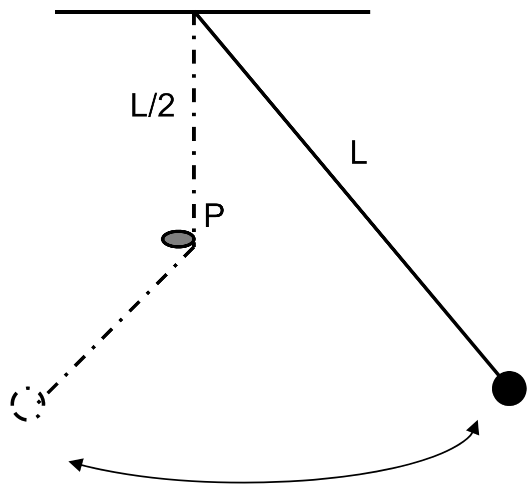
Tutorial questions 2018

A mass is hanging from the end of a string forming a simple pendulum, as shown in the figure below. The point P indicates the position of a peg, at a distance L/2 beneath the fixed point of the string. This alters the motion of the pendulum as shown. Derive an expression for the period of oscillation of this system.



Summer 2015

- (b) A string fixed at both ends is oscillating in its fourth harmonic. The ampliftude of the standing wave is 4.00 mm. The string with mass m = 2.500 g, and length L= 0.800 m is under a tension of 325.0 N.
- (i) Sketch the standing wave pattern.
- (ii) Determine the wavelength and frequency of the transverse waves producing the standing wave pattern.
- (iii) Determine the maximum magnitude of the transverse velocity of the element oscillating at x=0.180 m.
- (iv) At what point during this element's oscillation is the transverse velocity maximum?

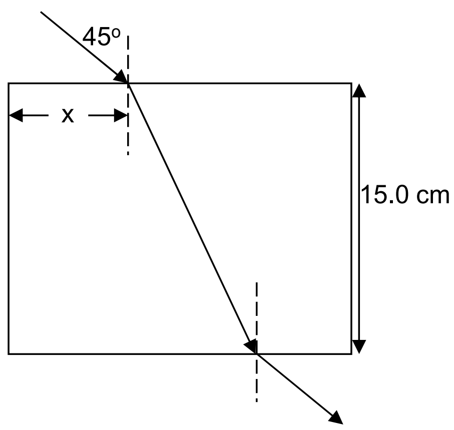
Two strings are each 1.00 m long with a mass of 0.10 g. Both are subjected to the same tension. Both are place in an elevator with one string stretched across fixed supports in the elevator while the other has one end attached to the ceiling while supporting a 6.00 kg mass at the other end. When the elevator is at rest both vibrate with the same fundamental frequency, but when the elevator is accelerating upwards a beat frequency of 2 Hz is heard. Determine the acceleration of the elevator.

33.40

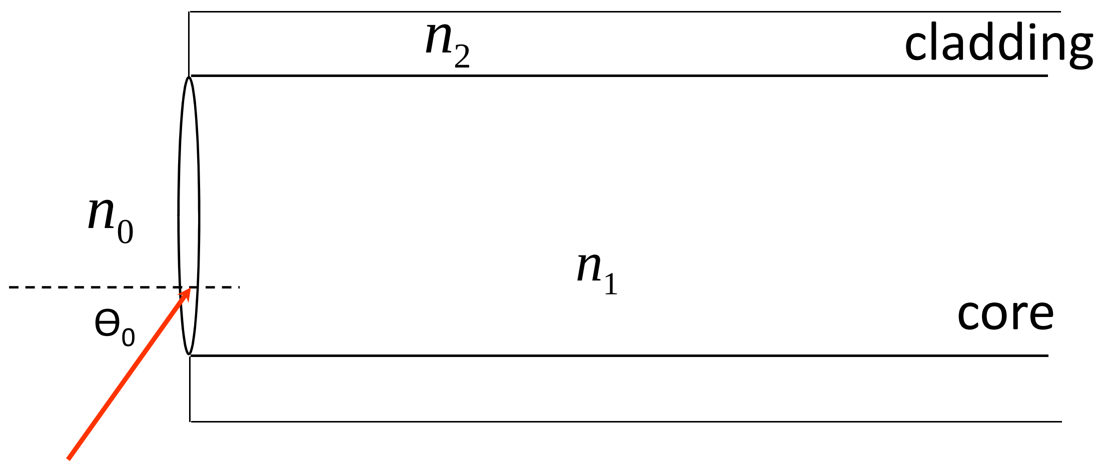
- In a physics lab, light with a wavelength of 570 nm travels in air from a laser to a photocell in a time of 17.4 ns. When a slab of glass with a thickness of 0.880 m is placed in the light beam, with the beam incident along the normal to the parallel faces of the slab, it takes the light a time of 21.6 ns to travel from the laser to the photocell.

What is the wavelength of the light in the glass?

A glass block (as in the diagram below) has a refractive index of 1.52 and is surrounded by air. Determine the maximum distance x for which the incident beam will exit from the opposite face of the block.



Consider an optical fibre a shown in the diagram. The incident medium is air and the refractive indices of the core (n_1) and cladding (n_2) are 1.5 and 1.485, respectively. What is the largest angle of incidence Θ_0 for which light will remain trapped inside the fibre and travel by total internal reflection?



33.34

- Three polarizing filters are stacked, with the polarizing axis of the second and third filters at angles of 19.0 and 56.0 , respectively, to that of the first. If unpolarized light is incident on the stack, the light has an intensity of 80.0 W/cm^2 after it passes through the stack.

If the incident light is kept constant what is the intensity of the light after it has passed through the stack if the second polariser is removed?

Summer 2015

- b) Unpolarized light is incident on a stack of two polarizers, which have an angle of 30^0 between their polarizing axes. Determine the percentage of light transmitted through the stack.
  [3 marks]

- c) By placing a third polarizing sheet between the two polarizers in part (b) the intensity of transmitted light can be increased. Determine an angle between the polarizing axes of the new polarizer and the polarizing axes of the first polarizer in the stack that will maximize the intensity of transmitted light?

Summer 2016

a) A double slit pattern is observed on a screen 1.0 m behind two slits spaced 0.30 mm apart. Ten bright fringes span a distance of 1.7 cm. Determine the wavelength of the light. Derive any equations used.

d) Determine the width of the central bright fringe on a screen 1.0 m away from the slit if the light has a wavelength $\lambda = 633$ nm and the slit width is 0.25 mm.

Summer 2016

The figure below shows single slit diffraction patterns. The distance between the slit and the viewing screen is the same in both cases. The slit width is labelled *a*. Which of the follow statements is true (there may be more than one)?

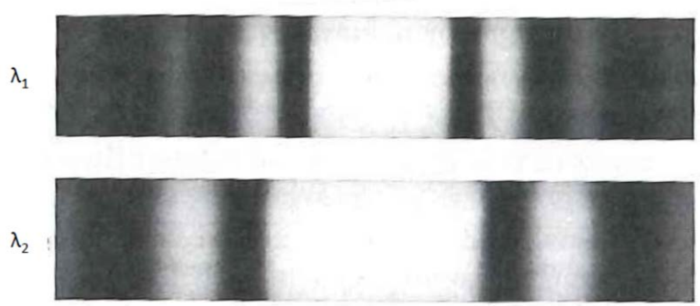
i) The slits are the same for both and $\lambda_1 > \lambda_2$

ii) The slits are the same for both and $\lambda_2 > \lambda_1$

iii) The wavelengths are the same for both and $a_1 > a_2$

iv) The wavelengths are the same for both and $a_2 > a_1$

Clearly justify your answer .

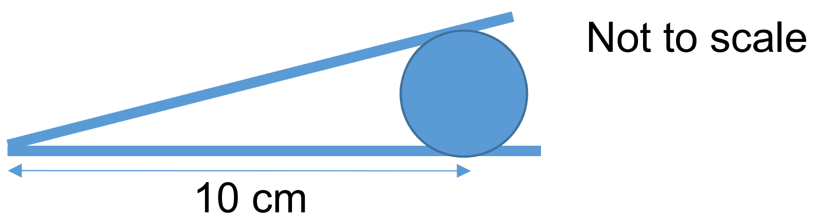


- Suppose you illuminate two thin slits by monochromatic coherent light in air and find that they produce their first interference minima at $\pm 35.20^0$ on either side of the central bright spot. You then immerse these slits in a transparent liquid and illuminate them with the same light. Now you find that the first minima occur at $\pm 19.46^0$ instead. What is the refractive index of the liquid?

Thin film Interference II

Two flat glass plates touch at one end but are separated by a wire of diameter d=0.01mm at the other end, at a distance of 10 cm as illustrated. Light shines almost perpendicularly on the glass and is reflected into the eye. What is the distance x between the observed maxima if the incident light has a wavelength of 420 nm?

What happens if you fill the gap with water instead of air? Do the fringes get closer together or further apart?



Fringes from different interfering wavelengths

Coherent light with wavelength 595 nm passes through two very narrow slits, and the interference pattern is observed on a screen a distance 3.00 m from the slits. The first order bright fringe is a distance of 4.84 mm away from the centre of the central bright fringe.

For what wavelength of light will the first order dark fringe be observed at this same point on the screen?

Summer 2008

- Light with a wavelength of 550 nm is used to illuminate a pair of double slits and an interference pattern is formed on a distant screen. A plastic sheet with a refractive index of 1.31 is placed over one of the slits, which causes a shift in the fringe pattern. With the plastic sheet in place the m=-1 bright fringe is shifted upwards to the position of the central (m=0) bright fringe. Determine whether the plastic sheet been placed over the top or bottom slit, and explain your reasoning? Determine the thickness of the plastic sheet.

Summer 2015

Light from a red laser with λ=700 nm illuminates two slits. At the same time light of a different wavelength also passes through the two slits. The interference pattern that can be seen on a far viewing screen is a mixture of the two colours. However, the centre of the third bright fringe (m=3) of the red light is pure red, with none of the second colour present. What are the possible wavelengths for the second colour of light?