MENGO SENIOR SCHOOL
S5 PHYSICS PAPER I1
END OF TERM/YEAR 2001 EXAM
TIME: 2½HOURS.

Instructions:

Attempt ONLY Five Questions.

1- a) What is meant by the magnifying power of a telescope? (1 mark)

b) (i) Draw a labelled diagram to show how two converging lenses can be arranged an image at infinity, for a distant object. (3 marks)

(ii) Derive the expression for the magnifying power of the lens system in (i) above. (3 marks)

c) Light from a distant object is incident on a concave mirror M1 of radius of curvature 2.0m and having a small hole at its pole. A small convex mirror M2 is arranged coaxially at a distance of 0.9M from the pole light rays reflected by M1, are reflected by M2 into lens E. (see the diagram above). If the focal length of the lens E is 5.0cm, find: (i) the distance of the lens from the pole such that if forms such that it forms a virtual image 25.0cm away from the lens. (3 marks)

(ii) the magnifying power of the system when the final image is at infinity. (3 marks)

2- a) What are the main differences between telescopes and compound microscopes? (3 marks)

b) (i) Explain with the aid of a ray diagram how a convex lens of long focal length and a concave lens of short focal are arranged to obtain a telescope which forms an image at infinity and has magnifying power of 0. (6 marks)

(ii) State one advantage and one disadvantage of the telescope in (i) over the astronomical telescope in the same adjustment. (2 marks)

c) A compound microscope consists of an objective of focal length 1.75cm and an eye-piece of focal length 12.5cm. An object is placed 2..0cm from the objective and the eye-piece adjusted so that a clear image is formed at the near point.

Find: (i) the separation between the objective and the eye-piece (5 marks)

(ii) the magnifying power of the microscope. (2 marks)

d) Explain why chromatic aberration in not observed in a magnifying glass. (2 marks)

3- a) Draw ray diagrams to explain the following terms as applied to a thin converging lens.

(i) principal focus. (1 mark)

(ii) conjugate points. (1 mark)

b) A converging lens of focal length 20cm forms an image on a screen placed 40cm beyond the lens. A concave lens of focal length 40cm is the placed between the convex lens and the screen at a distance of 20cm from the lens.

(i) where must the screen be placed in order to receive the new image? (3 marks)

(ii) What is the magnification produced by the lens system? (2 marks)

c) Show that the focal length f, of a thin convex lens in air is given by

$$\frac{1}{f} = (n - 1)\left(\frac{1}{r_1} + \frac{1}{r_2}\right)$$

where n is the refractive index of the material of the lens, r1 and r2 the radii of curvature of the surfaces of the lens. (5 marks)

d) A thin biconvex lens is placed on a plane mirror. A pin is clamped horizontally above the lens so that its apex lies on the principal axis of the lens. The position of the pin is adjusted until the pin coincides with its image at a distance of 5cm from the mirror. When a thin lay5cm from the mirror. When a thin lay of water or refactive index 1.33 is placed between the lens and the mirror, the pin coincides with its image at a point 22.5cm from the mirror.
When the water is replaced by paraffin, the pin coincides with its image at a distance of 27.5cm from the mirror.

Calculate the refractive index of paraffin. (8 marks)

4- a) (i) Define focal length of a lens. (1 mark)

(ii) A convex lens is contained in a cylindrical tube such that its exact position in the tube is not accessible.

Describe how you would determine the focal length of the lens without removing the lens from the tube. Derive the formula used to obtain the final result. (6 marks)

b) (i) Define angular magnification of an optical instrument. (1 mark)

(ii) Explain why the farthest vertical pole in line with others of equal height looks shorter. (2 marks

c) With help of a labelled diagram how a slide projector works. (5 marks)

d) A projector projects an image of area $1m^2$ onto a screen placed 5m from the projection lens. If the area of the object slide is $4cm^2$,

Calculate the:

(i) focal length of the projection lens. (3 marks)

(ii) distance of the slide from the lens. (2 marks)

5- a) Explain the term refractive index. (1 marks)

b) With the aid of a labellled diagram, describe how the refractive index of a liquid may be determined using an air-cell.
State the necessary precautions. (6 marks)

c)

A test tube is inclined at an angle, Q in a beaker containing a liquid as shown in the diagram above:

(i) Explain why the test tube appears silvery when viewed from above the surface of the liquid (3 marks)

(ii) Trace the path of light as seen from above the surface of the liquid. (2 marks)

(iii) If the incident ray makes an angle $i = 27°$ and the test tube is inclined at angle $\theta = 55°$, Calculate the refractive index of the liquid. (4 marks)

d) Explain how a primary rainbow is formed. Draw a diagram to illustrate your answer. (4 marks)

6- a) State the laws of reflection of light. (2 marks)

b)

The diagram above shows a cross section of an isosceles right angled prism. Sides PQ and QR are coated with reflecting substance. A ray of light is incident on PR at an angle Q as shown in the diagram.

(i) Draw a diagram to show the path of light through the prism. (2 marks)

(ii) Show that the ray caving the prism is parallel to the incident ray. (5 marks)

(iii) If θ is 20° and the refracted ray makes an angle of 58° with PQ, calculate the refractive index of the material of the prism. (3 marks)

c) (i) With the aid of a diagram, explain why a fish appears bigger in water than its actual size when out of water. (3 marks)

(ii) A fish is 3.0m below the surface of a pond and 2.5m from the bank. A man 2.0m tall stand s 4.0m from the edge of the pond. Assuming that the sides of the pond are vertical, calculate the distance the man should move towards the edge of the pond so that he is just seen by the fish.
(The refractive index of water is 1.33) (5 marks)