9 **(a)** **(i)** State the principle of superposition.

.....

.....

..... [2]

(ii) State what is meant by coherent light waves.

.....

..... [1]

(b) Coherent light of a single wavelength λ is incident normally on a double slit, as shown in Fig. 9.1.

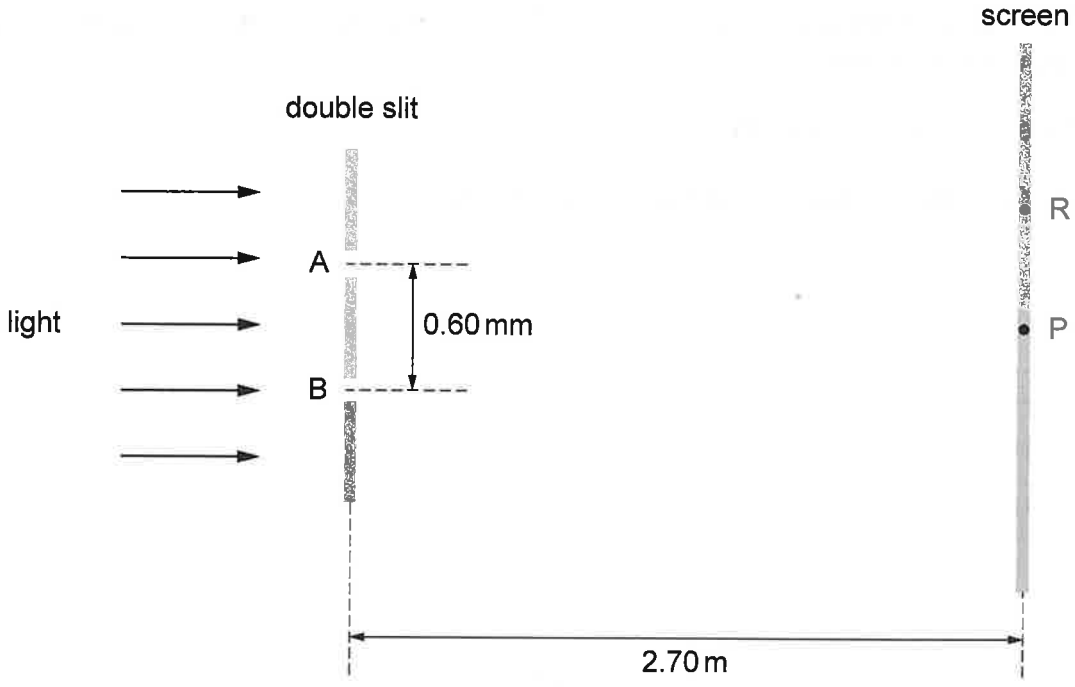

Fig. 9.1 (not to scale)

The separation of slits A and B is 0.60 mm, and the distance from the slits to the screen is 2.70 m. The double slit and the screen are parallel.

An interference pattern is observed on the screen. Point P is equidistant from both slits. Point R is the **second** minimum away from point P.

(i) State the path difference, in terms of λ, between the light from the two slits when the light reaches R.

path difference = ... λ [1]

(ii) Explain why a minimum is formed at R.

.....

.....

..... [2]

(iii) The distance between adjacent maxima on the screen is measured as 2.9 mm.

Calculate the wavelength of the incident light.

wavelength = ... m [2]

(iv) Explain why the maximum observed at P is of a greater intensity than any other observable maximum.

.....

.....

.....

.....

.....

..... [3]

(c) A thin filter is now placed over slit B in Fig. 9.1 so that the intensity of the light leaving the slit decreases but there is no change in phase.

Assume that at point P on the screen:

- The light reaching the screen from slit A alone has intensity I.
- The light reaching the screen from slit B alone has intensity $I/2$.

Determine, in terms of I, the intensity of the maximum at P.

intensity = ... I [4]

(d) The slits are now replaced with a diffraction grating, as shown in Fig. 9.2.

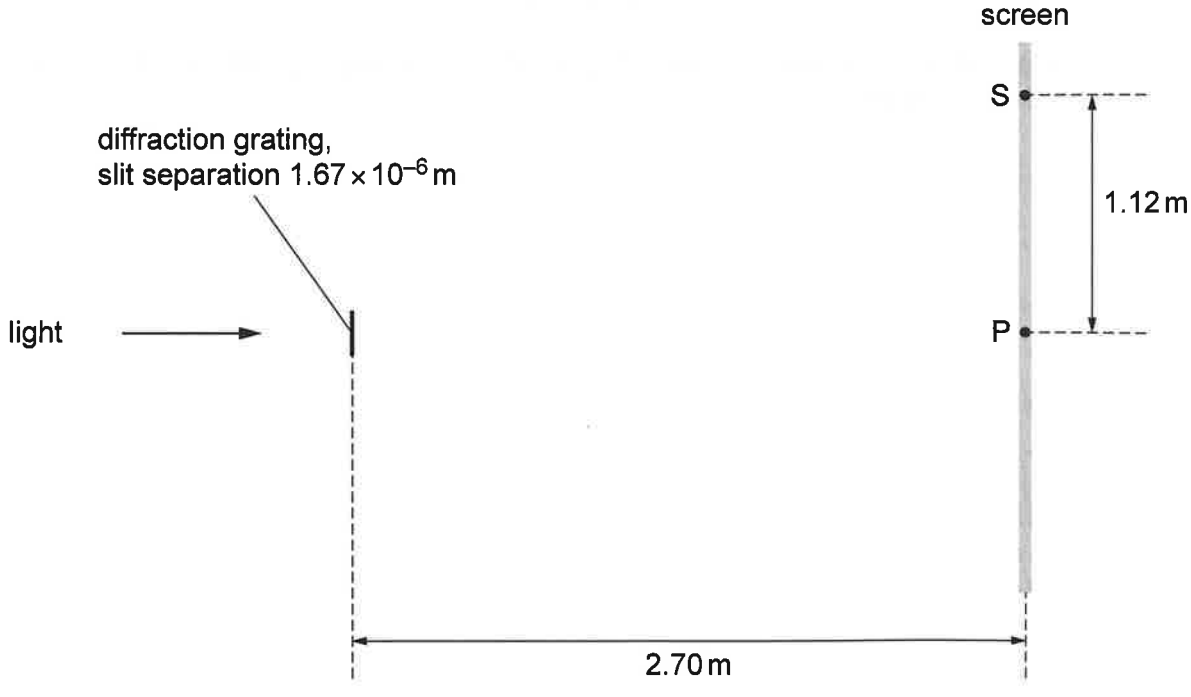

Fig. 9.2 (not to scale)

The slit separation of the diffraction grating is 1.67×10^{-6} m.

The central (zeroth order) diffraction maximum is formed at P and one of the first order maxima is formed at S, which is measured to be 1.12 m from P.

The distance between the grating and the screen is 2.70 m.

(i) Calculate the wavelength of the light. Give your answer to an appropriate number of significant figures.

wavelength = ... m [3]

(ii) Suggest why the value of wavelength calculated in **(d)(i)** is likely to have a smaller uncertainty than the value calculated in **(b)(iii)**.

.....

.....

..... [2]

[Total: 20]