Lecture 17

Week 10 ——— Midterm

friction, Gravity, Tension

force, Newton laws (1/2/3)

Oscillation

- free ——— more expected
- damped ——— less expected
- forced ——— less expected

Waves

Transverse, interference, Wave in a string

Lab recorded

10–20 min

will be recorded. you can watch them at your ease.

This lecture → Numerical problems

Pset

Friday Tutorial ——— 3 selected problems ——— 9:30-11

comment

Problem (—, —, —)

Chapter — Waves, Particles

$f \propto n_B\sqrt{\tau}$

9 Strings A and B have identical lengths and linear densities, but string B is under greater tension than string A. Figure 16-27 shows four situations, (a) through (d), in which standing wave patterns exist on the two strings. In which situations is there the possibility that strings A and B are oscillating at the same resonant frequency?

$\tau_B > \tau_A$

$f_A = f_B$

$f = n\frac{v}{2L}$

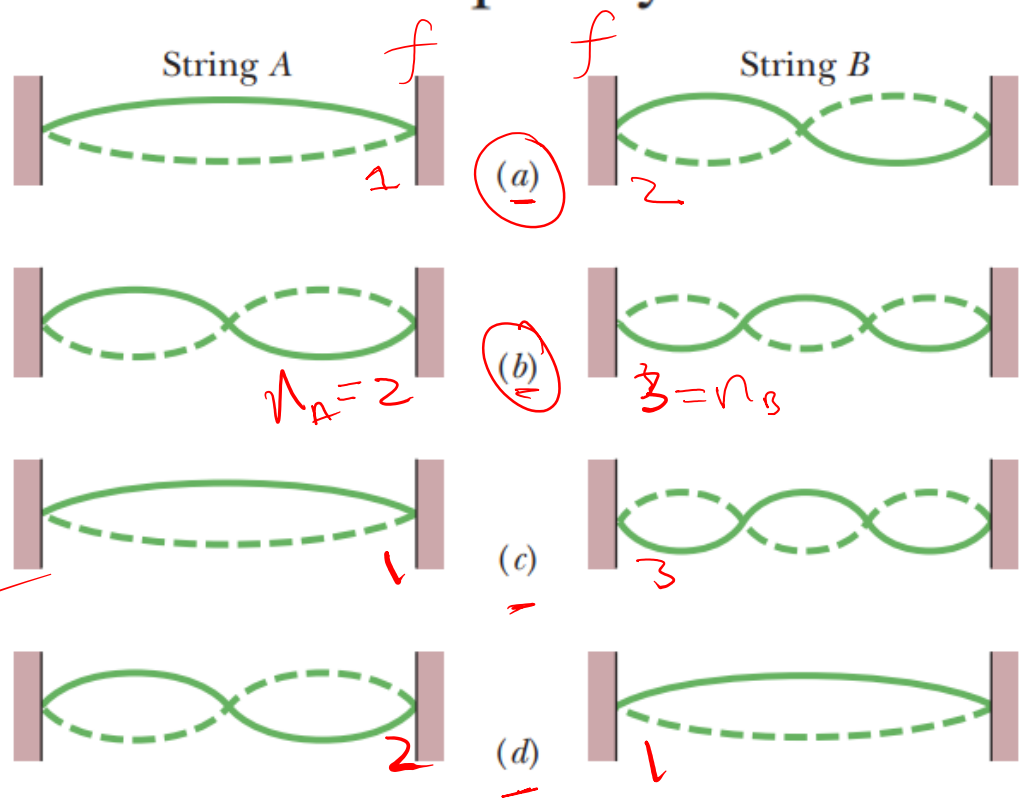
$\frac{n_A\sqrt{\tau_A}}{2L\sqrt{\mu_A}} = \frac{n_B\sqrt{\tau_B}}{2L\sqrt{\mu_B}}$

$f = \frac{n}{2L}\sqrt{\frac{\tau}{\mu}}$

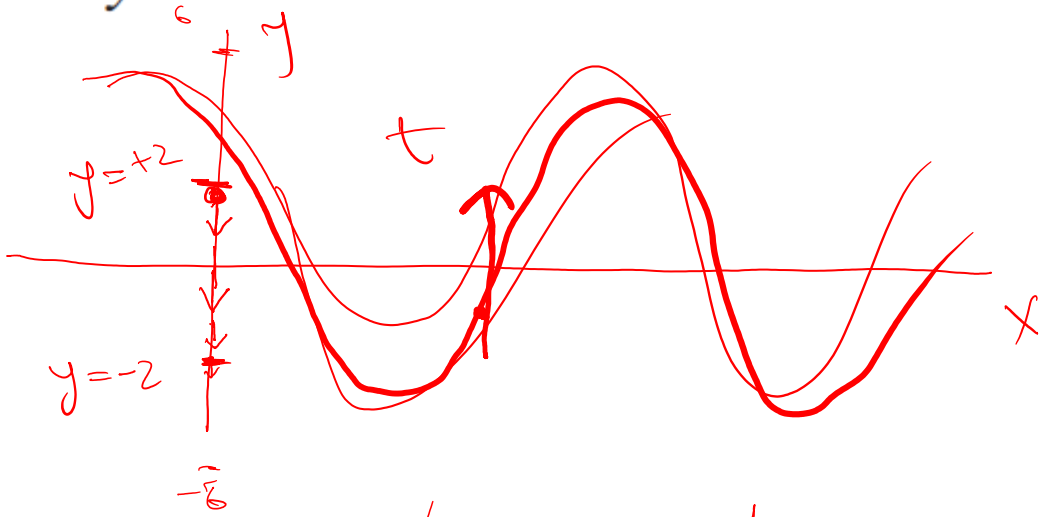
$\frac{\sqrt{\tau_B}}{\sqrt{\tau_A}} = \frac{n_A}{n_B}$

$n_A > n_B$

n — loop (Harmonic)



•1 If a wave $y(x, t) = (6.0\text{ mm})\ \sin(kx + (600\text{ rad/s})t + \phi)$ travels along a string, how much time does any given point on the string take to move between displacements $y = +2.0$ mm and $y = -2.0$ mm?



By comparison with

$y(x,t) = y_m \sin(kx + \omega t + \phi)$

$y_m = 6\text{ mm}$ $\omega = 600\text{ rad/s}$

$y = +2\text{ mm} = 6\text{ mm}\ \sin(kx_1 + \omega t_1 + \phi_1) \Rightarrow \sin^{-1}\left(\frac{2}{6}\right) = kx + \omega t_1 + \phi$

$y = -2\text{ mm} = 6\text{ mm}\ \sin(kx_1 + \omega t_2 + \phi_1) \Rightarrow \sin^{-1}\left(\frac{-2}{6}\right) = kx + \omega t_2 + \phi$

Δt = time

$\sin^{-1}\left(\frac{2}{6}\right) - \sin^{-1}\left(\frac{-2}{6}\right) = \omega(t_1 - t_2) = \omega\,\Delta t$

•••6 GO A sinusoidal wave travels along a string under tension. Figure 16-31 gives the slopes along the string at time $t = 0$. The scale of the x axis is set by $x_s = 0.80$ m. What is the amplitude of the wave?

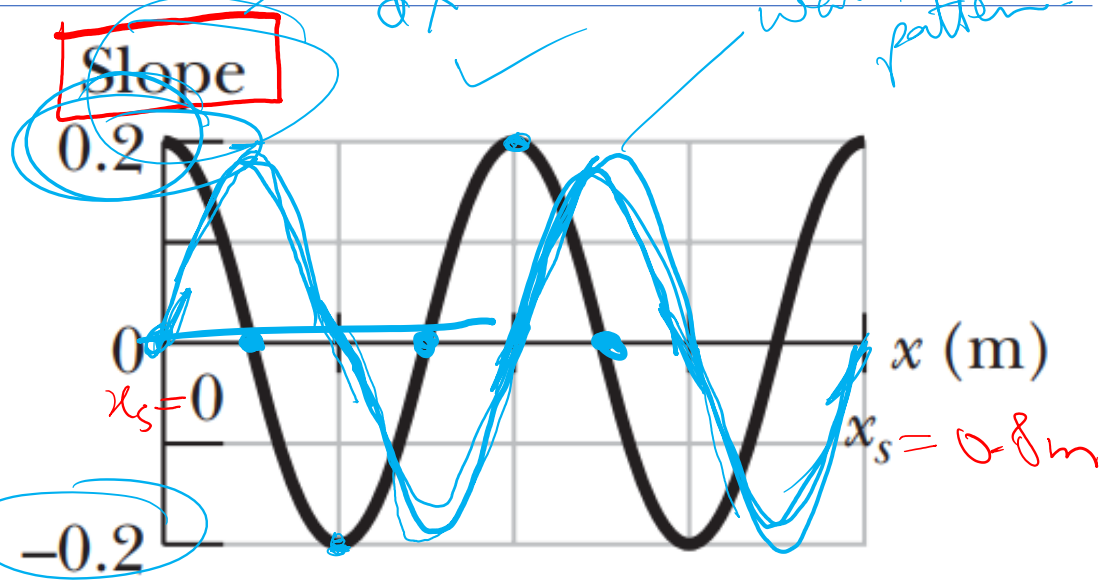


Figure 16-31 Problem 6.

$y(x,t) = y_m \sin(kx - \omega t + \phi)$

••7 A transverse sinusoidal wave is moving along a string in the positive direction of an x axis with a speed of 80 m/s. At $t = 0$, the string particle at $x = 0$ has a transverse displacement of 4.0 cm from its equilibrium position and is not moving. The maximum transverse speed of the string particle at $x = 0$ is 16 m/s. (a) What is the frequency of the wave? (b) What is the wavelength of the wave? If $y(x, t) = y_m \sin(kx \pm \omega t + \phi)$ is the form of the wave equation, what are (c) y_m, (d) k, (e) ω, (f) ϕ, and (g) the correct choice of sign in front of ω?

$v = 80\ m/s$

$v = \lambda / f$

$\lambda =$

$k = \frac{2\pi}{\lambda}$

$u(x,t) = u_m \cos(kx - \omega t + \phi)$

$y(0,0) = y_m \sin(0 - 0 + \phi)$

$4\ cm = y_m \sin(\phi) \cdot 1$

$y_m = 4\ cm$

$\phi = \frac{\pi}{2}$

$u_m = 16\ m/s = \omega y_m$

$+\omega y_m$

$\omega = \frac{16\ m/s}{y_m} = 400\ s^{-1} = \omega$

$f = \omega / 2\pi =$

$y = 4\ cm \sin\left(\square x - 400 \frac{rad}{s} t + \frac{\pi}{2}\right)$

$kx = 1 \Rightarrow k = 0.1\,\text{cm}^{-1}$
$k = 10\,\text{m}^{-1}$ —— $\lambda = \frac{2\pi}{k}$

••22 A sinusoidal wave is traveling on a string with speed 40 cm/s. The displacement of the particles of the string at $x = 10$ cm varies with time according to $y = (5.0\text{ cm}) \sin[1.0 - (4.0\text{ s}^{-1})t]$. The linear density of the string is 4.0 g/cm. What are (a) the frequency and (b) the wavelength of the wave? If the wave equation is of the form $y(x, t) = y_m \sin(kx \pm \omega t)$, what are (c) y_m, (d) k, (e) ω, and (f) the correct choice of sign in front of ω? (g) What is the tension in the string?

The values can be extracted from this equation

y_m μ $\omega = 2\pi f$

$\omega = 4\,\text{s}^{-1} \Longrightarrow f = \frac{\omega}{2\pi} = \frac{4\,\text{s}^{-1}}{2\pi}$

$\lambda = \frac{2\pi}{k} = \frac{2\pi}{10\,\text{m}^{-1}}$

$y_m = 5\,\text{cm}$

$k =$

$\tau = \mu v^2 = (4\,\text{g/cm})(40\,\text{cm/s})^2$

$=$ —— N

use proper units

→ -ve

plug the numbers in to get the results.

Practice problems:

Problems from **Fundamentals of Physics**
-Jearl Walker

Chapter 5 : Waves-I

Page#471 **Questions**

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Problems; 3,5,9,13,23,26,31,33,43,49