WAVES, SOUND & PHYSICAL OPTICS DAY 6: INTERFERENCE AND STANDING WAVES ON STRINGS

CED 14.6 · Skill 1.A · FRQ: TBR

PREDICT

A string fixed at both ends vibrates in its second harmonic. How many antinodes appear?

A. 1 B. 2 C. 3 D. 4

Commit before the pattern is revealed.

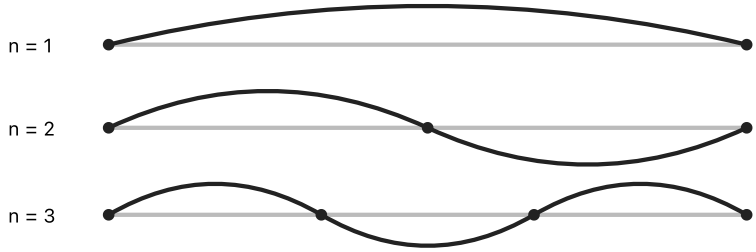
SUPERPOSITION

When waves overlap, displacements add point by point. Equal same-direction displacements interfere constructively; equal opposite displacements interfere destructively at that instant.

At one point, one pulse gives $+3.0\,\text{cm}$ and another gives $-1.0\,\text{cm}$. Find the net displacement.

A STANDING PATTERN

FIRST THREE FIXED-STRING HARMONICS



Node
Displacement remains zero.

Antinode
Displacement amplitude is largest.

For $n = 3$, count antinodes, interior nodes, and total nodes including endpoints.

PATTERN TO EQUATION

$$\lambda_n = \frac{2L}{n} \qquad f_n = \frac{nv}{2L}$$

WE DO A string has $L = 1.20\,\text{m}$, wave speed $v = 180\,\text{m/s}$, and vibrates at $n = 3$. Find λ_3 and f_3.

Identify n from the number of antinodes before substituting.

REPRESENTATION CHECK

1. Sketch $n = 4$ and mark every node.

2. A $0.90\,\mathrm{m}$ string carries waves at $120\,\mathrm{m/s}$. Find its fundamental frequency.

3. Find the fourth-harmonic frequency on that string.

4. Explain why doubling amplitude does not change allowed harmonic frequencies.