5 Fig. 5.1 shows a horizontal string of length 1.000 m, stretched between a vibrator at A and a pulley at B. The vibrator produces a small oscillation at A and energy is transferred as a wave along the string. P is a point 0.300 m from B. You may consider B to be a fixed point.

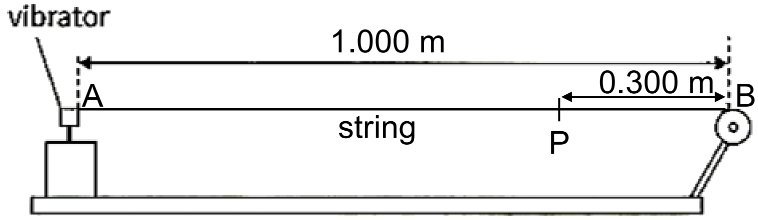


Fig. 5.1

(a) The wave from A, travelling along the string, reaches P along two paths:

Path 1: A to P (the incident wave)

Path 2: A to B to P (the reflected wave)

(i) Show that the path difference between the two waves meeting at P is 0.600 m.

[1]

(ii) The wavelength is 1.000 m. When the wave is reflected at B, an additional phase difference of π rad is added to the reflected wave. Determine the phase difference between the two waves when they superpose at P.

phase difference = ... rad [2]

(iii) A stationary wave is formed along AB in Fig 5.1. Sketch the stationary waveform along AB below. [2]

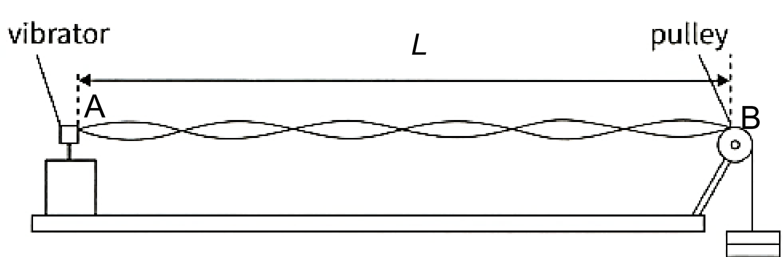
A

B

(iv) Point Q is 0.300 m to the right of A. Using your answer in **(a)(iii)**, state the phase relation between the motion of the particles at P and Q.

....
.... [1]

(b) Fig. 5.2 shows a modified set up where the string at B is now attached to slotted masses to vary the tension in the string. The pulley at B is frictionless.



The speed *v* of the wave travelling along the string is related to the weight *mg* of the slotted masses and the mass per unit length / of the string according to the equation:

$$v = \sqrt{\frac{mg}{\;}}$$

The amplitude of oscillation of the vibrator is small and hence point A is approximately a node.

L is 1.000 m.

(i) Show that for stationary waves to form along the string in Fig. 5.2, the frequency *f* of oscillation of the vibrator must satisfy the following relation:

$$f = \frac{n}{2}\sqrt{\frac{mg}{\;}}$$

where *n* is an integer.

[2]

(ii) The mass per unit length μ of the string is 7.0×10^{-3} kg m^{-1} and the frequency of oscillation of the vibrator is f = 25 Hz. Calculate the mass m of the slotted masses needed to produce the stationary wave shown in Fig 5.2.

m = ... kg [1]

(iii) The mid-point of the string in Fig 5.2 is now fixed so that it will always be a node. The total mass hanging from the pulley at B remained unchanged. The frequency of oscillation of the vibrator is slowly increased from 25 Hz. Determine the next higher frequency that a stationary wave will form along the string.

frequency = ... Hz [2]

[Total: 11 marks]

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