SQUARECAP

What are the big assignments/projects/exams you’re focused on these last couple of weeks?

Notes

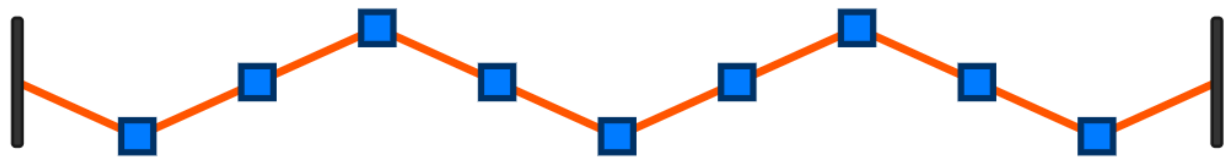
- Just one more homework on oscillations/waves/sound, due the last day of class (Monday, Dec 9)

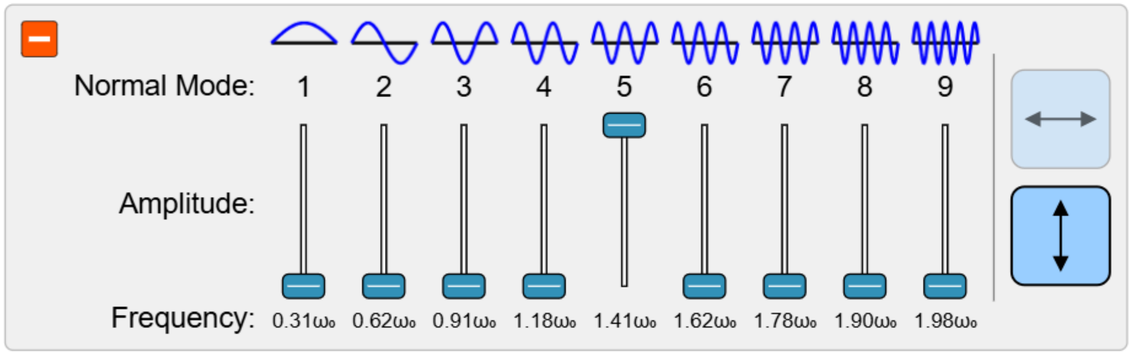
- Final Exam Structure
  - Cumulative Aspect: 9 Zombie questions from previous exams
  - New Material: 6 questions from homework

→Can replace lowest midterm score!

- Survey #2 for participation points available

Prelecture Review: Waves on a String





https://phet.colorado.edu/sims/html/normal-modes/latest/normal-modes_all.html

Try plucking the string. What happens? Can you imagine how this works if the links between the masses are linear elastic objects, like rubber bands?

Try increasing the number of masses. Then, play with the amounts of the different vibrational modes ("normal modes"). What do you notice?

What are our comments and questions?

Key Points: Waves

Waves

$$f\lambda = c = \frac{\omega}{k}$$

$$f(x,t) = A\cos(kx - \omega t + \phi)$$

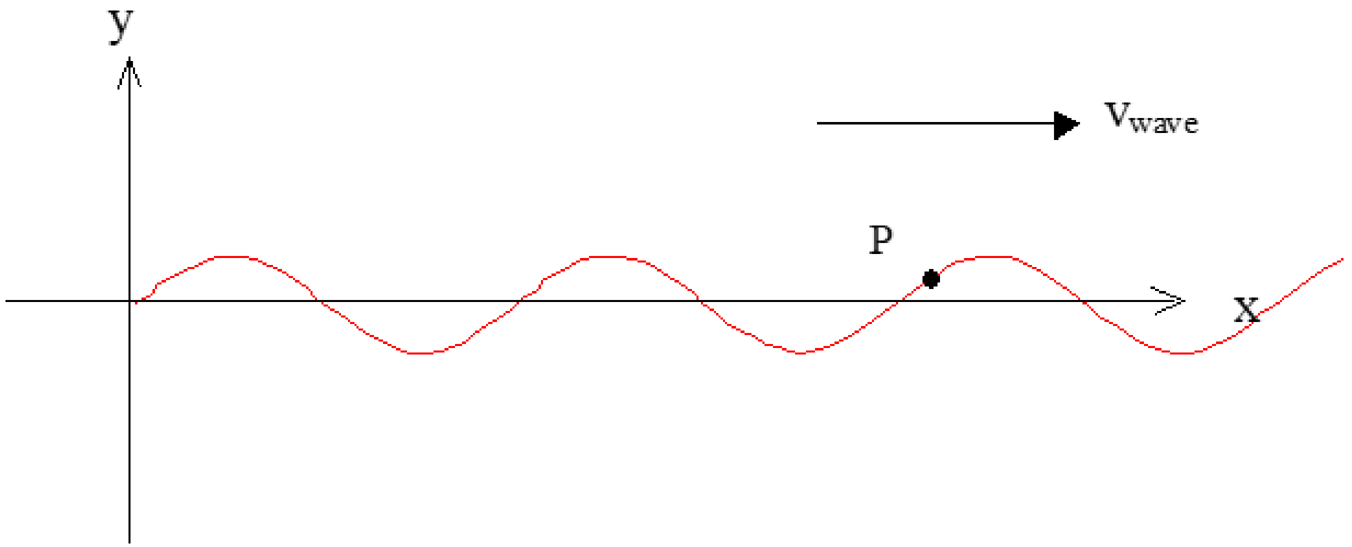
$$f(x,t) = \frac{1}{2}(f(x - vt, 0) + f(x + vt, 0))$$

$$\lambda_{fixed} = \frac{2L}{n} \qquad n = 1,2,3 \ldots$$

$$c_{String} = \sqrt{T/\mu} \qquad \mu = m/L$$

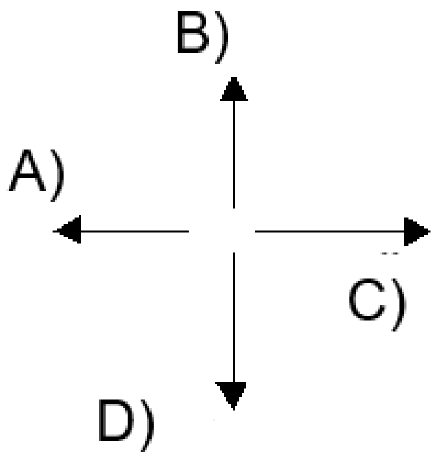
- The frequency, wavelength, and speed are related.
- We can write the wavefunction for normal modes and for a more general shape.
- For a string with fixed endpoints we can determine the wavelengths of the normal mode
- We can find the speed of “sound” for a wave on a string

The graph below shows a snapshot of a wave on a string which is traveling to the right. There is a bit of paint on the string at point P.



Discuss and Answer:

At the instant shown, the velocity of the painted point P has direction:



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Discuss and Answer:

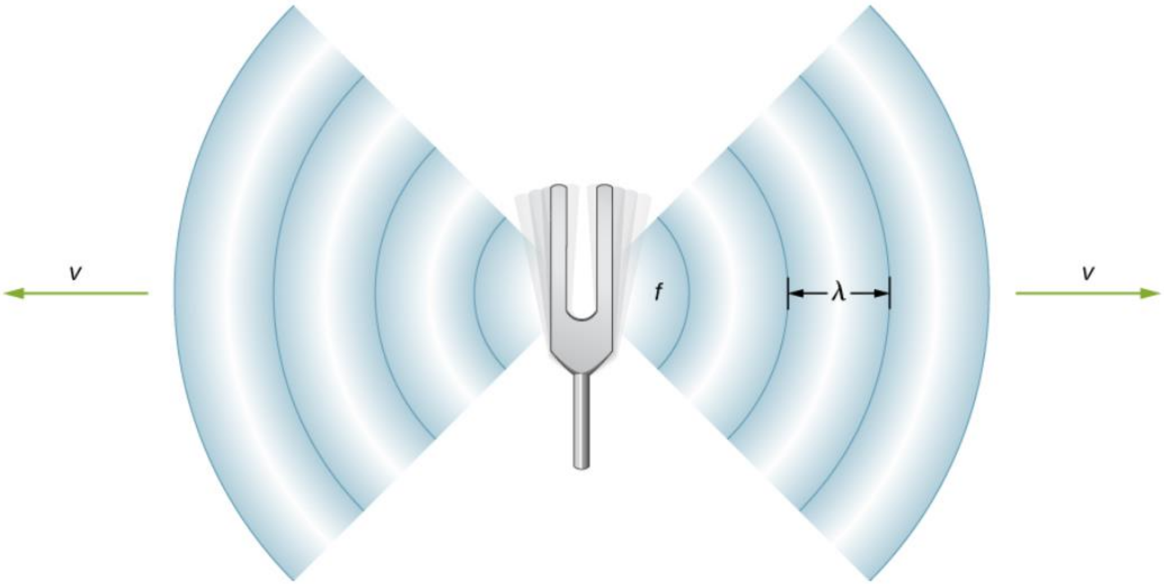
Two travelling waves 1 and 2 are described by the equations.

$$y_1(x,t) = 2\sin(2x - t)$$
$$y_2(x,t) = 4\sin(x - 2t)$$

All the numbers are in the appropriate SI (mks) units.
Which wave has the higher speed?

A) 1 B) 2 C) Both have the same speed.

Prelecture Review: Acoustic Oscillations



$$v = \sqrt{\frac{\text{elastic property}}{\text{inertial property}}}.$$

Speed of sound on a string
Speed of sound in a solid
Speed of sound in an ideal gas
Sonic Boom

What are our comments and questions?

Key Points: Sound in Air

Sound

$P = \frac{\mathrm{I}}{\mathrm{A}}$

$dB = 10\log_{10}(\frac{I}{I_0})$ $\quad I_0 = 10^{-12}\frac{W}{m^2}$

$c_{air} \approx 343\, m/s$

$c = \sqrt{\gamma P/\rho} = \sqrt{\gamma kT/m}$ $\quad PV = nkT$

$f_0 = \frac{v + v_0}{v + v_s} f_s$

- The intensity is the power per area
- Intensity is usually measured logarithmically, in dB
- The speed of sound depends on the pressure and density, which are related to the temperature via the ideal gas law.
- Doppler effect

Comments and Questions

- I understand the way we can calculate the magnitude and area of a sonic boom over land, but what sort of countermeasures could we take to mitigate the effect? Would a specific shape for an aircraft reduce the pressure change that causes the noise?
- When the hyperbola sound wave projections are produced from the extremely fast moving object, are the sound waves colliding with each other when they are produced from the object, or are they just getting very close together without actually touching?
- How do different forms of waves affect the propagation of sound through various mediums?

My comments and Questions

- Comment: A sonic boom is a limiting case of the doppler effect which we’ll look at next.

- Question: Warp drives hypothetically allow travel “faster than light.” Is there a “boom” associated with this?

Example:

You stand at the top of a deep well. To determine the depth, *D*, of the well you drop a rock from the top of the well and listen for the splash as the rock hits the water's surface. The sound of the splash arrives t = ***3.1*** s after you drop the rock. The speed of sound in the well is v_s = ***330*** m/s.

How deep is the well?