**8** **(a)** Fig. 8.1 shows the variation with time $t$ of the displacement $x$ of two progressive waves P and Q passing the same point with the same speed.

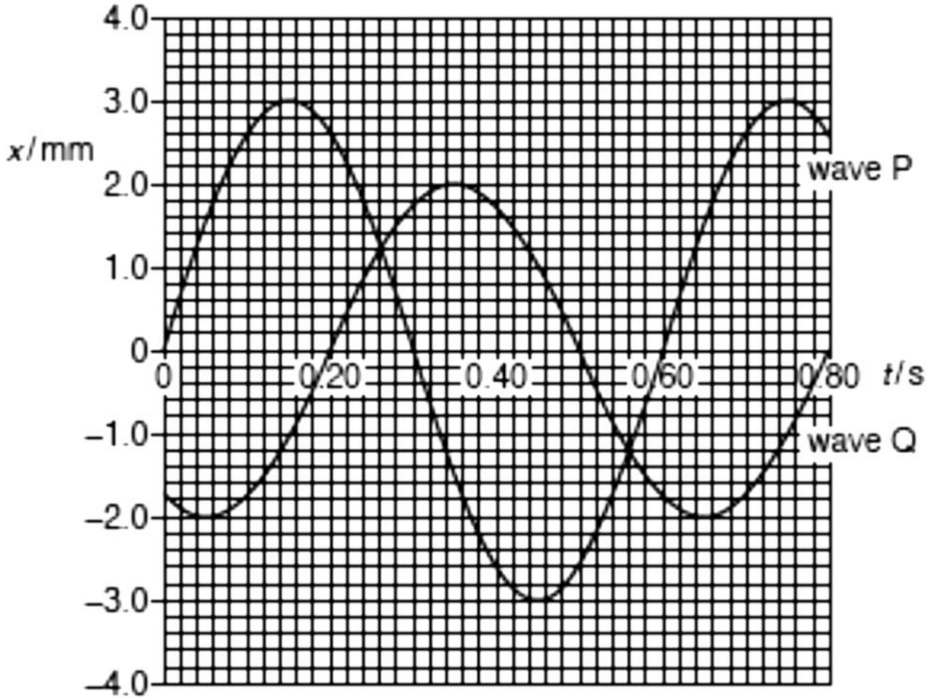



**Fig. 8.1**

The speed of the waves is 20 cm s$^{-1}$.

**(i)** Calculate the wavelength of the waves.

wavelength = ………………………. cm [1]

**(ii)** Determine the phase difference between the two waves phase difference = ………………………. ° [1]

**(iii)** Calculate the ratio $\dfrac{\text{intensity of wave Q}}{\text{intensity of wave P}}$.

ratio = ………………………. [2]

**(iv)** The two waves superimpose as they pass the same point. Use Fig. 8.1 to determine the resultant displacement at time $t$ = 0.45 s.

displacement = ………………………. mm [1]

**(b)** An arrangement for demonstrating the interference of light is shown in Fig. 8.2.

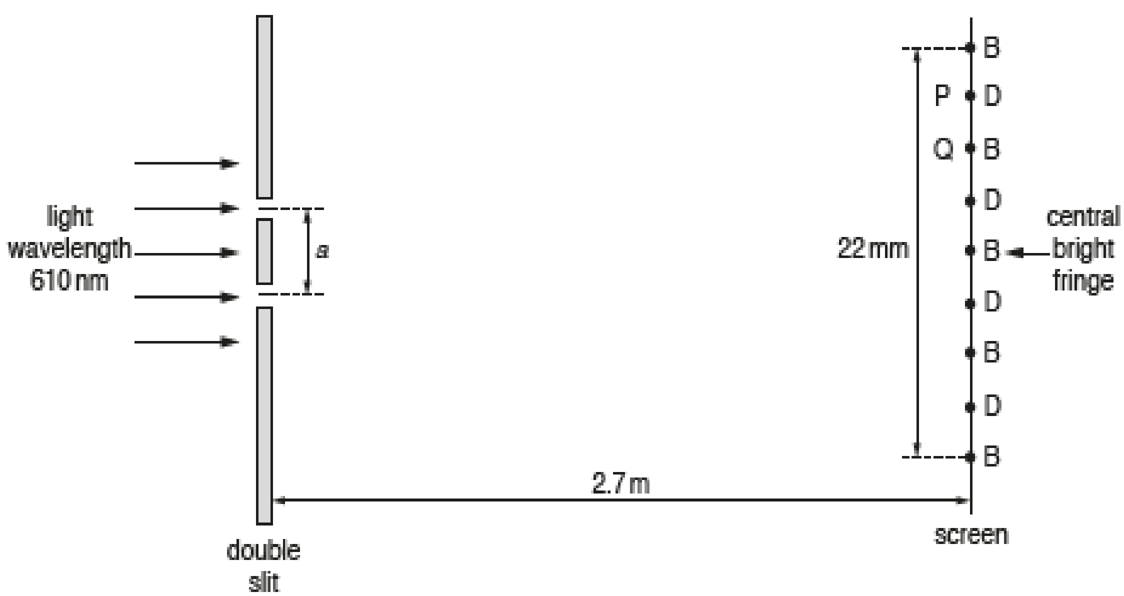



**Fig. 8.2** (not to scale)

The wavelength of the light is 610 nm. The distance between the double slit and the screen is 2.7 m.

An interference pattern of bright fringes and dark fringes is observed on the screen. The centres of the bright fringes are labelled B and centres of the dark fringes are labelled D. Point P is the centre of a particular dark fringe and point Q is the centre of a particular bright fringe, as shown in Fig. 8.2. The distance between five bright fringes is 22 mm.

**(i)** The light waves leaving the two slits are coherent.

State what is meant by *coherent*.

……………………………………………………………………………………………………

……………………………………………………………………………………………[1]

**(ii)** Calculate the path difference, in nm, of the waves meeting at P.

path difference = ………………………. nm [1]

**(iii)** Determine the distance *a* between the two slits

*a* = ………………………. m [2]

**(iv)** A higher frequency of visible light is now used. State and explain the change to the separation of the fringes.

……………………………………………………………………………………………………

..............................................................................................................[1]

**(v)** The intensity of the light incident on the double slit is now increased without altering its frequency. Compare the appearance of the fringes after this change with their appearance before this change.

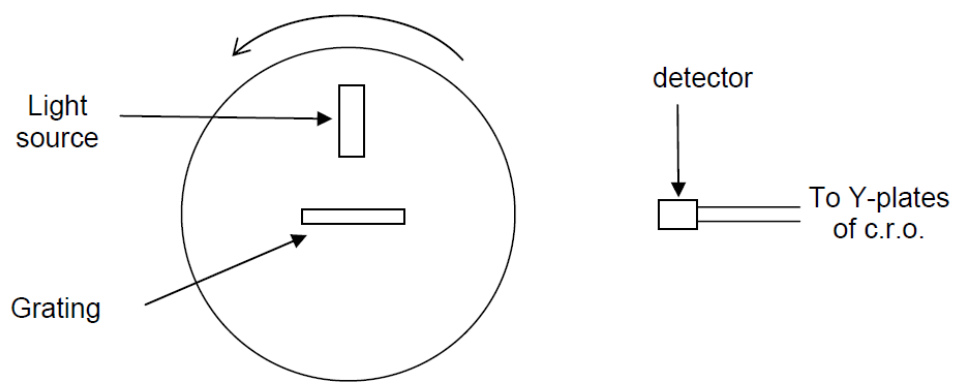
..............................................................................................................

..............................................................................................................

..............................................................................................................

..............................................................................................................[2]

**(c)** A diffraction grating is set up at the centre of a rotating table which completes a revolution every 3.0 s. The grating is illuminated normally by monochromatic light of wavelength $\lambda$ from a source which is also mounted on the table as shown in Fig. 8.3.




Plan (top) view

**Fig. 8.3**

The emergent beams of light from the grating are monitored by means of a stationary opto-electrical detector. The output from the detector is displayed on a cathode ray oscilloscope (c.r.o.). With the timebase set at 0.10 s cm$^{-1}$, the trace obtained is shown in Fig. 8.4. The relative positions of the peaks are as indicated.

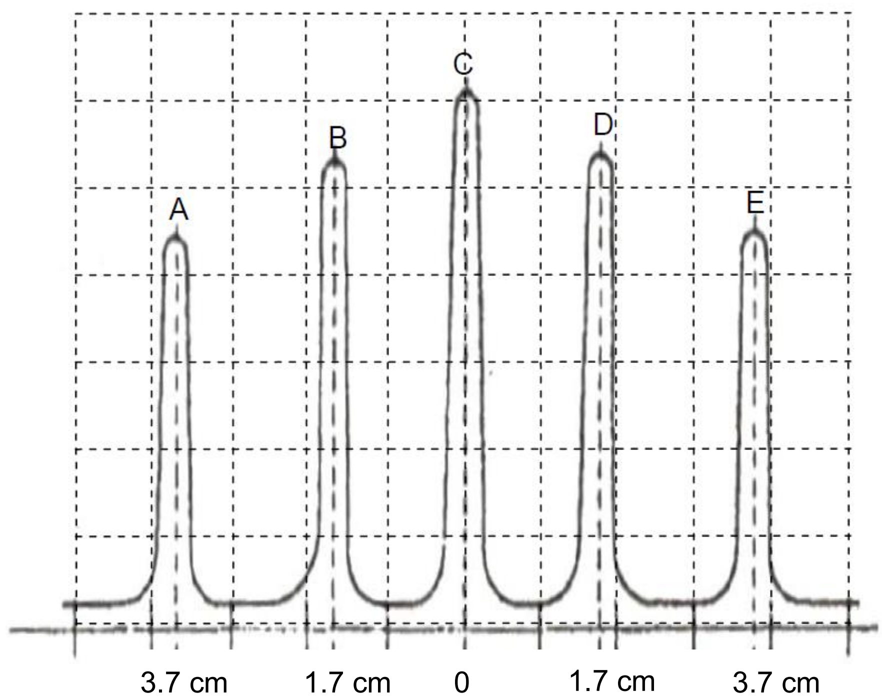



**Fig. 8.4**

**(i)** Calculate the angular speed of rotation of the grating.

angular speed = ……………………… rad $s^{-1}$ [1]

**(ii)** Explain the appearance of the trace in Fig. 8.4.

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………..……………[2]

**(iii)** Using peak D, calculate the wavelength of the light if the grating has 550 lines per millimetre.

wavelength = ………………………. m [3]

**(iv)** Sketch in Fig. 8.5, the c.r.o. display if the diffraction grating is replaced by a double slit of the same slit separation as the diffraction grating.

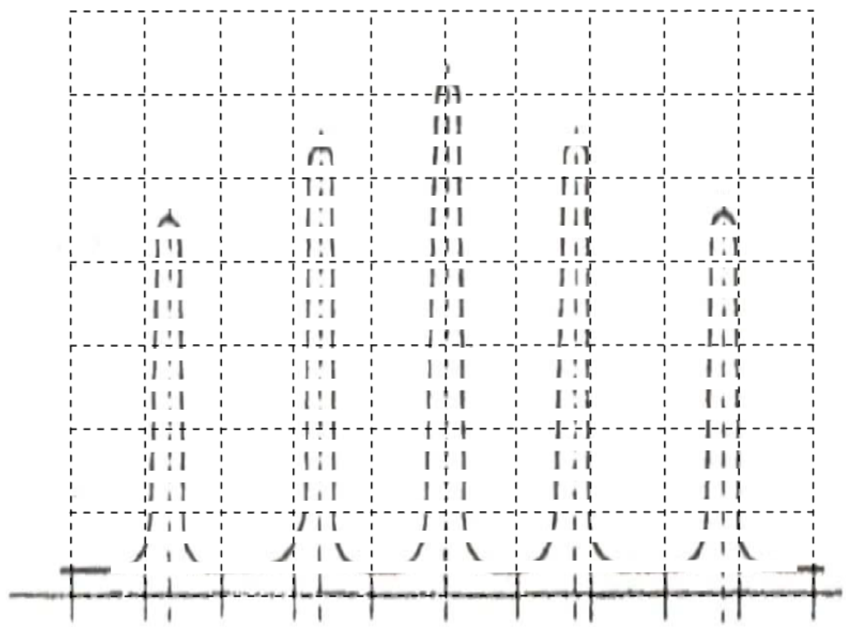



**Fig. 8.5**

(The original display from the grating is shown in dotted line) [2]

[Total: 20]

BLANK PAGE