Physics 2C 1/16/20

0. Quiz next Thursday! Two practice exams to be posted today! Format:

1. Doppler for light ; Intensity vs Amplitude
2. Interference / Superposition, Reflection of waves on strings
3. Standing waves (on strings)

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1 Doppler for light (no medium!)

relative speed $\beta = \frac{v}{c}$

$$f' = f\sqrt{\frac{1 \mp \beta}{1 \pm \beta}}$$

− on top
+ on bot.
OR
+ on top
− on bot

relativity ⇒ • has to only depend on relative speed
• interchanging $f' \leftrightarrow f$ and $\beta \to -\beta$ has to yield same eq.

Intensity vs. Amplitude

$I \propto A^2$
"prop to"

At a distance D from an isotropic source the wave amplitude is A. What is the wave amplitude @ distance 2D?

(A) A

(B) $\frac{1}{\sqrt{2}}$ A

(C) $\frac{1}{2}$ A

(D) $\frac{1}{4}$ A

(E) None

$$I \propto \frac{1}{r^2}$$

$$\propto \frac{1}{(2D)^2}$$

$$I = \frac{I_0}{4}$$

$$A = \frac{A_0}{2}$$

CLICKER QUESTION

Doppler Effect

The panel on the left are spectral lines from the sun.

The panel at right are spectral lines of a distant Star.

The star is
[A] A different composition of gasses as our sun
[B] Moving away from Earth
[C] Moving toward Earth
[D] Not enough information.

2 Interference / Superposition

$t = 0$

constructive int

$t > 0$

$t = 0$

destructive int

$t > 0$

pass through each other undisturbed

~~Simulation demo~~

WILEY

16.9.2. Two waves are traveling along a string. The graph shows the position of the waves at time $t = 0.0$ s. One wave with a maximum amplitude of 0.5 cm is traveling toward the right at 0.5 cm/s. The second wave with a maximum amplitude of 2.0 cm is traveling toward the left at 2.0 cm/s. At what elapsed time will the two waves completely overlap and what will the maximum amplitude be at that time?

a) 2.0 s, 1.5 cm

b) 1.3 s, 2.5 cm

c) 1.0 s, 1.5 cm

d) 1.0 s, 2.5 cm

e) 1.3 s, 0.0 cm

$x_2 = 2 - (2.0\,cm/s)t$

$x_1 = -2 + (0.5\,cm/s)t$

$x_1 = x_2$

$-2 + 0.5t = 2 - 2t$

$2.5t = 4$

$t = \frac{4}{2.5}$

Reflection

Simulation demo

A symmetric pulse is approaching the right end of a string tied to two walls, as shown below on the right. Which of the following best represents the shape of the string after it has completely reflected off the wall on the right?

4. None of the above.

A symmetric pulse is approaching the right end of a string tied to two walls, as shown below on the right. At the precise moment when half of the wave has hit the wall, which of the following best represents the shape of the string?

5. None of the above.

Two identical pulses move in opposite directions toward opposite ends of a string tied to two walls, as shown on the right. Which of the following represents possible shape(s) for the string after both pulses have undergone reflections and meet somewhere in the middle.

1.

2.

3.

4.

5. 3 AND 4.

6. None of the above.

3 Standing Waves on Strings

modes

$m = 1$

$\lambda_1 = 2L$

special values of λ create "standing waves"

really: superposition of left-moving & right-moving waves that always

$m = 2$

$\lambda_2 = L$

$m = 3$

$\lambda_3 = \frac{2}{3}L$

General formula

$$\lambda_m = \frac{2L}{m}$$

$$f_m = \frac{v}{\lambda_m} = m\frac{v}{2L}$$

$$\frac{6.25\ \text{cm/s}}{2(7.5\text{cm})}$$

Simulation demo

$f_1 = 0.42\ \text{Hz}$

$f_2 = 0.83\ \text{Hz}$

$f_3 = 1.25\ \text{Hz}$

$v_{string} = 6.25\ \text{m/s}$ $\quad L = 7.5\text{cm}$

what is f, λ for fundamental mode?

10

A string is vibrating at 300 Hz. Using a strobe light and an ultra fast camera you get a picture of the string as sketched below. The blue walls are separated by 1 meter. If the string were vibrating in its lowest possible frequency, what would that frequency be?

$f_3 = 300\ Hz = mf_1$

$\lambda = \frac{2}{3}L$

$\Rightarrow m = 3$

$m = 1$

$f_1 = 100\ Hz$

1. 50 Hz
2. 100 Hz
3. 150 Hz
4. 200 Hz
5. 300 Hz
6. None of the above

A string is vibrating at 300 Hz. Using a strobe light and an ultra fast camera you get a picture of the string as sketched below. The blue walls are separated by 1 meter. What is the speed of the wave?

$v = \lambda f$

$v = \left(\frac{2}{3}\ m\right)(300\ Hz)$

$200\ m/s$

1. 50 m/s
2. 100 m/s
3. 150 m/s
4. 200 m/s
5. 300 m/s
6. None of the above

A string is vibrating at 300 Hz. Using a strobe light and an ultra fast camera you get a picture of the string as sketched below. The blue walls are separated by 1 meter. As determined in the previous question, the speed of the wave vibrating as shown is 200 m/s. what would its speed be if it were vibrating in the lowest possible frequency?

1. 50 m/s
2. 100 m/s
3. 150 m/s
4. 200 m/s
5. 300 m/s
6. None of the above.