

PHY2208 Problem Sheet 1

- 1) The image of a red rose is formed by a concave spherical mirror on a screen 100cm away. If the rose is 25cm from the mirror, determine the radius of curvature of the mirror. (Answ: $R=40\text{cm}$)
- 2) Locate the image of a paper clip 100cm away from a convex spherical mirror having a radius of curvature of 80cm. Is the image real or virtual? Is it magnified ($|M|>1$) or minified $|M|<1$? (Answ: 28.6cm from mirror, virtual, minified)

- 3) We have discussed the **Gaussian** lens equation:-

$$\frac{1}{s} + \frac{1}{s'} = \frac{1}{f}$$

If an object point O lies a distance x_0 from the front focal point of a thin lens and the image point P lies a distance x_1 from the back focal point, show that this equation may be re-expressed as:-

$$x_0 \cdot x_1 = f^2$$

(the so-called **Newtonian** lens equation).

- 4) Show that a glass ($n=1.5$) lens immersed in water ($n=4/3$) has *4 times* the focal length it would have if immersed in air.
- 5) An astronomical telescope is used to project a real image of the moon onto a screen 25cm from the eyepiece, which has a focal length of +5cm. How far must the eyepiece be moved from its normal position? (Answ: 1.25cm away from objective)
- 6) The intensity of solar radiation at the Earth's surface is 1 KWm^{-2} and the sun has an angular diameter of 0.5° as seen from Earth. If a lens with 5cm diameter and 50cm focal length is used to project a real image of the sun onto a screen, what is the intensity of light in this image? (Answ: $1.3 \times 10^5 \text{ Wm}^{-2}$)
- 7) A thin lens of focal length f is used to produce a real image of an object. Show that, provided the separation of these conjugate object and image points, L , exceeds $4f$, then there are **two** locations of the lens, separated by a distance d , which will produce these same conjugate points, where:-

$$f = \frac{L^2 - d^2}{4L}$$

(This is a useful way to measure the focal length of a +ve lens, which avoids having to measure distances from the lens surface).

- 8) What is the numerical aperture of an optical fibre with core refractive index 1.62 and cladding refractive index 1.52? When immersed in air, what is the maximum acceptance angle of the fibre? (Answ: 0.56 , 68°)