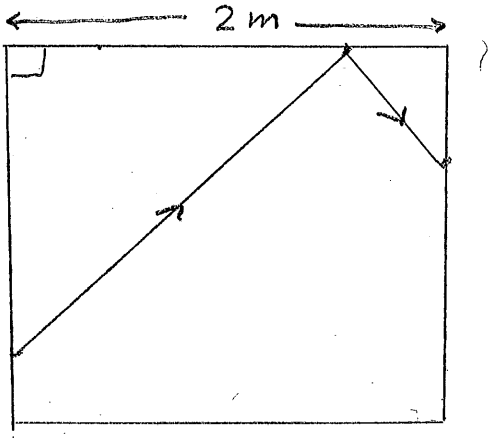
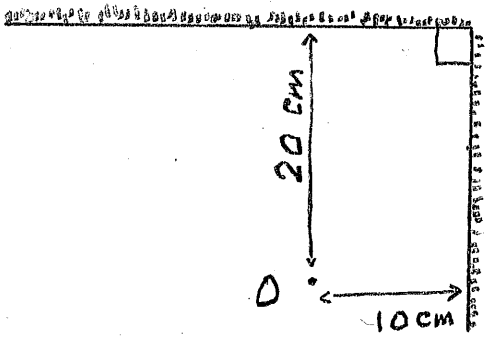
Problems: Week 12

Note: All solutions must be supported by ray diagrams.

12-1. As shown, laser light enters a room at a point 0.8m below the left top corner, reflects off the ceiling which is 2m wide and hits the opposite wall 0.3m below the top. At what point did it hit the ceiling?

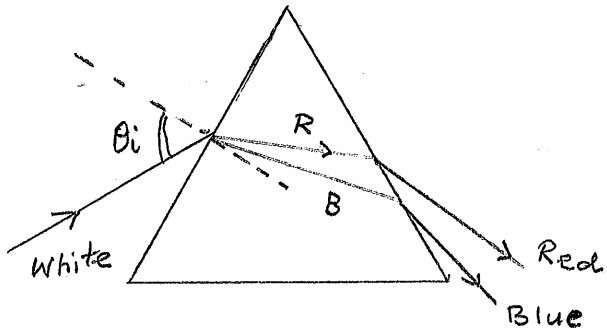


12-2. The object O is located as shown in "front" of two mirrors. Draw rays to locate the images that it will produce. [Hint: You need two rays to locate an image.]



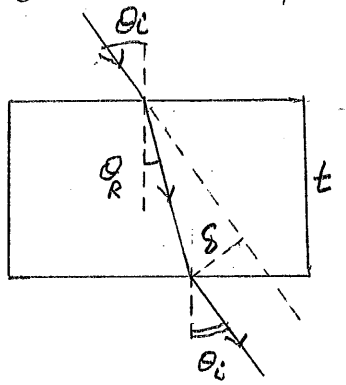
12-3. You drop a tiny ball from a height of 1m toward a plane mirror. How fast will its image move toward it? Why? (neglect air friction)

12-4. In Newton's experiments, white light was incident on a glass prism but after passage through the prism it split into several colors. What properties of light did he learn from these experiments?



12-5. From the schematic shown in problem 12-4 which light (red or blue) has the larger refractive index in the prism? Why?

12-6. Light is incident on a parallel plate of glass of thickness t. The angle of incidence is Θ_i and the refracted ray makes the angle $\Theta_R < \Theta_i$ since n > 1. Eventually, it emerges parallel to its original direction. If $\Theta_i = 30°$, n = 1.5, and t = 10cm what is the "side jump" δ ?



12-7. What is the difference between a real image and a virtual image?

12-8. Magnification is defined as $m = \frac{image\ size}{object\ size} = \frac{-q}{p}$ where q is the distance of the image from the optical device and p is the distance of the object. Why is there a negative sign on the right side of this equation?

12-9. For plane and spherical mirrors we have derived the equation

$$\frac{1}{p} + \frac{1}{q} = \frac{2}{r}$$

where r is the radius of curvature of the mirror. How do you distinguish among (i) a convex mirror (ii) a plane mirror and (iii) a concave mirror?

12-10. Why do you need to assume paraxial rays to prove the formula of problem 12-9 for spherical mirrors?

12-11. For a concave mirror show that a real image can never come closer to the mirror than its focal point.

12-12. (i) Can you use a convex mirror to produce a real image? (ii) Where would you locate an object to produce an image furthest from the mirror?

12-13. If you want a convergent mirror to produce an upright image where would you place the object? Why? Is the magnification greater or less than unity?

12-14. An object is placed 20cm in front of a convergent mirror and produces an inverted image one half the size of the object. What is the focal length of the mirror?