Third Level Module - Optics - 2002/03

Tutorial 1

1. Sketch a system using two <u>convex</u> lenses for increasing the diameter of a laser beam from 2 mm to 10 mm. Would the same system of lenses, used in the reverse direction, give a laser beam of smaller diameter?

2. The image formed on a screen by an optical instrument is too small. Explain how you would select an additional lens to provide an image $10x$ as large and how you would position the lens and reposition the screen.

3. Use the geometry of a ray diagram to show that for a thin lens of focal length f the object and image plane distances are related by

$$\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$$

4. Show that the minimum separation between (conjugate) real object and image points for a thin positive lens is $4f$, where f is the focal length of the lens.

5. The lens of the eye is of variable focal length and "automatically" adjusts so that the images of objects at different distances are in focus on the retina. The object will be seen clearly only if the image on the retina is larger than some minimum size. Estimate the minimum <u>angular</u> size of objects which will be seen clearly by people with normal vision. You can estimate this a) by experiment or b) by calculation using 'minimum standards of vision data' required to pass a driving test.

6. An A4 sheet of paper with 18pt typing on it has been photographically copied onto a 35 mm slide. This slide is to be projected in Lecture Theatre A (JCMB) so that it can be read from the back of the lecture theatre. What focal length of projector lens should be used?
(Assume that the projector lens is a single thin lens.)
(1pt is equivalent to 1/72 of an inch and, of course, 1 inch = 2.54 cm)
(The size of a 35*mm* slide is 24×36mm.)

7. This question is given to encourage you to observe "physics" as part of your everyday experience.

   Discuss and explain, qualitatively, the properties of the "rainbow"; the order of the colours, the relative positions of the rainbow, the Sun and the observer; *etc.*

   The primary rainbow is formed by light being refracted on entering the water drop, being reflected once and then being refracted on leaving the drop - see figure below.
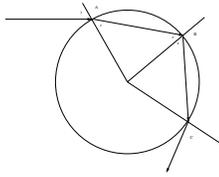
Assuming that the water drops responsible for the formation of the rainbow are spherical, which colour should be on the outside of the primary bow?

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