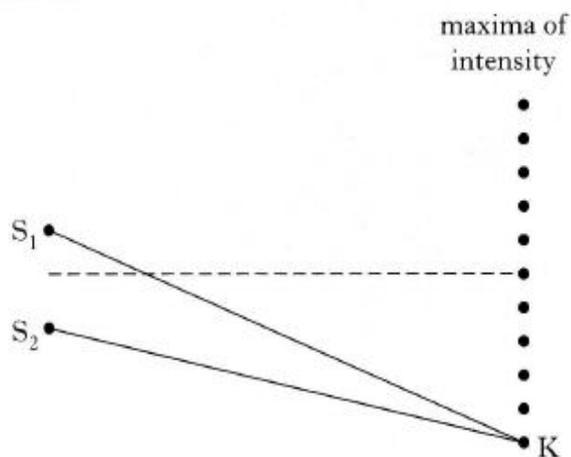


## Exercise 14 – Interference and Diffraction

### Past Paper Homework Questions

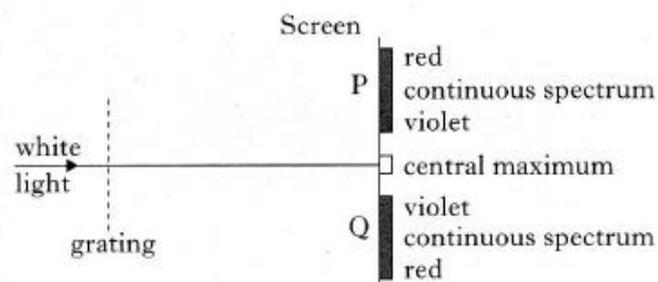
1. Waves from coherent sources,  $S_1$  and  $S_2$ , produce an interference pattern. Maxima of intensity are detected at the positions shown below.



The path difference  $S_1K - S_2K$  is 154 mm.  
The wavelength of the waves is

- A 15.4 mm
- B 25.7 mm
- C 28.0 mm
- D 30.8 mm
- E 34.2 mm.

2. When white light passes through a grating, maxima of intensity are produced on a screen, as shown below. The central maximum is white. Continuous spectra are obtained at positions P and Q.

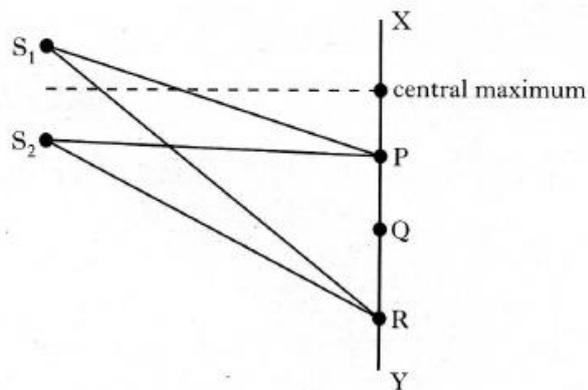


In the continuous spectra, violet is observed closest to the central maximum.

Which of the following statements is/are true?

- I Violet light has the shortest wavelength of all the visible radiations.
  - II Violet light has the longest wavelength of all the visible radiations.
  - III Violet light travels faster through air than the other visible radiations.
- A I only
  - B II only
  - C III only
  - D I and III only
  - E II and III only

3.  $S_1$  and  $S_2$  are sources of coherent waves which produce an interference pattern along the line XY.



The first maximum occurs at P, where  $S_1P = 20$  cm and  $S_2P = 18$  cm.

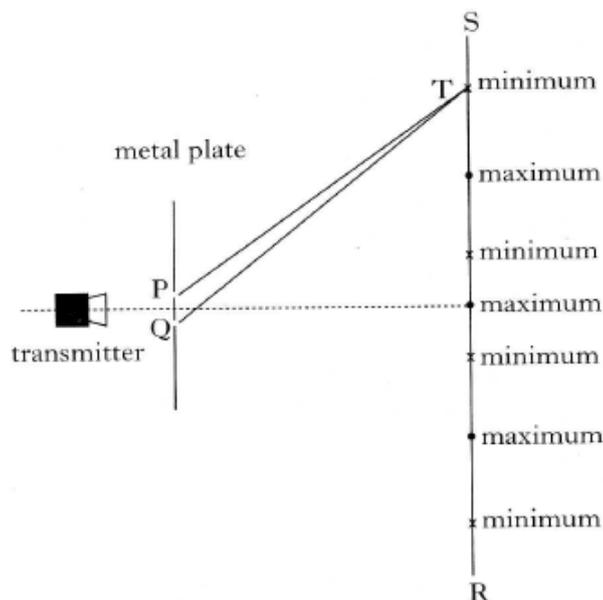
For the third maximum, at R, the path difference ( $S_1R - S_2R$ ) is

- A 3 cm  
 B 4 cm  
 C 5 cm  
 D 6 cm  
 E 8 cm.
4. The spectrum of white light from a filament lamp may be viewed using a prism or a grating. A student, asked to compare the spectra formed by the two methods, made the following statements.
- I The prism produces a spectrum by refraction. The grating produces a spectrum by interference.
- II The spectrum formed by the prism shows all the wavelengths present in the white light. The spectrum formed by the grating shows only a few specific wavelengths.
- III The prism produces a single spectrum. The grating produces more than one spectrum.

Which of the above statements is/are true?

- A I only  
 B II only  
 C I and II only  
 D I and III only  
 E I, II and III

5. Microwave radiation is incident on a metal plate which has 2 slits, P and Q. A microwave receiver is moved from R to S, and detects a series of maxima and minima of intensity at the positions shown.



The microwave radiation has a wavelength of 4 cm.

The path difference between PT and QT is

- A 2 cm  
 B 3 cm  
 C 4 cm  
 D 5 cm  
 E 6 cm.

6. In the following passage three words have been replaced by the letters **X**, **Y** and **Z**.

“Monochromatic light is incident on a grating and the resulting interference pattern is viewed on a screen. The distance between neighbouring areas of constructive interference on the screen:

is .....**X**..... when the screen is moved further away from the grating;

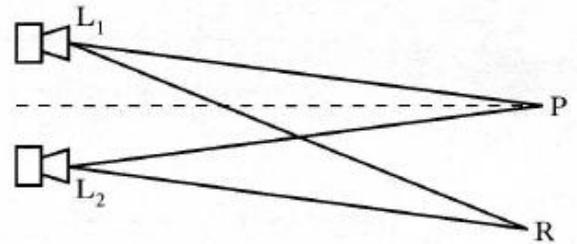
is .....**Y**..... when light of a greater wavelength is used;

is .....**Z**..... when the distance between the slits is increased.”

Which row of the table shows the missing words?

	<b>X</b>	<b>Y</b>	<b>Z</b>
A	increased <sup>+</sup>	increased <sup>+</sup>	increased <sup>+</sup>
B	increased <sup>+</sup>	increased <sup>+</sup>	decreased
C	decreased	decreased <sup>+</sup>	increased <sup>+</sup>
D	decreased	decreased <sup>+</sup>	decreased
E	increased <sup>+</sup>	decreased <sup>+</sup>	decreased

8. Two identical loudspeakers,  $L_1$  and  $L_2$ , are operated at the same frequency and in phase with each other. An interference pattern is produced.



At position P, which is the same distance from both loudspeakers, there is a maximum intensity.

The next maximum intensity is at position R, where  $L_1R = 5.6$  m and  $L_2R = 5.3$  m.

The speed of sound is  $340 \text{ m s}^{-1}$ .

The frequency of the sound emitted by the loudspeakers is given by

A  $\frac{5.6 - 5.3}{340} \text{ Hz}$

B  $\frac{340}{5.6 + 5.3} \text{ Hz}$

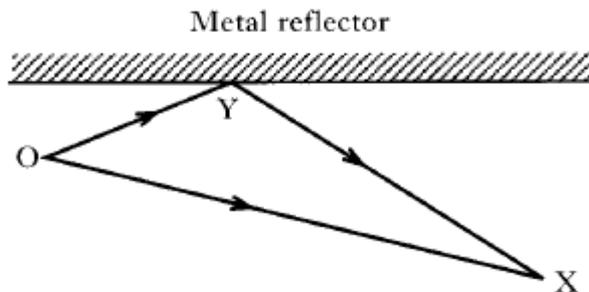
C  $\frac{340}{5.6 - 5.3} \text{ Hz}$

D  $340 \times (5.6 - 5.3) \text{ Hz}$

E  $340 \times (5.6 + 5.3) \text{ Hz}$ .

7. A microwave source at point O produces waves of wavelength 28 mm.

A metal reflector is placed as shown.



An interference pattern is produced.

**Constructive interference** occurs at point X.

The distance OX is 400 mm.

The total path length OYX is

A 414 mm

B 421 mm

C 442 mm

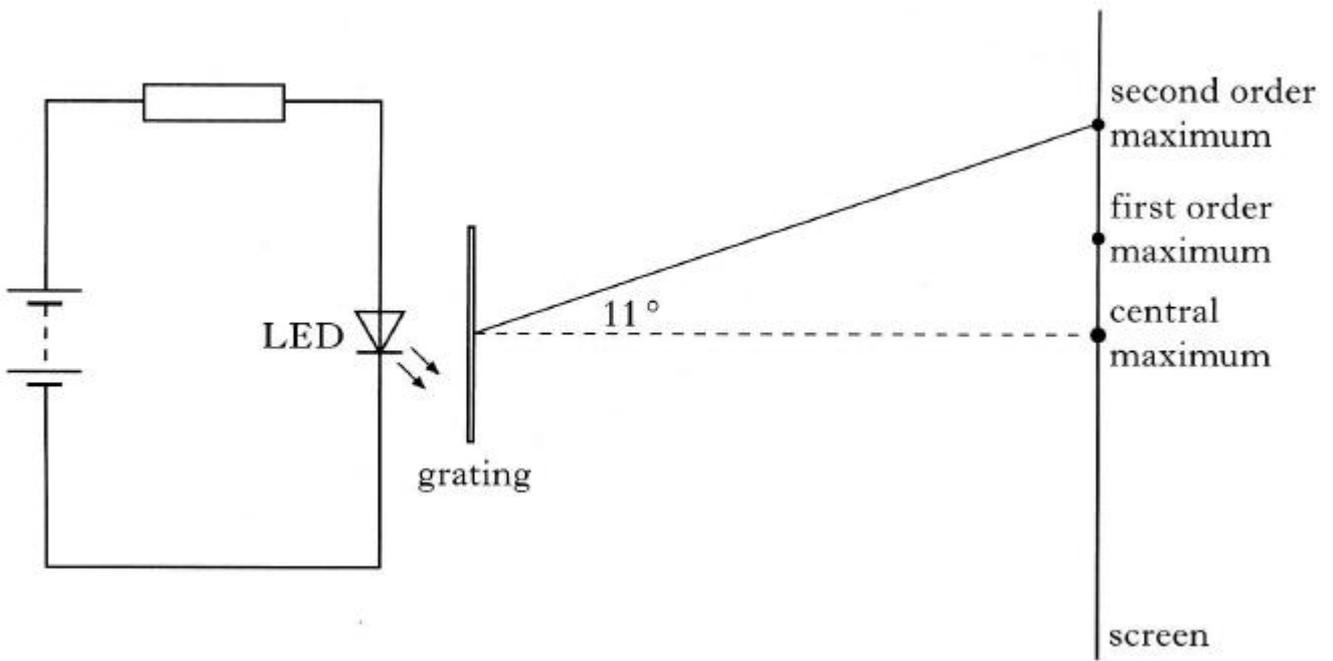
D 456 mm

E 463 mm.

9. (a) Light of wavelength  $486 \times 10^{-9} \text{ m}$  is viewed using a grating with a slit spacing of  $2.16 \times 10^{-6} \text{ m}$ .  
Calculate the angle between the central maximum and the second order maximum.

2

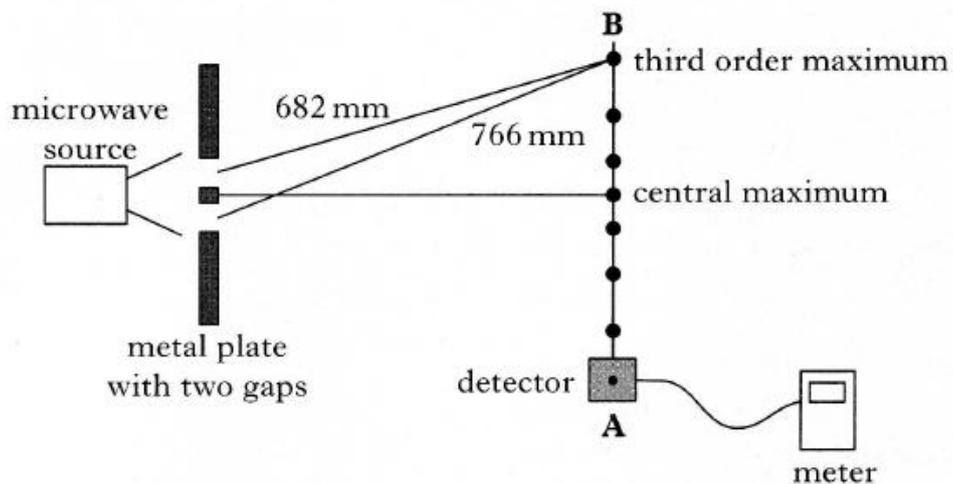
10. Monochromatic light from the LED is incident on a grating as shown.  
The spacing between lines in the grating is  $5.0 \times 10^{-6} \text{ m}$ .



What is the wavelength of the light emitted by the LED?

4

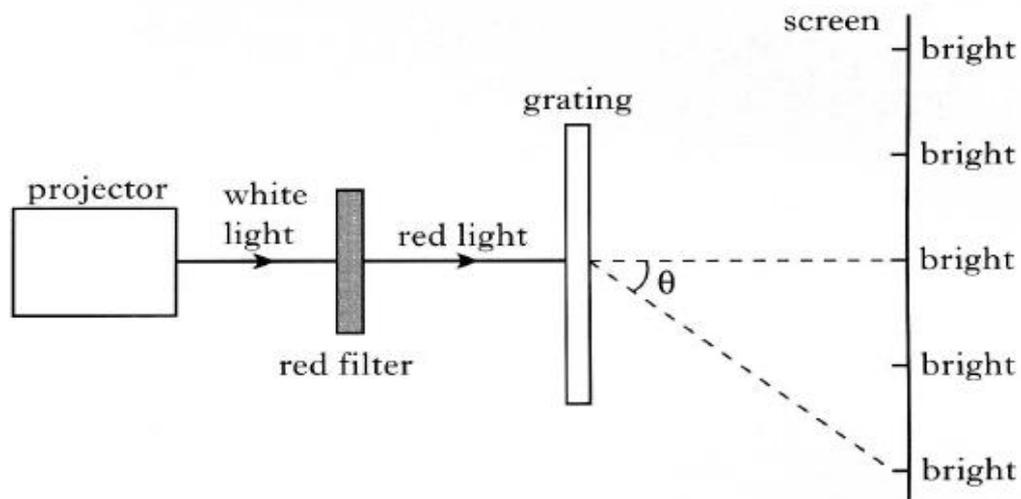
11. (a) An experiment with microwaves is set up as shown below.



- (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.

12. A physics student investigates what happens when monochromatic light passes through a glass prism or a grating.

The apparatus for the second experiment is shown below.

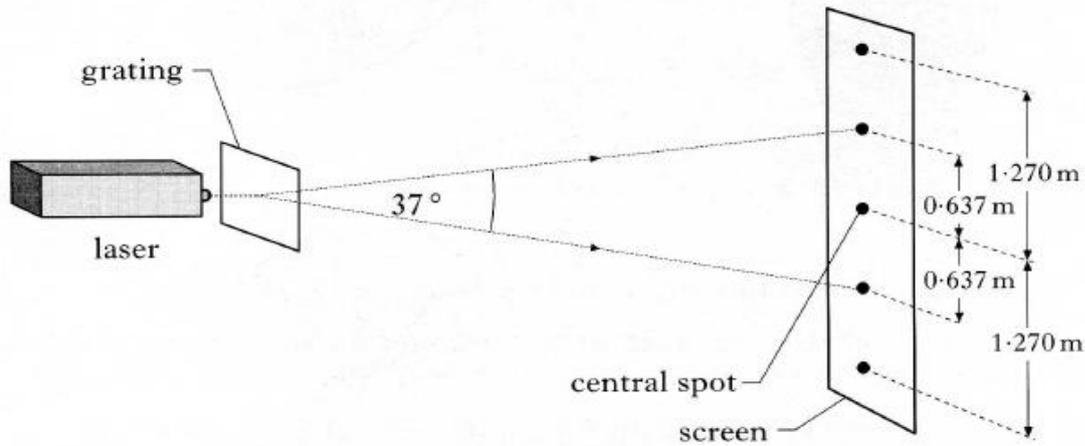


A pattern of bright and dark fringes is observed on the screen.

The grating has 300 lines per millimetre and the wavelength of the red light is 650 nm.

- (i) Explain how the bright fringes are produced. 1
- (ii) Calculate the angle  $\theta$  of the second order maximum. 2
- (iii) The red filter is replaced by a blue filter. Describe the effect of this change on the pattern observed. 1  
Justify your answer.

13. a) In an experiment, laser light of wavelength 633 nm is incident on a grating. A series of bright spots are seen on a screen placed some distance from the grating. The distance between these spots and the central spot is shown.



Calculate the number of lines per metre on the grating.

3

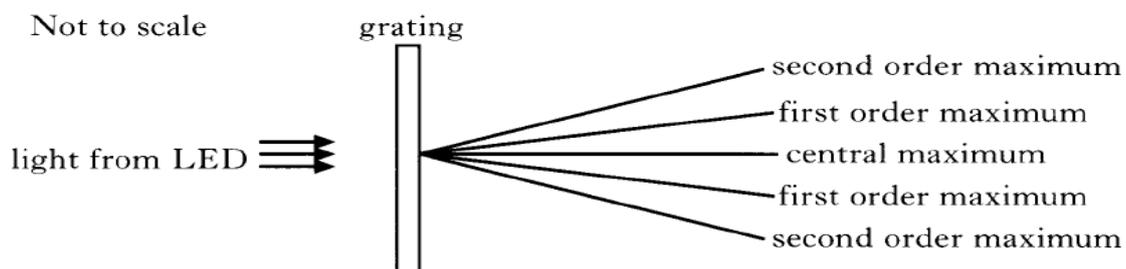
- b) The laser is replaced with another laser and the experiment repeated. With this laser the bright spots are closer together.

How does the wavelength of the light from this laser compare with that from the original laser?

You must justify your answer.

2

14. Light from an LED is passed through a grating as shown below.

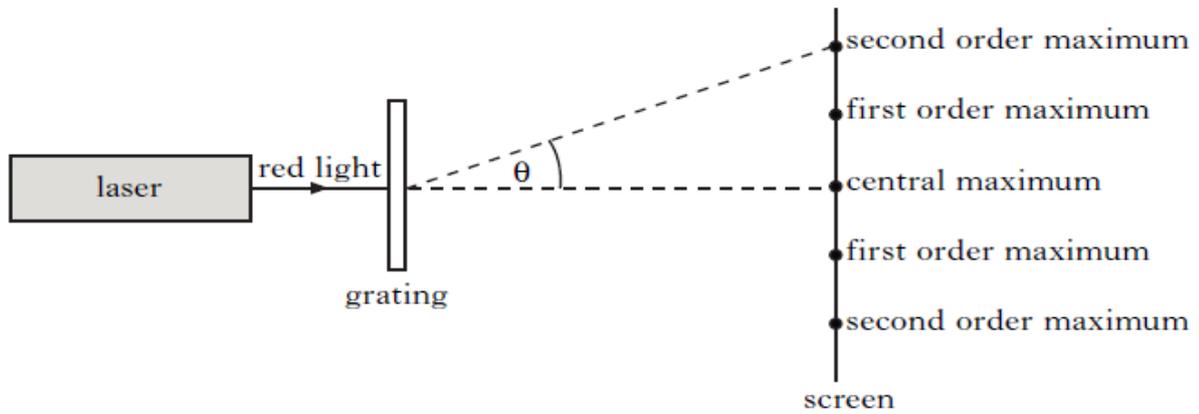


Light from this LED has a wavelength of  $6.35 \times 10^{-7}$  m. The spacing between lines in the grating is  $5.0 \times 10^{-6}$  m.

Calculate the angle between the central maximum and the **second** order maximum.

2

15. A laser produces a narrow beam of monochromatic light.  
(a) Red light from a laser passes through a grating as shown.



A series of maxima and minima is observed.

Explain in terms of waves how a **minimum** is produced. 1

- (b) The laser is now replaced by a second laser, which emits blue light.

Explain why the observed maxima are now closer together. 1

**30 marks**