able to see all of herself in the mirror at the same time.
b. she will see no change in how much of herself she can see.
c. she will see less of herself as she steps back.
d. some other result (explain)

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.



A bigger lens

In the figure shown below, point O is a source of light. Two rays from O are shown passing through a thin converging lens and crossing each other at the point marked C.



a. On a copy of the figure on your answer sheet, find the two principal foci of the lens by drawing appropriate rays. Label the foci F1 and F2. Explain your reasoning.
b. Suppose the lens is replaced by another lens having the same focal length but a larger diameter. For each of the following partial sentences, indicate whether they are correctly completed by the phrase greater than (>), less than (<), or the same as (=).
    - The distance of the image from the principal axis is _____ it was with the smaller lens.
    - The brightness of the image with the large lens is _____ it was with the smaller lens.

Bizarre behavior with light

I have observed people with cameras undergoing some strange behavior.

a. When I was at a concert the other night, my friend Cindy tried to take a picture of the band far away on the stage. Since the concert hall was darkened, she used a flash. Explain why this is a bad idea and what her pictures are likely to show.
b. I mentioned to her that she probably should not be using the flash so she turned it off. She then proceeded to try and take pictures of other people in the darkened concert hall! Explain why this is a bad idea and what her 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.