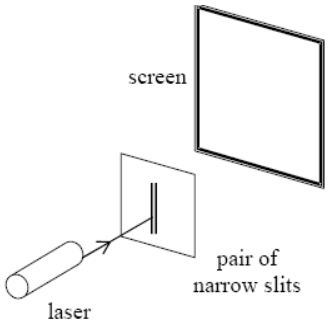
State Examination Commission – Physics Higher Level, 2005

Question 7

A student used a laser, as shown, to demonstrate that light is a wave motion.



(i) Name the two phenomena that occur when the light passes through the pair of narrow slits. (6)
(ii) A pattern is formed on the screen. Explain how the pattern is formed. (12)
(iii) What is the effect on the pattern when
(a) the wavelength of the light is increased.
(b) the distance between the slits is increased. (8)

Describe an experiment to demonstrate that sound is also a wave motion. (12)

Sound travels as longitudinal waves while light travels as transverse waves. Explain the difference between longitudinal and transverse waves. (9)

Describe an experiment to demonstrate that light waves are transverse waves. (9)

(i) Name the two phenomena that occur when light passes through the pair of narrow slits. (6)

The phenomena are diffraction and interference

(ii) A pattern is formed on the screen. Explain how the pattern is formed. (12)

Diffraction of the laser light occurs at the slits, so the slits behave like coherent sources of light that spreads and overlaps into the space behind the slits. Where there is a path difference of $n\lambda$ ($n = 0,1,2,3, ...$) between the waves, constructive interference will occur and bright lines appear on screen. Destructive interfernce results in dark fringes.

(iii) What is the effect on the pattern when (a) the wavelength of the light is increased

For constructive interference to occur, $\sin\theta = n\lambda/d$.
As λ increases, so does $\sin\theta$ and hence θ also. This increased angle at which we get constructive interference is evident from the lines on the screen spreading apart.

(b) the distance between the slits is increased.

For constructive interference to occur, $\sin\theta = n\lambda/d$.
As d increases, $n\lambda/d$ decreases, so does $\sin\theta$ and hence θ also. The lines of the interference pattern come together.

Describe an experiment to demonstrate that sound is also a wave motion. (12)

If sound is a wave motion it should show interference. If a tuning fork is struck, held close to the ear and rotated slowly it will be heard to increase and decrease in amplitude. This is because the sound waves from each tine add together to give a resultant wave that is greater or smaller than either of the individual waves, i.e., interference occurs, and hence sound is a wave motion.

Sound travels as longitudinal waves while light travels as transverse waves. Explain the difference between longitudinal and transverse waves. (9)

Longitudinal waves vibrate parallel to the direction of propagation of the wave, transverse wave vibrate perpendicular to it.

Describe an experiment to demonstrate that light waves are transverse waves. (9)

If two polaroid pieces are held up to the light and looked through, whilst being rotated through 900, the light intensity will be observed to fall from that of the original plane polarised wave, to zero. Polarization is a phenomenon that is associated with transverse waves, and not longitudional waves. Hence, light is transverse.