Online courses for schools across Scotland
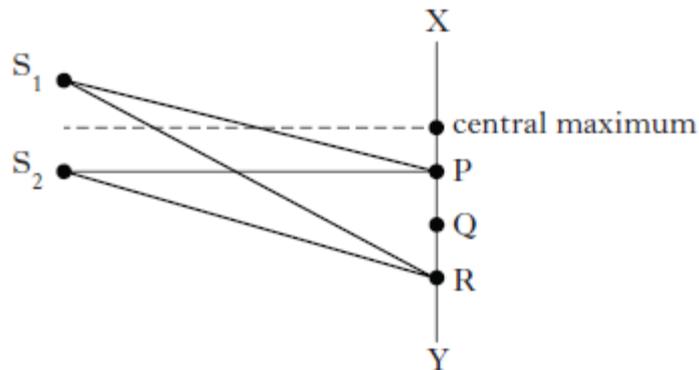
Interference and Diffraction

1. S_1 and S_2 are sources of coherent waves. An interference pattern is obtained between X and Y.

The first order maximum occurs at P, where S_1P = 200 mm and S_2P = 180 mm.

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

    A. 20 mm
    B. 30 mm
    C. 40 mm
    D. 50 mm
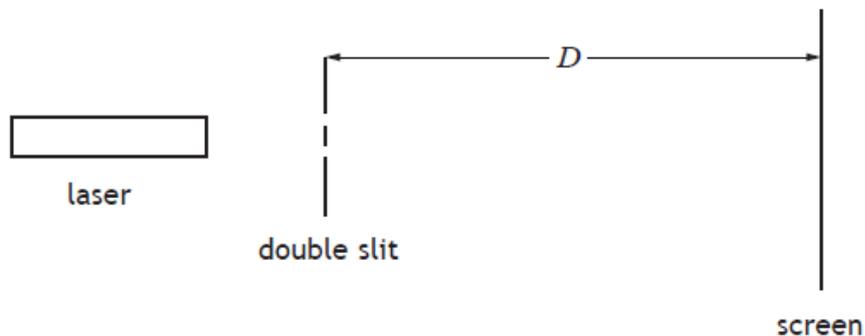   E. 60 mm   1

2. A helium-neon laser produces a beam of coherent red light.

a) State what is meant by *coherent light*.   1

b) A student directs this laser beam onto a double slit arrangement as shown in the diagram.

A pattern of bright red fringes is observed on the screen.

i) Explain, in terms of waves, why bright red fringes are produced.   1

ii) The average separation, Δx, between adjacent fringes is given by the relationship

$$\Delta x = \frac{\lambda D}{d}$$

where: λ is the wavelength of the light
             D is the distance between the double slit and the screen
             d is the distance between the two slits

The diagram shows the value measured by the student of the distance between a series of fringes and the uncertainty in this measurement.

$(9\cdot5 \times 10^{-3} \pm 0\cdot2 \times 10^{-3})$ m
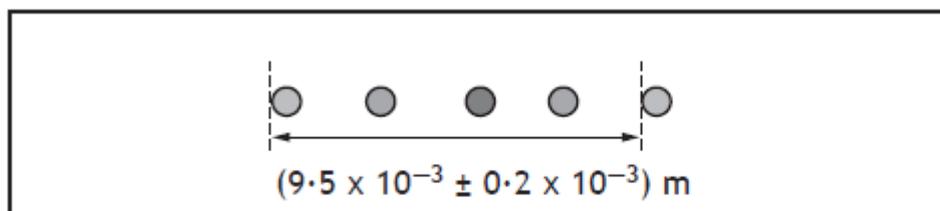
The student measures the distance, D, between the double slit and the screen as $(0\cdot750 \pm 0\cdot001)$ m.

Calculate the best estimate of the distance between the two slits.

An uncertainty in the calculated value is not required.   4

iii) The helium-neon laser is replaced by a laser emitting green light. No other changes are made to the experimental set-up.

Explain the effect this changes has on the separation of the fringes observed on the screen.   2

3. Two experiments are carried out to study the interference of waves.

a) In the first experiment, monochromatic light of wavelength 589 nm passes through a grating. The distance between the slits of the grating is $5 \cdot 0 \times 10^{-6}$ m.
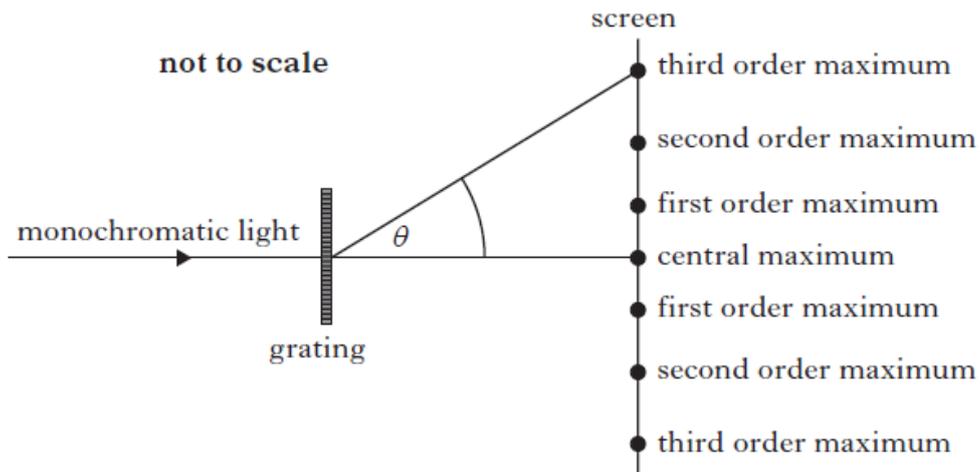
Calculate the angle θ between the central maximum and the third order maximum.   3

b) In the second experiment, microwaves of wavelength 30 mm pass through two gaps between metal plates as shown.
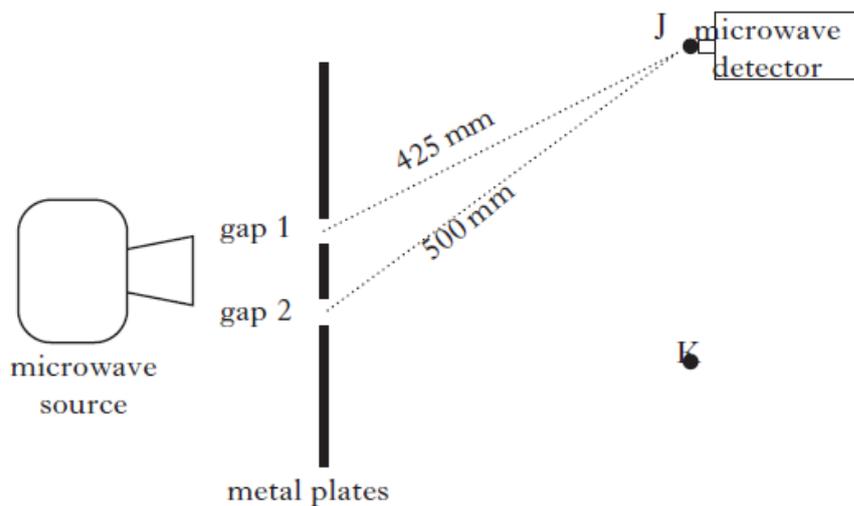
The distances from each of the gaps to point J are shown in the diagram.

Use this information to determine whether J is a point of constructive or destructive interference.

You must justify your answer by calculation.   3