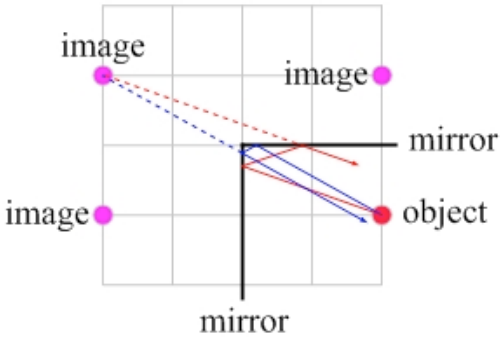
Answers to selected problems from Essential Physics, Chapter 23

1. Yes, the image is in the same location for both of you. A plane mirror acts somewhat like a window. Two observers, standing in different locations, looking through a window at the same object agree on the object's location. The same thing happens for a plane mirror. Another way to see this is that the observers see the image because of light rays reflecting from the mirror towards each observer. The image is located where all the reflected rays appear to diverge from.

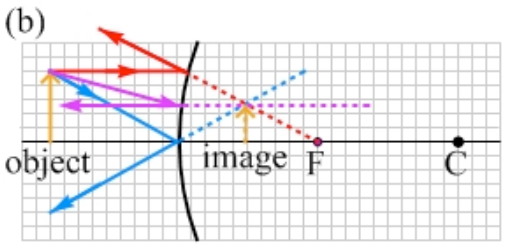
3. The resulting pattern is a bright vertical line, twice as tall as the slit.

5. (a) You see three images. (b) + (c)



7. Because light rays are reversible, and the image is real, we can't tell which is the object and which is the image.

9. (a) The red ray is drawn incorrectly. The red ray is a parallel ray (parallel to the principal axis), so when it reflects from the mirror it should go directly away from the focal point, F, rather then the center of curvature.



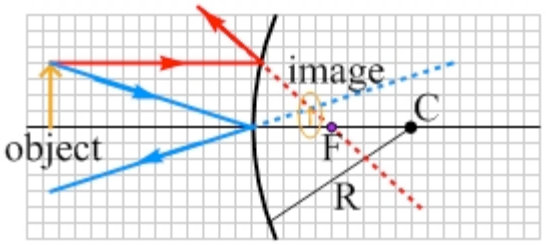
11. (a) Any mirror can produce a virtual image, so this information does not help much. (b) This, also, would happen with any of the three types of mirror. (c) It cannot be a plane mirror, because the height of the image created by a plane mirror is always the same as that of the object. It cannot be a convex mirror, either – moving the object closer to a convex mirror results in an increase in image size. It must be a concave mirror – moving the object closer to a concave mirror when the mirror is creating a virtual image will result in a decrease in the image size.

13. (a) 20° (b) 20°

15. (a) 1/(+12 cm) (b) +12 cm (c) concave mirror

17. (a) 1/(+30 cm) (b) +30 cm (c) concave mirror

19. (a) zero (b) infinity

21. (a) 

(b) –7.1 cm (c) –0.29

25. (a) –0.56 m (b) 0.070 (c) The result for the magnification is consistent with the warning. The image of the truck is a lot smaller than the real truck, making it appear that the truck is farther away than it really is.

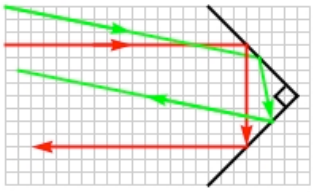
27. (a) 2.5 m (b) inverted

29. (a) 0.49 m (b) Yes, if you can see the clerk, the clerk can, in general, see you. For you to be able to see the clerk in the mirror, light travels in a straight line from the clerk to the mirror, reflects off the mirror (obeying the law of reflection), and travels in a straight line to your eye. Light would travel from you to the clerk along the reverse path so, in general, the clerk could also see you.

31. In conditions where there is lots of light passing through the window from outside, as there is on a sunny day, the light coming through the window into your eye overwhelms the light reflecting from the inside of the window into your eye. When there is very little light passing through the window from outside, on the other hand, as when the train is passing through a dark tunnel, the reflected light dominates.

33. The image maintains its position. Thus, a mirror is much like a window. When you look at a stationary object through a window, the object maintains its position when you move. Similarly, a mirror creates an image of a stationary object that is at a fixed location in space, so looking into the mirror at that image while you are moving is a lot like looking through a window at an object while you are moving.

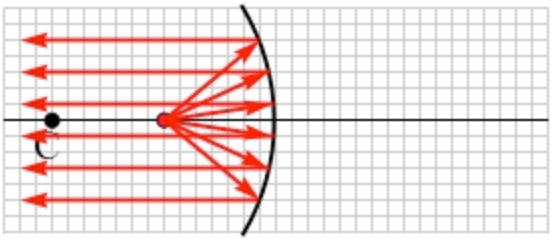
35. (a) 3.0 m (b) 5.0 m, 8.0 m, and 8.0 m (there are two images 8.0 m from you).

37. (a) 180° (b) 180° 

41. (a) –48 cm (b) +16 cm

45. The mirror is in between the object and image, 1.0 m to the right of the object. The mirror is convex, with a focal length of –1.5 m.

47. The LED is at the focal point, so the ray diagram is the opposite of the traditional diagram to show the location of the focal point.



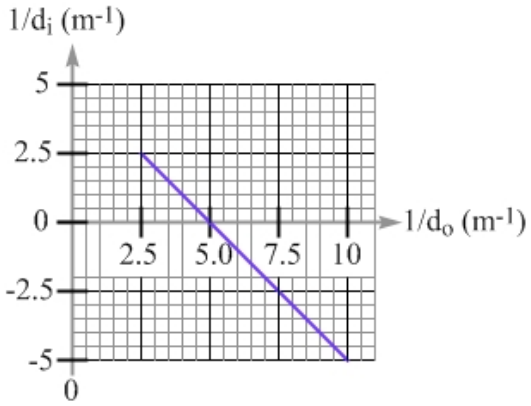
49. The image is located 3.5 cm above the principal axis, and 5.25 cm horizontally to the right of the center of the mirror.

51. (a) 53 cm from the mirror, on the same side as the object (b) –8.3 cm
(c) real (d) inverted.

53. (a) 12.3 cm from the mirror, on the opposite side as the object (b) 1.9 cm
(c) virtual (d) upright.

55. The image shifts a little farther from the mirror, and gets a little larger.

57. (a)



(b) The focal length can be found from the intercept of the graph (either intercept). For instance, the x-intercept is 5.0 m^{-1}. The focal length is the inverse of this, or 1/5 m (= 20 cm).

59. A convex mirror with a focal length of –20 cm.