Higher Waves Questions

1. a) State the names of the **four** different wave effects.

b) What effect must **all waves** be able to undergo?

c) What does the **energy** of a wave depend on?

d) What happens to the **total energy in a water wave** when it spreads out into a larger wavefront?

e) What is meant by **'coherent sources'**?

2. Two sets of overlapping circular waves are produced from two point sources.

a) **At which points** on the overlap will:

i) Constructive interference take place?

ii) Destructive Interference take place?

b) How is the **amplitude** of the waves **affected** in a) i) and a) ii) ?

3. **State the equations** for **path difference** and label the quantities and units involved in:

a) i) Constructive interference.

ii) Destructive interference.

b) How do the waves meet on the screen in terms of **phase and path difference** in:

i) Constructive interference.

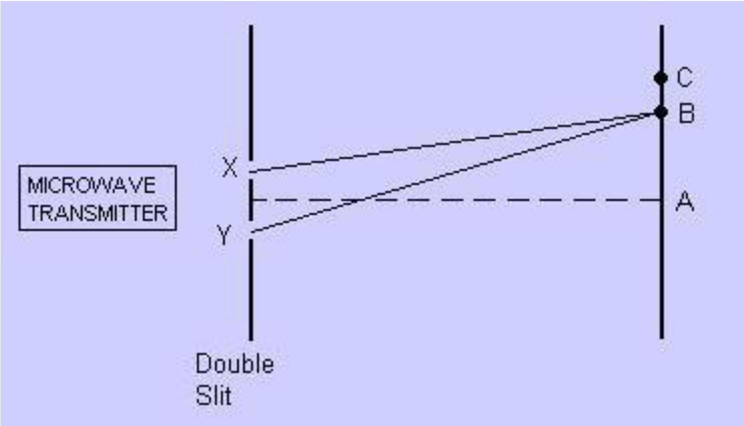
ii) Destructive interference.

4. A microwave transmitter is used with a double slit to produce an interference pattern on the screen.

A is a **central order maxima** and **B** is the **second maxima**.

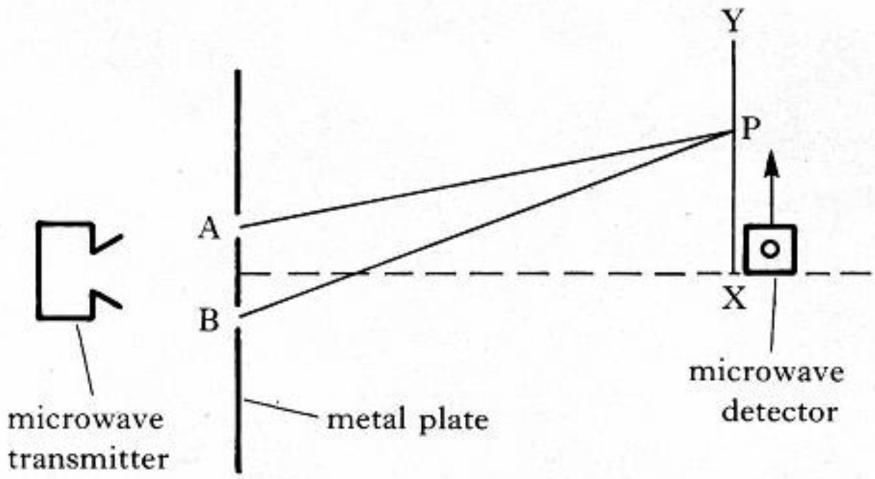
If **XB = 0.504m** and **YB = 0.560m** then calculate or find:

a) **Wavelength** of the microwaves.
b) Path difference between YC and XC if C is the **third minima**.



5.

Microwaves are passed through two slits, A and B, in a metal plate as shown in the diagram below.



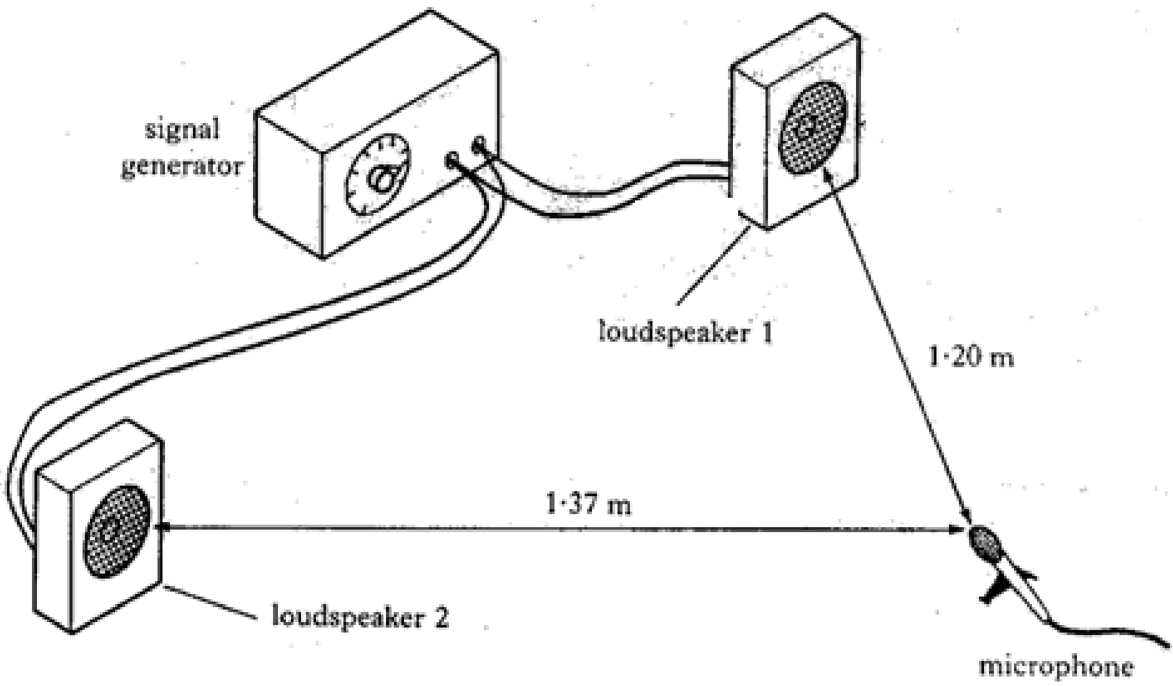
A microwave detector is moved along a straight line from X to Y. The **first minimum** of microwave intensity is detected at point P. The distance AP is 41 cm and BP is 43 cm.

Find the wavelength of the microwaves.

6.

Loudspeakers 1 and 2 are both connected to the same signal generator which is set to produce a 1 kHz signal.

Loudspeaker 1 is switched on but loudspeaker 2 is switched off.

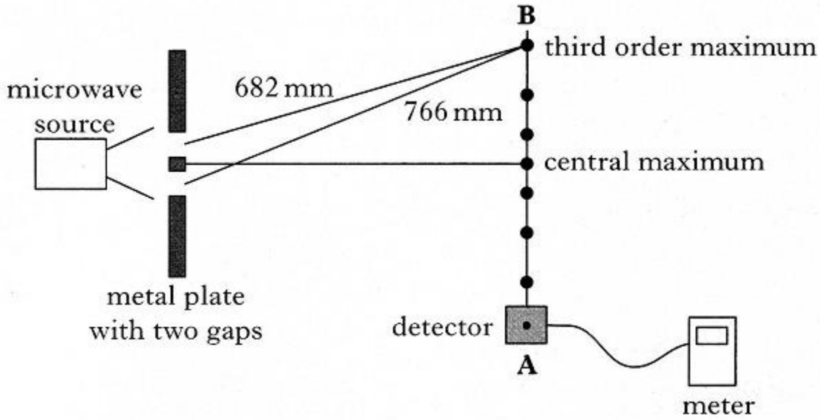


State **and** explain what happens to the amplitude of the signal picked up by the microphone when loudspeaker 2 is switched on.

Your explanation should include a calculation using the value of the speed of sound in air as 340 m s^{-1}.

7.

An experiment with microwaves is set up as shown below.



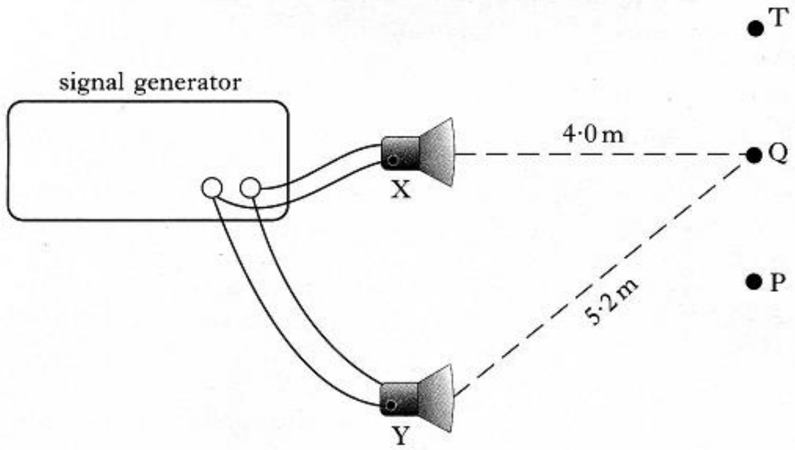
(i) As the detector is moved from **A** to **B**, the reading on the meter increases and decreases several times.

Explain, in terms of waves, how the pattern of maxima and minima is produced.

(ii) The measurements of the distance from each gap to a third order maximum are shown. Calculate the wavelength of the microwaves.

8.

Two identical loudspeakers X and Y are set up in a room which has been designed to eliminate the reflection of sound. The loudspeakers are connected to the same signal generator as shown.



(*a*) (i) When a sound level meter is moved from P to T, maxima and minima of sound intensity are detected.

Explain, in terms of waves, why the maxima and minima are produced.

(ii) The sound level meter detects a maximum at P.

As the sound level meter is moved from P, it detects a minimum then a maximum then another minimum when it reaches Q.

Calculate the wavelength of the sound used.

(*b*) The sound level meter is now fixed at Q.

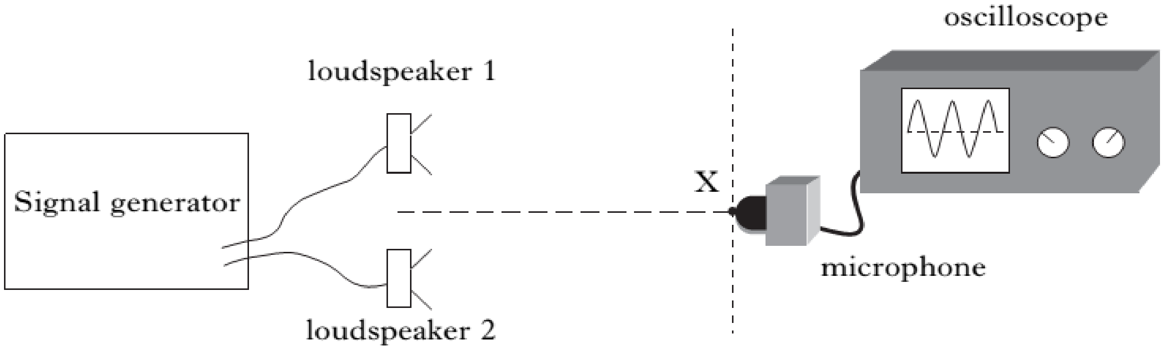
The frequency of the output from the signal generator is increased steadily from 200 Hz to 1000 Hz.

(i) What happens to the wavelength of the sound as the frequency of the output is increased?

(ii) Explain why the sound level meter detects a series of maxima and minima as the frequency of the output is increased.

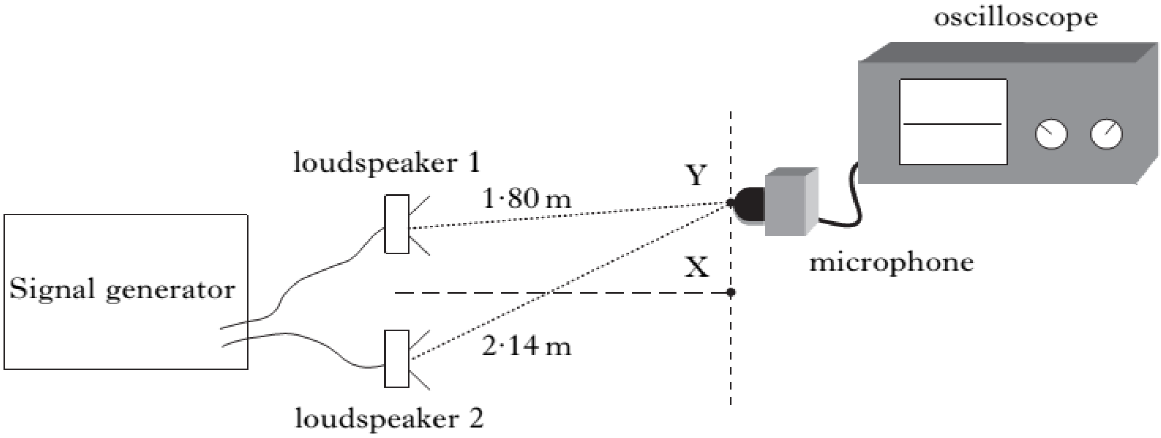
9.

A student is carrying out an experiment to investigate the interference of sound waves. She sets up the following apparatus.



The microphone is initially placed at point X which is the same distance from each loudspeaker. A maximum is detected at X.

(*a*) The microphone is now moved to the first minimum at Y as shown.



Calculate the wavelength of the sound waves.

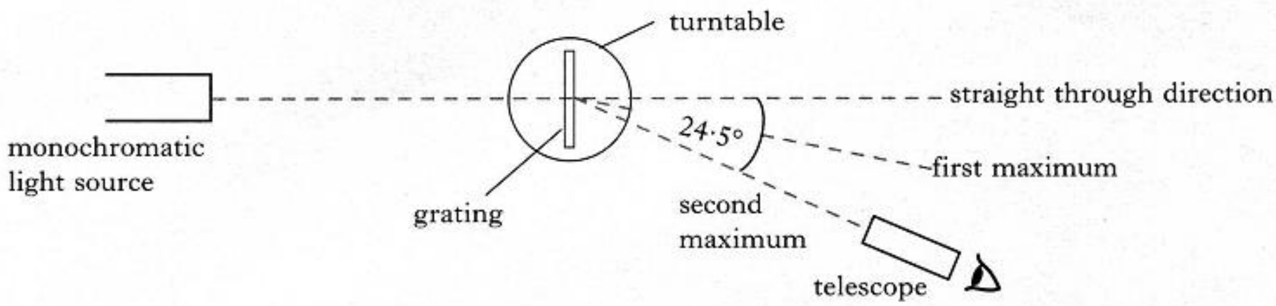
(*b*) Loudspeaker 1 is now disconnected.

What happens to the amplitude of the sound detected by the microphone at Y?

Explain your answer.

10.

A grating with 300 lines/mm is used with a spectrometer and a source of monochromatic light to view an interference pattern as shown below.

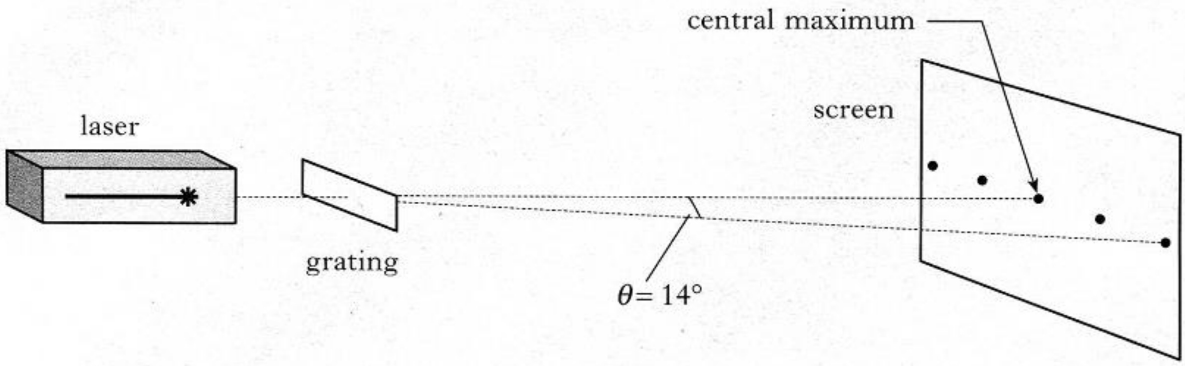


The second maximum of interference is observed when the telescope is at an angle of 24·5°.

Calculate the wavelength of the light.

11.

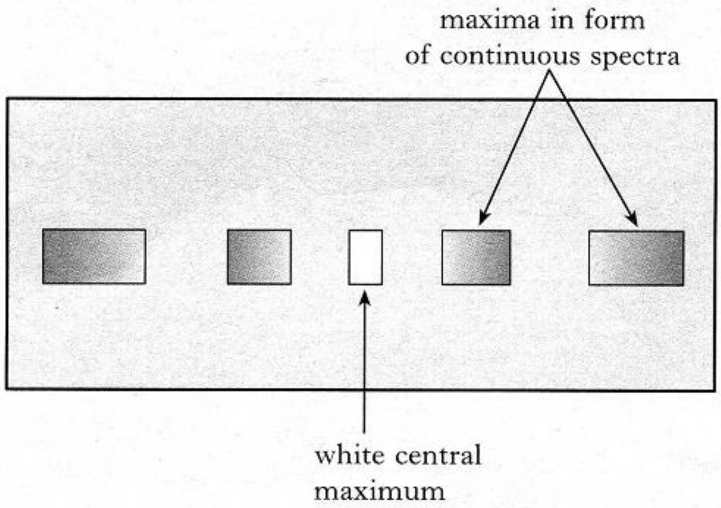
Light from a laser is shone onto a grating. The separation of the slits on the grating is $5{\cdot}0 \times 10^{-6}$ m. A pattern is produced on a screen as shown below.



(*a*) (i) The angle θ between the central maximum and the 2nd order maximum is 14°. Calculate the wavelength of the light produced by this laser.

(ii) A pupil suggests that a more accurate value for the wavelength of the laser light can be found if a grating with a slit separation of $2{\cdot}0 \times 10^{-6}$ m is used. Explain why this suggestion is correct.

(*b*) The laser is replaced by a source of white light and the pattern on the screen changes to a white central maximum with other maxima in the form of continuous **spectra** on each side of the central maximum.



Explain:

(i) why the central maximum is white;

(ii) why the other maxima are in the form of continuous spectra.

12. A grating is used with a monochromatic light to produce an interference pattern on a screen.

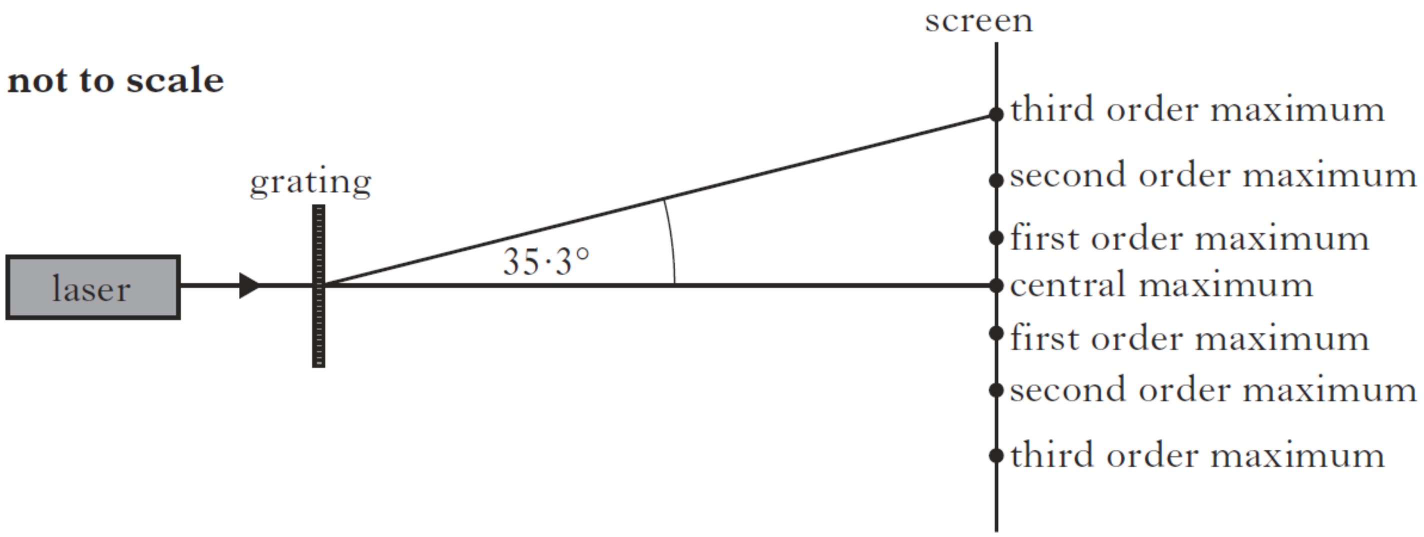
The **third order** bright fringe is found at an angle of **61.8°** using a source of wavelength **470nm**.

Calculate or find:

a) The **number of lines per mm** in the grating used.
b) The angle of the **second order bright fringe** if the grating is changed to **375 lines per mm**.
c) **How would the interference pattern differ** if the grating is moved nearer the screen.

13.

A manufacturer claims that a grating consists of $3{\cdot}00 \times 10^5$ lines per metre and is accurate to $\pm\, 2{\cdot}0\%$. A technician decides to test this claim. She directs laser light of wavelength 633 nm onto the grating.



She measures the angle between the central maximum and the third order maximum to be $35{\cdot}3°$.

(*a*) Calculate the value she obtains for the slit separation for this grating.

(*b*) What value does she determine for the number of lines per metre for this grating?

(*c*) Does the technician's value for the number of lines per metre agree with the manufacturer's claim of $3{\cdot}00 \times 10^5$ lines per metre $\pm\, 2{\cdot}0\%$?

You must justify your answer by calculation.

14. White light is passed through a grating and on to a screen with multiple orders of spectra viewed.

The white light has a **wavelength range** between **410nm and 690nm**, with a grating of **5000 lines per cm** used.

a) What is the **colour** of the **central order maxima**?

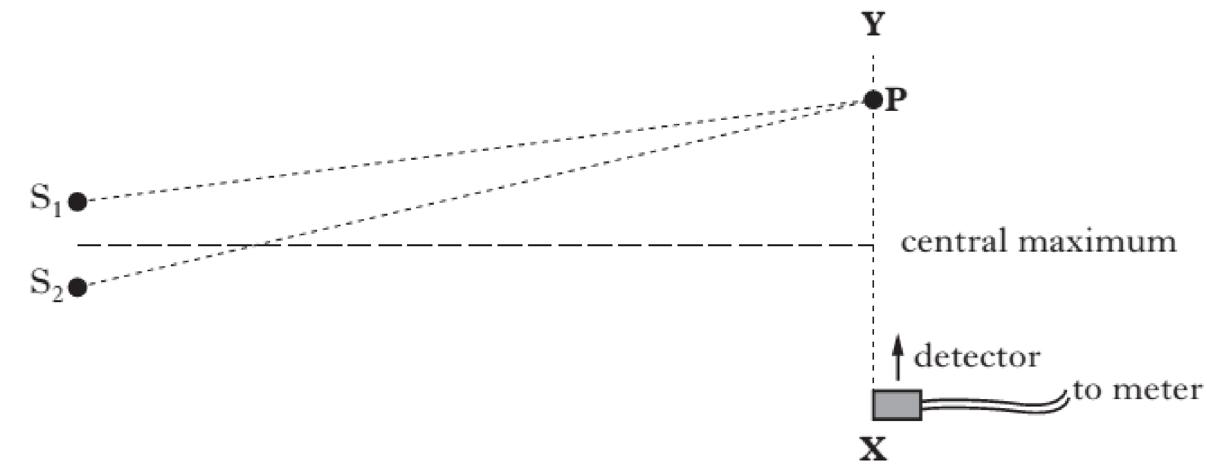
b) **Calculate the angle** from the central order maxima to the **second order maxima** for:

i) Red light.
ii) Violet light.

15.

A student is using different types of electromagnetic radiation to investigate interference.

(*a*) In the first experiment, two identical sources of microwaves, S_1 and S_2, are positioned a short distance apart as shown.



(i) The student moves a microwave detector from X towards Y. The reading on the meter increases and decreases regularly.

Explain, in terms of waves, what causes the minimum readings to occur.

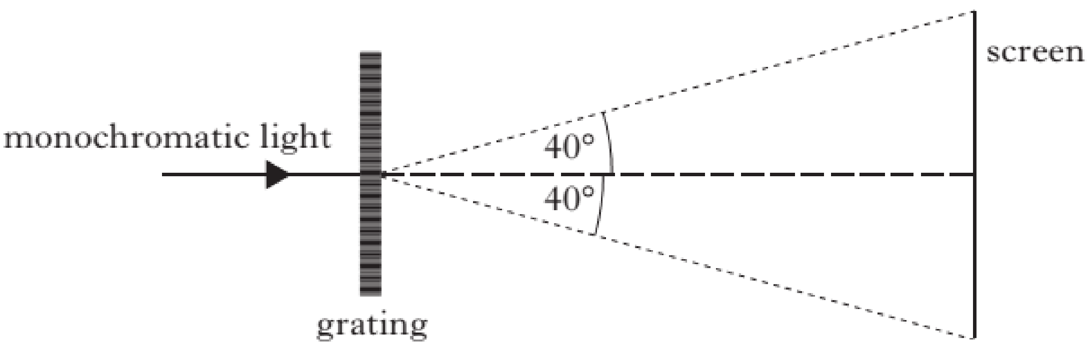
(ii) The **third** maximum from the central maximum is located at P.

The distance from S_1 to P is 620 mm.

The wavelength of the waves is 28 mm.

Calculate the distance from S_2 to P.

(*b*) In the second experiment, a beam of parallel, monochromatic light is incident on a grating. An interference pattern is produced on a screen. The edges of the screen are at an angle of 40° to the centre of the grating as shown.



The wavelength of the light is 420 nm and the separation of the slits on the grating is $3{\cdot}27 \times 10^{-6}$ m.

Determine the total number of maxima visible on the screen.