Name <u>KEY</u> SP436 Quiz

A sheet poster 2.00 m by 4.00 m is stretched over a rigid square frame such that the density is homogeneous and the tension is isotropic, resulting in a wave speed of 10.0 m/s.
We showed that:

$$\tilde{y} = \tilde{A}\sin(k_x x)\sin(k_z z)e^{j\omega t}$$

where:

$$k_{mn}^2 = \frac{n^2\pi^2}{L_x^2} + \frac{m^2\pi^2}{L_z^2}$$

What are the four lowest frequencies of the normal modes this sheet poster vibrates (in Hz)?

$$\omega_{mn}^2 = c^2\left(\frac{n^2\pi^2}{L_x^2} + \frac{m^2\pi^2}{L_z^2}\right)$$

$$f_{mn} = \frac{c}{2\cancel{\pi}}\sqrt{\frac{n^2\cancel{\pi^2}}{L_x^2} + \frac{m^2\cancel{\pi^2}}{L_z^2}} = \frac{c}{2}\sqrt{\frac{n^2}{L_x^2} + \frac{m^2}{L_z^2}}$$

$$f_{mn} = \frac{10\,\mathrm{m/s}}{2}\sqrt{\frac{n^2}{(2\mathrm{m})^2} + \frac{m^2}{(4\mathrm{m})^2}} = 5\,\mathrm{m/s}\sqrt{\frac{n^2}{4\mathrm{m}^2} + \frac{m^2}{16\mathrm{m}^2}}$$

$$f_{10} = 5\,\mathrm{m/s}\sqrt{\frac{1}{16\mathrm{m}^2}} = \frac{5}{4}\,\mathrm{s}^{-1} = 1.25\,\mathrm{Hz}$$

$$f_{01} = 5\,\mathrm{m/s}\sqrt{\frac{1}{4\mathrm{m}^2}} = \frac{5}{2}\,\mathrm{s}^{-1} = 2.5\,\mathrm{Hz}$$

DOES NOT VIBRATE! $k_x = 0$ OR $k_y = 0$

$$f_{11} = 5\,\mathrm{m/s}\sqrt{\frac{1}{4\mathrm{m}^2} + \frac{1}{16\mathrm{m}^2}} = 5\,\mathrm{m/s}\sqrt{\frac{5}{16\mathrm{m}^2}} = \frac{5}{4}\sqrt{5}\,\mathrm{s}^{-1} = 2.80\,\mathrm{Hz}$$

$$f_{21} = 5\,\mathrm{m/s}\sqrt{\frac{1}{4\mathrm{m}^2} + \frac{4}{16\mathrm{m}^2}} = 5\,\mathrm{m/s}\sqrt{\frac{2}{4\mathrm{m}^2}} = \frac{5}{\sqrt{2}}\,\mathrm{s}^{-1} = 3.54\,\mathrm{Hz}$$

$$f_{12} = 5\,\mathrm{m/s}\sqrt{\frac{4}{4\mathrm{m}^2} + \frac{1}{16\mathrm{m}^2}} = 5\,\mathrm{m/s}\sqrt{\frac{17}{16\mathrm{m}^2}} = \frac{5\sqrt{17}}{4}\,\mathrm{s}^{-1} = 5.15\,\mathrm{Hz}$$

$$f_{22} = 5\,\mathrm{m/s}\sqrt{\frac{4}{4\mathrm{m}^2} + \frac{4}{16\mathrm{m}^2}} = 5\,\mathrm{m/s}\sqrt{\frac{5}{4\mathrm{m}^2}} = \frac{5}{2}\sqrt{5}\,\mathrm{s}^{-1} = 5.59\,\mathrm{Hz}$$

$$f_{31} = 5\,\mathrm{m/s}\sqrt{\frac{1}{4\mathrm{m}^2} + \frac{9}{16\mathrm{m}^2}} = 5\,\mathrm{m/s}\sqrt{\frac{13}{16\mathrm{m}^2}} = \frac{5}{4}\sqrt{13}\,\mathrm{s}^{-1} = 4.51\,\mathrm{Hz}$$

$$f_{41} = 5\,\mathrm{m/s}\sqrt{\frac{1}{4\mathrm{m}^2} + \frac{16}{16\mathrm{m}^2}} = 5\,\mathrm{m/s}\sqrt{\frac{5}{4\mathrm{m}^2}} = \frac{5}{2}\sqrt{5}\,\mathrm{s}^{-1} = 5.59\,\mathrm{Hz}$$

Follador Equations: $\omega = ck$ $f = \frac{\omega}{2\pi}$

m, n
WHY NOT 0, 1
0, 2 ?