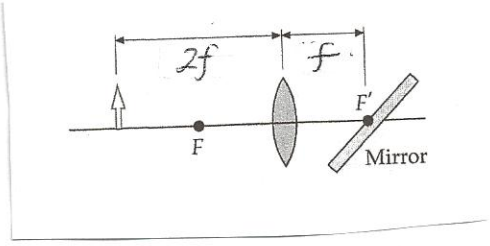
4C Problem Set 8 – Lenses

1. An object located a distance *4d* from a concave mirror forms a real image distance *3d* from the mirror. The mirror is then turned around so that its convex side faces the object. The mirror is moved so that the image is now $\frac{7}{5}d$ behind the mirror. How far was the mirror moved? Was it moved toward or away from the object?
2. Two converging lenses, both of focal length *f* are separated by a distance d = 3.5f. An object is placed at *S = 2f* to the left of the first lens. (a) find the position of the final image using both a ray diagram and the thin-lens equation. (b) Is the image real or inverted? (c) What is the overall lateral magnification?
3. If two point objects close together are to be seen as two distinct objects, the images must fall on the retina on two different cones that are not adjacent. That is, there must be an unactivated cone between them. The separation of the cones is about 1μm. (a) What is the smallest angle the two points can subtend? (b) How close can two points be if they are 20m from the eye?
4. A small object is a distance *S = 2f* to the left of a small thin positive lens of focal length *f*. To the right of the lens is a plane mirror that crosses the axis at the second focal point of the lens and is tilted so that the reflected rays do not go back through the lens. (a) Find the position of the final image. (b) Is this image real or virtual? (c) Sketch a ray diagram showing the final image.



5. An object is placed at *S = 1.2 f* to the left of a lens of focal length *f*. A second lens of focal length f_2 = *1.25 f* is placed a distance *2f* to the right of the first lens. (a) find the position of the final image (b) What is the magnification of the image. (c) Sketch a ray diagram showing the final image.
6. Show that if *f* is the focal length of a thin lens in air, its focal length in water is

$$f' = \frac{n_w(n-1)}{n-n_w}f$$

7. While sitting in your car, you see a jogger in your side mirror, which is convex with a radius of curvature of magnitude 2m. The jogger is 5m from the mirror and is approaching at 3.5 m/s . How fast does the jogger appear to be running when viewed in the mirror?
8. When an object is placed at the proper distance to the left of a converging lens, the image is focused on a screen a distance 6d from the right of the lens. A diverging lens is now placed 3d to the right of the converging lens and it is found that the screen must be moved 4d farther to the right to obtain a sharp image. What is the focal length of the diverging lens?
9. An object and screen are a fixed distance *D* apart. (a) Show that a converging lens of focal length *f* will form a real image on the screen for two positions that are separated by

$$d = \sqrt{D(D-4f)}$$

(b) Show that the ratio of the two image sizes for these two positions is

$$\left(\frac{D-d}{D+d}\right)^2$$

10. Show that the distance between a real object and its real image formed by a thin converging lens is always greater than or equal to four times the focal length of the lens