7

(a)

A progressive wave transfers energy. A stationary wave does not transfer energy.
State **two other** differences between progressive waves and stationary waves.

1.

2.

[2]

(b)
Fig. 7.1 shows a progressive wave travelling from left to right along a stretched string at a speed of 0.40 m s^{-1}. The diagram shows the string at time t = 0 s.

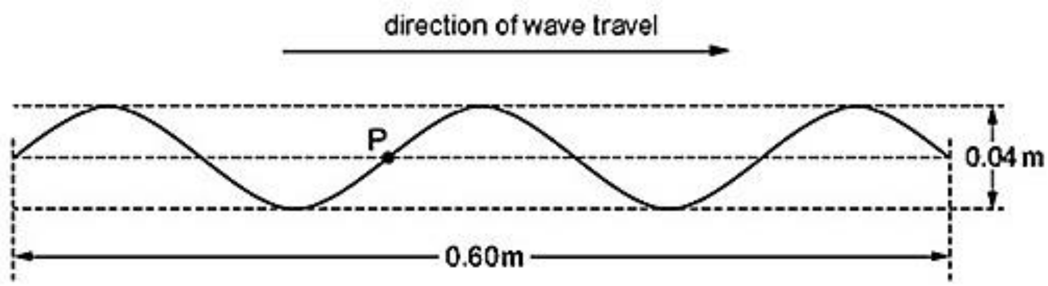

Fig. 7.1

Sketch, on the grid in Fig 7.2, the variation with time of the displacement of point **P** on the string between $t = 0$ s and $t = 0.9$ s. Show your workings in the space below the grid.

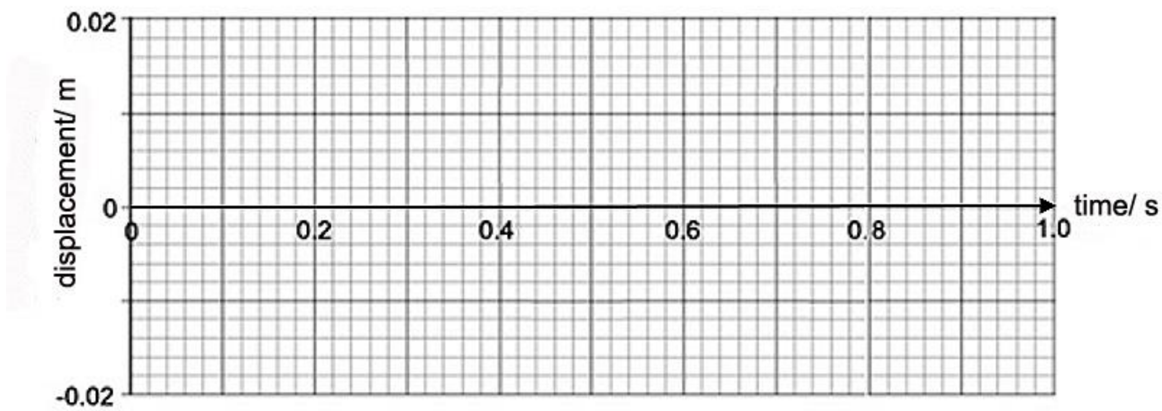

Fig. 7.2

[3]

(c)
A stationary wave is formed on a stretched string between two fixed points A and B.

The variation with distance x along the string of the displacement y of particles of the string for the wave at time t = 0 s is shown on Fig. 7.3.

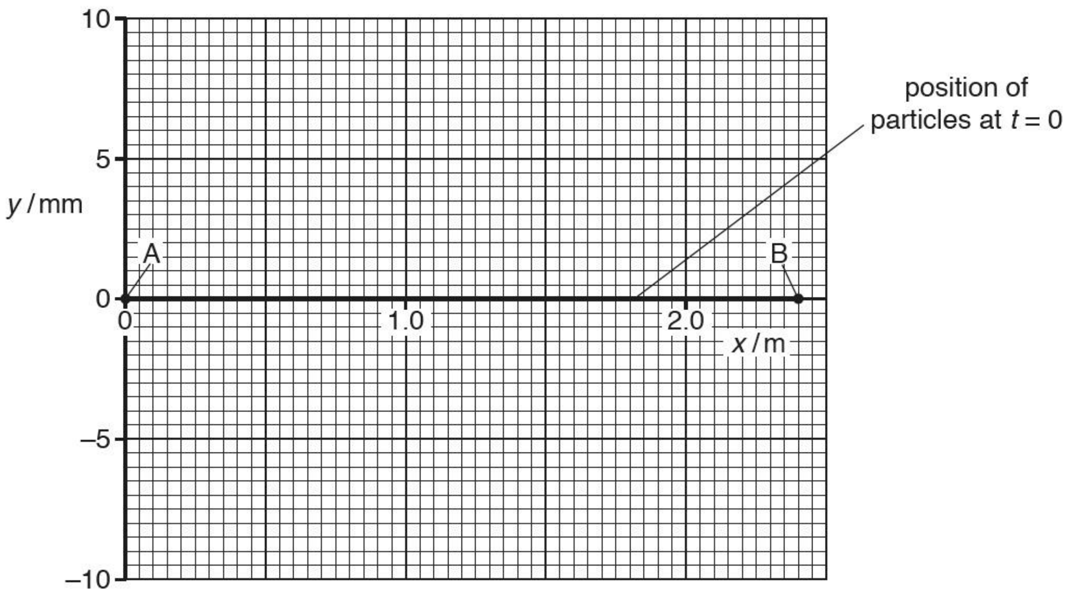

Fig. 7.3

The wave has a period of 20 ms and a wavelength of 1.2 m. The maximum amplitude of the particles of the string is 5.0 mm.

(i)
On Fig. 7.3, draw a line to represent the position of the string at t = 5.0 ms. [2]

(ii)
State the phase difference between the particles of the string at x = 0.40 m and at x = 0.80 m.

phase difference =

rad

[1]

(iii)
State and explain the change in the kinetic energy of a particle at an antinode between t = 0 and t = 5.0 ms. A numerical value is not required.

[2]

(d)

Fig. 7.4 shows two emitters A and B, placed 2.00 m apart, emitting radio waves of same frequency and same phase which interfere with one another to produce lines of constructive and destructive interference.

The Automated Guided Vehicle (AGV) is a device that detects radio waves and searches for lines of constructive interference. When placed equidistant from both emitters, the AGV will automatically adjust its position so that it is always aligned along the centre-line.

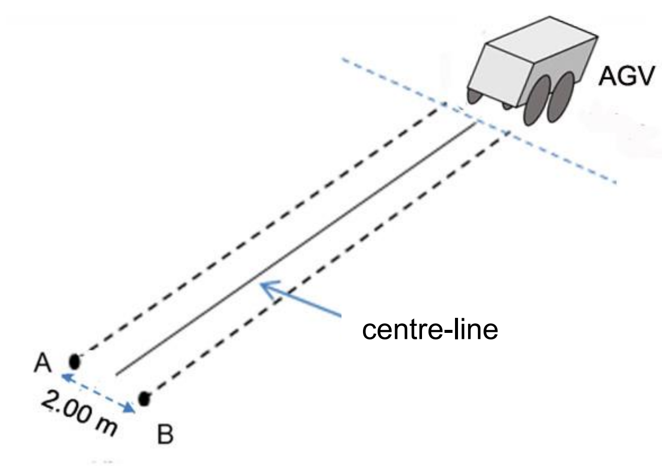

Fig 7.4 (not to scale)

(i)

Explain why the centre-line is a line of constructive interference.

[1]

(ii)

During one such operation, the AGV strays off from the centre-line as shown in Fig. 7.5.

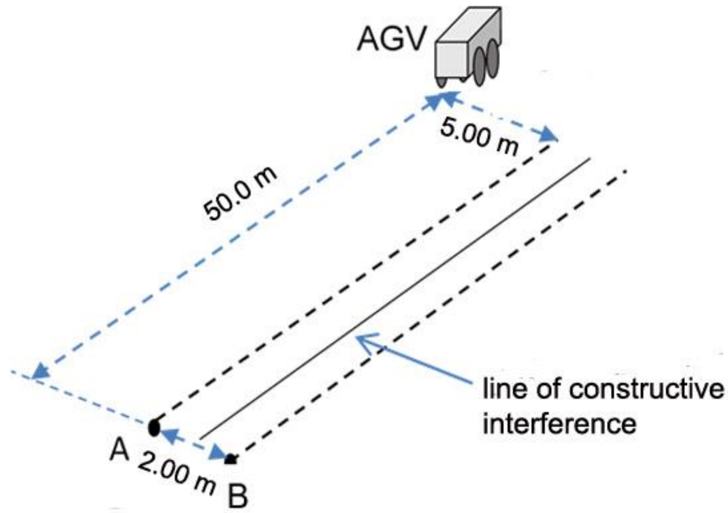

Fig 7.5 (not to scale)

Fig. 7.6 shows the separate radio signals X and Y detected by the receiver on the AGV.

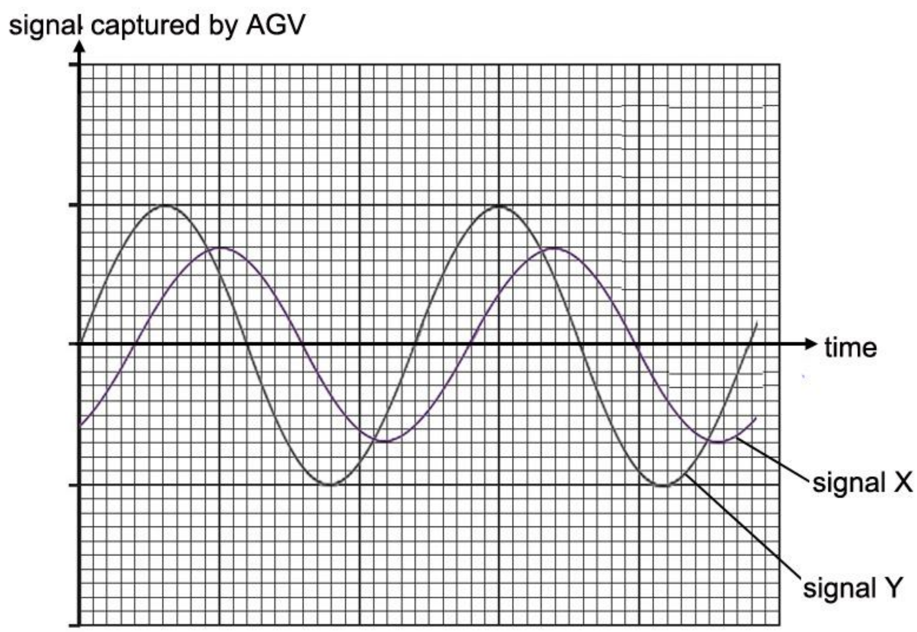

Fig 7.6

1.
State and explain whether the source of signal X is from emitter A or B.

2.

[2]

2.

Calculate the phase difference between signals X and Y.

phase difference =

rad

[1]

3.

Assuming the path difference is less than one wavelength, determine the frequency of the radio waves.

frequency =

Hz

[4]

4.

Sketch on Fig. 7.6 the resultant signal detected by the AGV as a result of interference.
[2]

[Total: 20]