

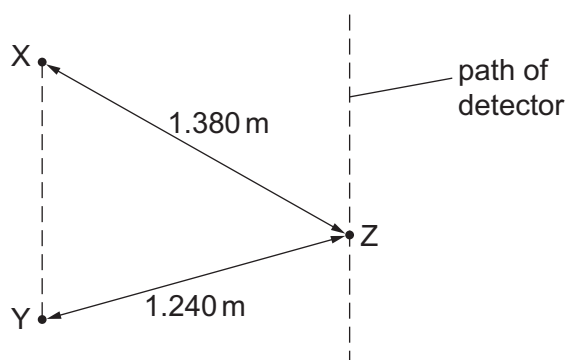
- 4 (a) a progressive wave, state what is meant by its *period*.

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

- (b) State the principle of superposition.

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

- (c) Electromagnetic waves of wavelength  $0.040\text{ m}$  are emitted in phase from two sources X and Y and travel in a vacuum. The arrangement of the sources is shown in Fig. 4.1.



**Fig. 4.1** (not to scale)

A detector moves along a path that is parallel to the line XY. A pattern of intensity maxima and minima is detected.

Distance XZ is  $1.380\text{ m}$  and distance YZ is  $1.240\text{ m}$ .

- (i) State the name of the region of the electromagnetic spectrum that contains the waves from X and Y.

..... [1]

- (ii) Calculate the period, in ps, of the waves.

period = ..... ps [3]

- (iii) Show that the path difference at point Z between the waves from X and Y is  $3.5\lambda$ , where  $\lambda$  is the wavelength of the waves.

[1]

- (iv) Calculate the phase difference between the waves at point Z.

phase difference = .....° [1]

- (v) The waves from X alone have the same amplitude at point Z as the waves from Y alone.

State the intensity of the waves at point Z.

..... [1]

- (vi) The frequencies of the waves from X and Y are both decreased to the same lower value. The waves stay within the same region of the electromagnetic spectrum.

Describe the effect of this change on the pattern of intensity maxima and minima along the path of the detector.

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

[Total: 11]