A2-2010 Q1(d)

(d) A cinema screen is a white painted surface designed to reflect light back into your eye. The more light that is reflected back the brighter the image will be. Why then can a mirror not be used instead?

(2 marks)

A2-2010 Q1(i)

(i) A glass prism with an apex angle of 30° has a monochromatic beam of light passing through it, as shown in Fig. 6. The critical angle for the glass of the prism is 42°. (The critical angle is the largest angle of incidence within the glass for which the light can just escape from the glass or the smallest angle of incidence at which Total Internal Reflection can occur).

The normals for the incident and emergent rays are shown. The ray of light emerges at angle q_e for a ray incident on the prism at angle q_i. As angle q_i increases to 90°, which side of its normal does the emerging ray appear? (You do not need to calculate angle q_e but you DO NEED to give the angles of the rays inside the glass). You may draw a diagram with all the angles within the glass marked.

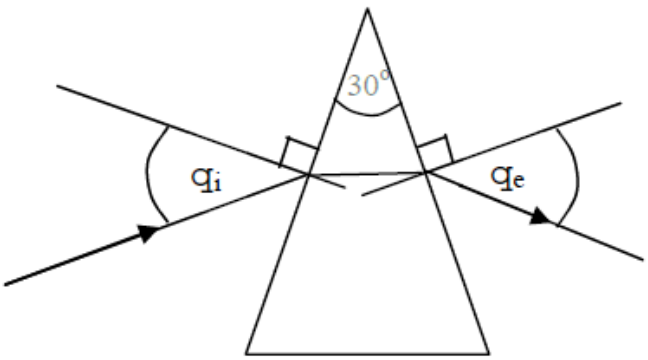

Fig. 6

(3 marks)

A2-2008 Q8

8. (a) The average wavelength of light emitted from an incandescent torch bulb with a metal filament is 120 nm. Calculate the number of photons emitted by a 20 W torch bulb in one hour.

(b) A photon has a momentum given by E/c where E is the energy of the photon and c is the speed of light. If the torch bulb emits a parallel beam of light, then calculate the force on the torch.

(c) Calculate the initial acceleration of the torch if it was in empty space and it had a mass of 200g.

(d) If the spectrum of the light remained the same, and the mass of the torch remained unchanged, what power of torch bulb would be needed in order for it to levitate in the earth's gravitational field?

(6 marks)

A2-2008 Q9

9. (a) In a two source interference experiment (double slits), monochromatic light is used to produce light and dark fringes on a screen. The maxima of the fringe pattern, symmetric about the beam of light at normal incidence, is given by

$$n\lambda = d \sin(\theta),$$

where n is the order of the fringe, λ is the wavelength of the light, d is the separation of the slits and θ is the inclination of the light rays to the horizontal.

If d = 0.2 mm and a wavelength of 450 nm is incident on the two slits, what is the angular separation of the 9^{th} and 10^{th} order fringes? If a different wavelength of 495 nm is incident, what would be the angular separation of the 9^{th} and 10^{th} order fringes now?

(b) The change in wavelength was a 10% increase. Using your calculated angles, state clearly which of your angles have increased by 10%.
Why should a 10% increase in the wavelength change the fringes by 10% almost exactly?

(8 marks)

A2-2009 Q6

When a parallel beam of light passes through a narrow aperture, the beam spreads out so that it is no longer parallel. When diffraction occurs through a circular aperture, the majority of the energy is confined to a beam whose angular spread is given by $2\theta = 2 \times 1.2 \frac{\lambda}{d}$ where d is the diameter of the aperture and λ is the wavelength, and θ is indicated in Fig. 5. (θ is measured in radians)

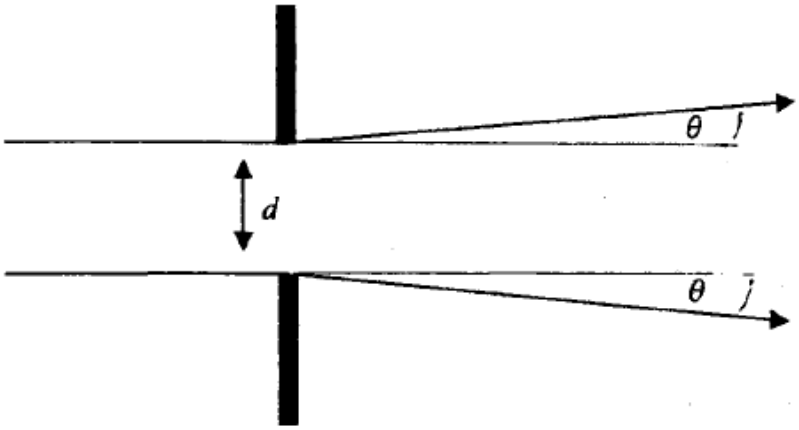

Fig. 5

(a) Light is emitted from a laser with a circular beam of diameter of 1.0 cm, at a wavelength of 530 nm and with a power of 10.0 W. If it is shone at the moon, calculate the area of the moon which is illuminated by the beam (the area of the moon which is illuminated can be taken to be a flat surface)

(3 marks)

(b) If the parallel beam from the laser of part (a) is focussed down by a lens to a spot on a screen, calculate the average intensity (power per unit area) of the spot. The width of the spot is determined by the angular spread of the beam and the focal length (the distance away from the lens that the spot is focussed), such that the width of the spot is the focal length multiplied by the angular spread. The focal length of the lens is 15 cm.

(3 marks)

For a dish aerial shown in Fig. 6, a source of radio waves placed at the focus will also suffer from diffraction with the angle of diffraction also given by $2\theta = 2\times1.2\frac{\lambda}{d}$, where the angle θ is given in Fig. 6.

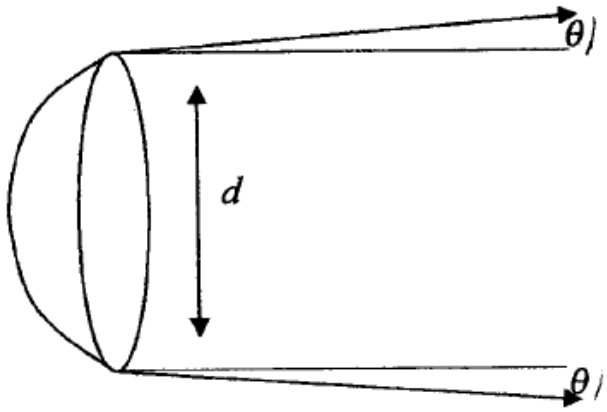

Fig. 6

(c) A satellite carrying a dish aerial of 10 m diameter is placed in orbit at a height of 44,000 km above the earth, transmitting at a frequency of 1.5 GHz. The dish is aimed vertically downwards. Show that the area of the earth illuminated with the signal is approximately 3×10^{12} m^2.

(4 marks)

Distance between earth and moon is 4.0×10^8 m

[10]