

Problems for chapter 12.

Revision: $f = \frac{v_j}{\lambda_j}$ a n d $n = \frac{c}{v}$

reflection $\theta_i = \theta_r$

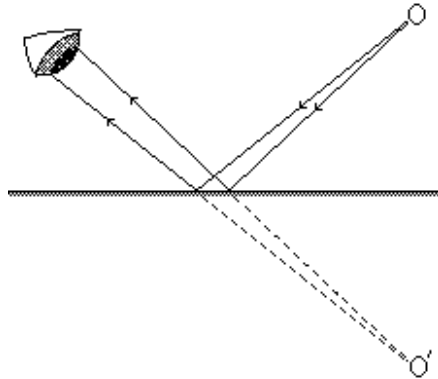
refraction $\frac{\sin \theta_i}{\sin \theta_r} = \frac{n_2}{n_1} = n_{21}$

Two slit interference maximum $m \mathbf{l} = d \sin \mathbf{q}$

 minimum $(m + \frac{1}{2}) \mathbf{l} = d \sin \mathbf{q}$

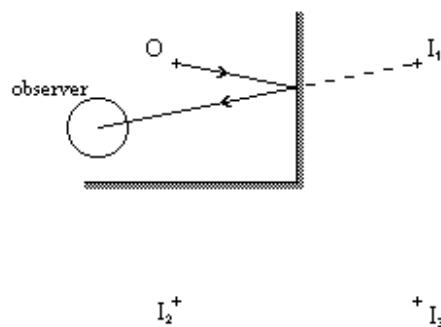
- 1.* A typical wavelength for a visible colour is 500 nm. If this light is observed in a vacuum (air is nearly the same as a vacuum for light) what is the corresponding frequency of the light? Is this frequency similar in order of magnitude to the period of an electron orbiting an atom?
2. A typical wavelength for a visible colour is 500 nm. If this light is observed in a water (of refractive index $n = 1.33$ compared with air) what is the corresponding frequency of the light? Is this frequency similar in order of magnitude to the period of an electron orbiting an atom?
- 3.* The frequency of a photon stays fixed as photons travel through different media. What is the wavelength of light of frequency 6.0×10^{14} Hz, when it is in a vacuum? What are the effective wavelengths of this light in water $n = 1.33$ and in glass $n = 1.55$?
4. What is the wavelength of light of frequency 4.5×10^{14} Hz, when it is in a vacuum? What are the wavelengths of this light in water $n = 1.33$ and in glass $n = 1.55$?

5. The diagram below has been drawn to show how the reflections from a mirror appear as rays diverging from an object in the mirror.



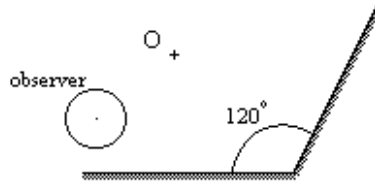
Use the laws of reflection to show that the distance of the real object O from the mirror is the same as the distance of the apparent object O' .

6.* In another diagram of similar nature to that of question 5, we have two perpendicular

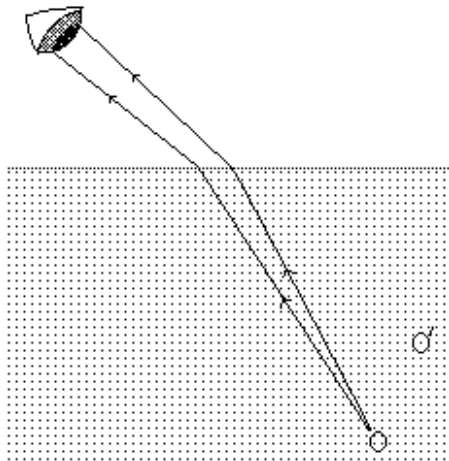


plane mirrors with an object O that reflects to give three images (I_1 , I_2 and I_3) that can be observed by the observer beside O . Two rays that follow the laws of reflection have been drawn from O to the observer, these rays help us to understand why the image I_1 can be seen. Draw similar rays from O to the observer, that would help us understand the origin of the other two images I_2 and I_3 .

7. The vertical mirror in question 7, is rotated so that it is 120° from the horizontal mirror. Find the location of the new images and draw rays from O to the observer, that help explain the image locations.

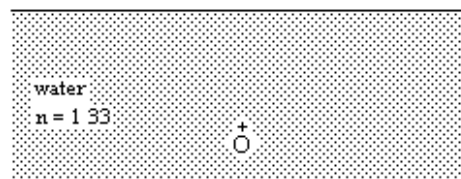
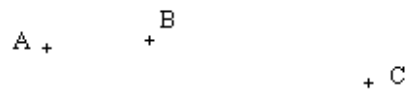


8. A similar diagram to that in problem 5. has been drawn to show the rays of light from an object at O inside a material of refractive index 1.5, these rays follow the laws of refraction.



Draw the apparent rays that show why the object appears to be more shallow than it really is below the surface.

9. Draw rays from O to A, B and C (or points conveniently near to A, B and C) using the diagram below, or a reasonable copy; make sure that each ray follows the laws of refraction. Show that the rays reaching A, B and C do not appear to come from a common point inside the water.



water.

You will need to use some approximations or guesswork to get your rays about right.

10.* Water has a refractive index of 1.33. When a ray has an angle of incidence greater than 48.8° coming from water into air the ray will reflect inside the water. Why can these rays not refract from the water?

11.* Why are Polaroid sun-glasses (shades) effective for people who go fishing?

12.* Two adjacent parallel slits have monochromatic (single colour) light shining through them. If the slits are $2.5 \mu\text{m}$ ($2.5 \times 10^{-6} \text{ m}$) apart and the wavelength of the light is 500 nm ($500 \times 10^{-9} \text{ m}$) find the angle between the first two interference maxima that are found nearest the perpendicular line from the centre of the two slits. What is the angle from the perpendicular to the first minimum found off the central perpendicular line?

13. Two adjacent parallel slits have monochromatic light shining through them. If the slits are $1.25 \mu\text{m}$ ($1.25 \times 10^{-6} \text{ m}$) apart. If the angle from the central normal to the second order maximum of the diffraction pattern is 46° , what is the wavelength of the light? What is the angle between the central normal and the first minimum or zero in the diffraction pattern?

14.* Two adjacent parallel slits have monochromatic (single colour) light shining through them. If the slits are $31.5 \mu\text{m}$ apart and the wavelength of the light is 633 nm , find the angle between the central normal and the first three interference maxima. What is the angle from the central normal to the third minimum or zero?