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QUESTION WORKBOOK

Stationary waves

Waves · Year 12

AQA 3.3.1.3 · CIE 8.1.1, 8.1.2, 8.1.3, 8.1.4
OCR A 4.4.3(a)(i), 4.4.3(b), 4.4.4(a), 4.4.4(b), 4.4.4(c), 4.4.4(d), 4.4.4(e)(i), 4.4.4(e)(ii), 4.4.4(f), 4.4.4(g)

19 questions · 55 marks

NAVY SCREEN EDITION

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SECTION A · Warm-up

A1 Describe how a stationary wave is formed on a string. [2]

A2 State the distance between two adjacent nodes on a stationary wave, in terms of the wavelength λ. [1]

A3 Distinguish between a node and an antinode. [2]

A4 The frequency of the first harmonic of a stretched string is given by $f_1 = (1/2L)\sqrt{(T/\mu)}$. State what the symbols T and μ represent, and give the SI unit of μ. [2]

A5 State why a stationary wave on a string fixed at both ends must have a node at each end. [1]

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A6 Points P and Q lie between the same pair of adjacent nodes on a stationary wave. Point R lies between the next pair of nodes along. State the phase difference between P and Q, and between P and R. [2]

SECTION B · Standard

B1 A string of length 0.60 m is fixed at both ends and vibrates in its fundamental mode. The wave speed on the string is 240 m s^{-1}. Calculate (a) the wavelength and (b) the fundamental frequency. [3]

B2 A string of length 0.60 m is fixed at both ends. The speed of waves on the string is 240 m s^{-1}. Calculate the frequencies of the second and third harmonics. [3]

B3 A string of length 0.80 m fixed at both ends vibrates at its fundamental frequency of 150 Hz. Calculate the speed of the waves on the string. [3]

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B4 A stationary wave has a wavelength of 0.50 m. Calculate the distance between adjacent nodes, and the distance between a node and the next antinode. [3]

B5 A guitar string has a vibrating length of 0.750 m, and this length of string has a mass of 1.20 g. The string is under a tension of 90.0 N. Calculate the frequency of the first harmonic. Use $f_1 = (1/2L)\sqrt{(T/\mu)}$. [3]

B6 A string fixed at both ends vibrates at its first-harmonic frequency. The length of the string and the string itself are unchanged. Determine the factor by which the tension must change for the first-harmonic frequency to double. [2]

B7 A string of length 1.2 m fixed at both ends vibrates in its fourth harmonic. State the number of nodes and the number of antinodes on the string, and calculate the wavelength. [3]

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SECTION C · Stretch

C1 A string of length 1.2 m fixed at both ends carries waves travelling at 180 m s^{-1}. Calculate the frequencies of the first three harmonics. [4]

C2 A string of length 1.0 m fixed at both ends vibrates at 300 Hz, and the wave speed on it is 200 m s^{-1}. Determine which harmonic this is. [4]

C3 State three differences between a progressive wave and a stationary wave. [3]

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C4 A violin string has a vibrating length of 0.328 m and a mass per unit length of 0.60 g m^{-1}. The maker states that when the tension is 50.0 N the first harmonic of the string is concert pitch A, 440 Hz. Deduce whether the maker's statement is correct. Use $f_1 = (1/2L)\sqrt{(T/\mu)}$. [4]

C5 The driving frequency applied to a stretched string of fixed length 1.5 m is increased slowly. Stationary waves form at 240 Hz and next at 300 Hz, with none in between. Determine the frequency of the first harmonic and the speed of the waves on the string. [4]

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C6 Describe an experiment to investigate how the first-harmonic frequency of a stretched string depends on its vibrating length L. Your answer should include how the stationary wave is produced, the measurements taken, and how the results would be used to show that f_1 is inversely proportional to L. [6]

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