Announcements

- Physics 19 begins today
- We start waves today
- Second Hour Exam tomorrow

November 7, 2011

2^{nd} Hour Exam (21 only)

- Review session, LL 270, tonight at 7:00 pm
- Exam is Wednesday, Nov. 9 at 4:10 pm
- Room assignments: same as for first exam

Chandler-Ullman 248	Glueckstein (all), Beels (9 a.m.) and all extra time students
Packard 466	Malenda (all), Faust (all)
Packard 416	Tupa (all), Beels (10 a.m.)

- Exam covers chapters 27–31 (no transformers)
- Study guide, practice exam, and more information are on the class website

Today

- Waves: mathematical form
- Types of waves
- Wave Equation
- Demonstrations

Definition

A wave is a time dependent "disturbance." What is the disturbance?

- Sound wave: a travelling density variation in air or a material
- Water wave: wave height

Traveling Pulse

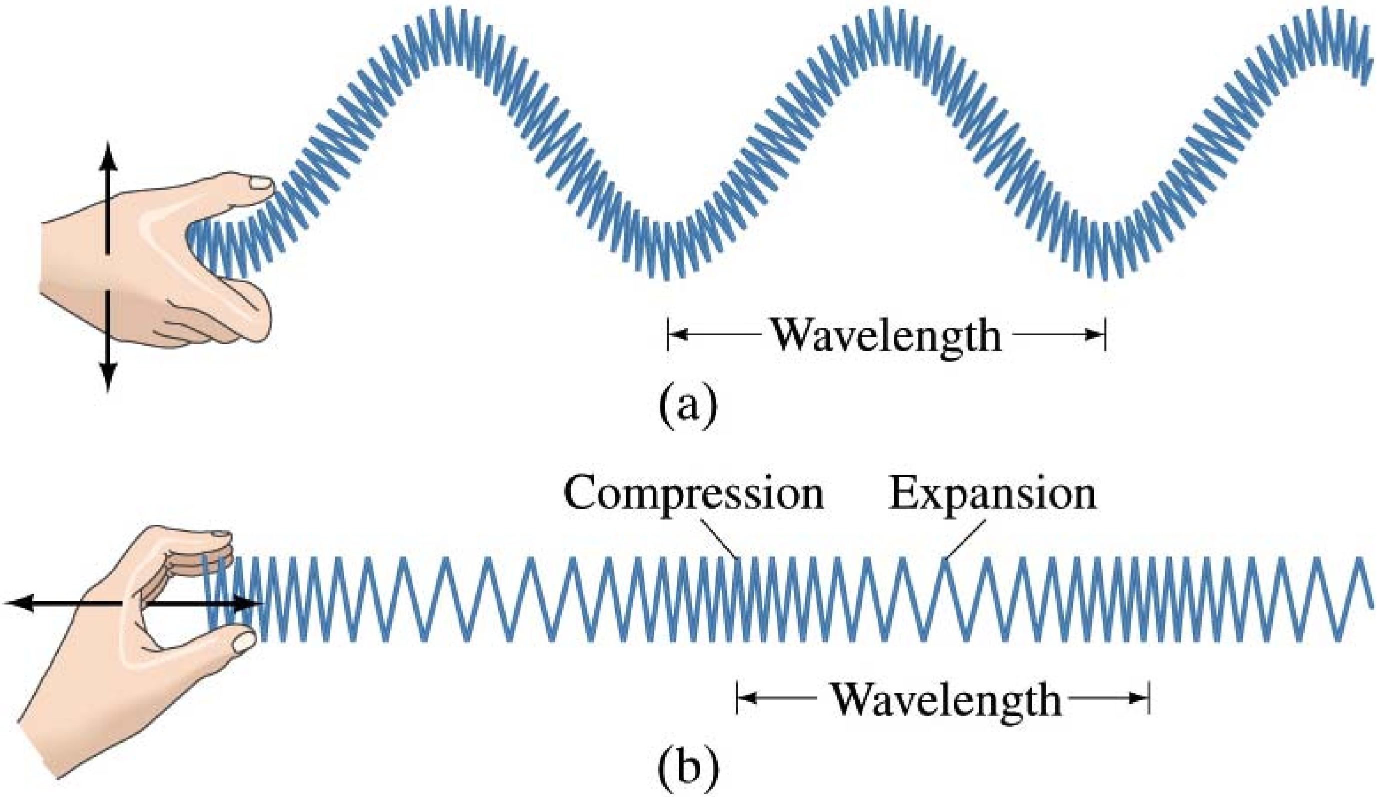
One way to describe a traveling “disturbance” or pulse is to use the following mathematical function:

$$D(x,t) = f(t - \frac{x}{v})$$

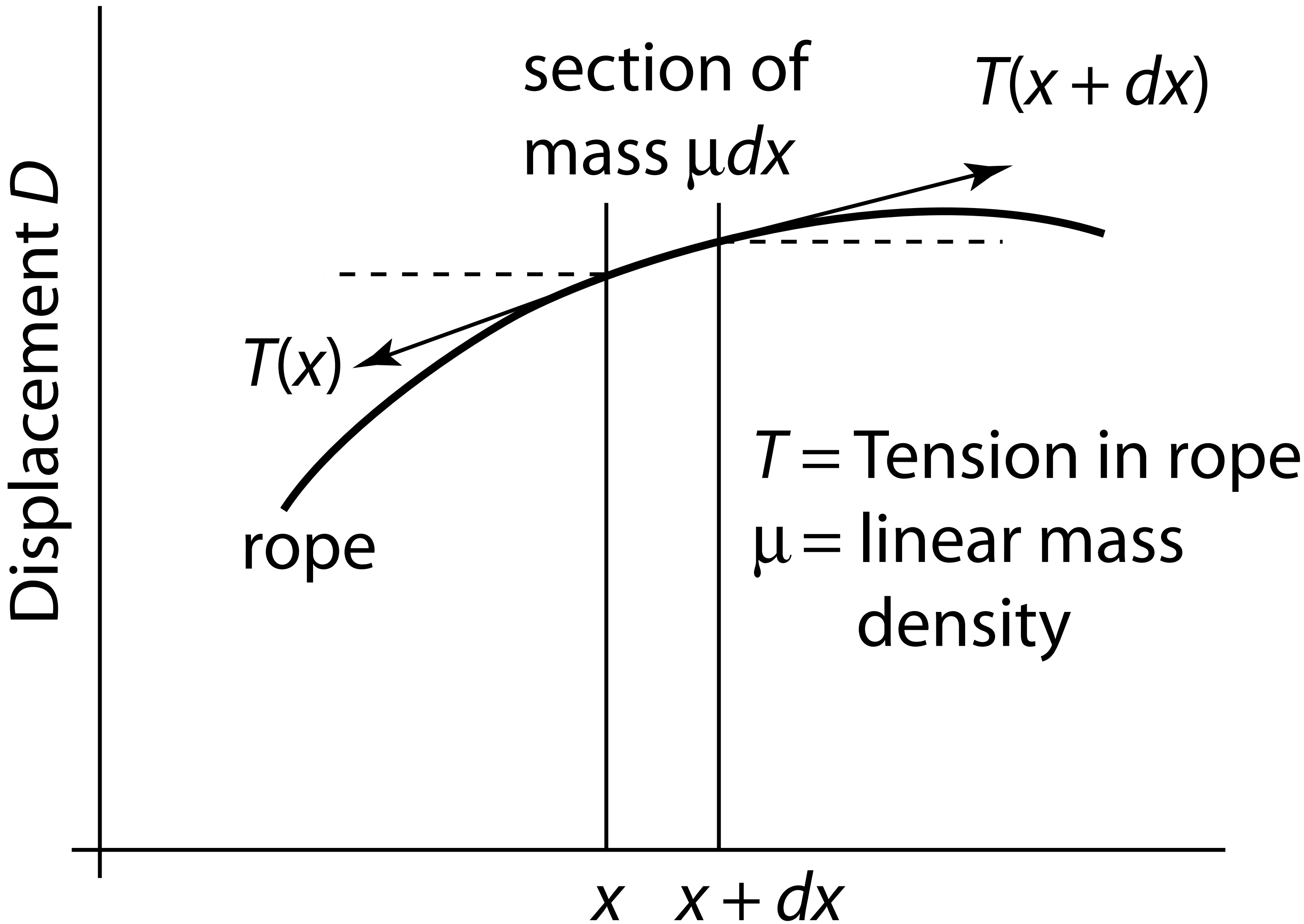
- The disturbance or pulse D travels at velocity v.
- The travel time from coordinate 0 to x is $\Delta t = x/v$.
- The time-dependence of the pulse at the point x is the same as it was at 0, except that everything is delayed by the travel time Δt.

Types of Waves

- Transverse: displacement $\perp$ to direction of propagation
- Longitudinal: displacement $\parallel$ to direction of prop.



Apply $F = ma$ to section of rope



The Wave Equation

$$\frac{\partial^2 D}{\partial x^2} - \frac{1}{v^2}\frac{\partial^2 D}{\partial t^2} = 0$$

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($v =$ speed of wave)

The Wave Equation

$$\frac{\partial^2 D}{\partial x^2} - \frac{1}{v^2}\frac{\partial^2 D}{\partial t^2} = 0 \qquad (v = \text{speed of wave})$$

It's easy to show that our general form for a traveling pulse,

$$D(x,t) = f\left(t - \frac{x}{v}\right),$$

is a solution to the wave equation. Just evaluate

$$\frac{\partial^2 D}{\partial x^2} = \left(-\frac{1}{v}\right)^2 f''\left(t - \frac{x}{v}\right) = \frac{1}{v^2} f''\left(t - \frac{x}{v}\right)$$

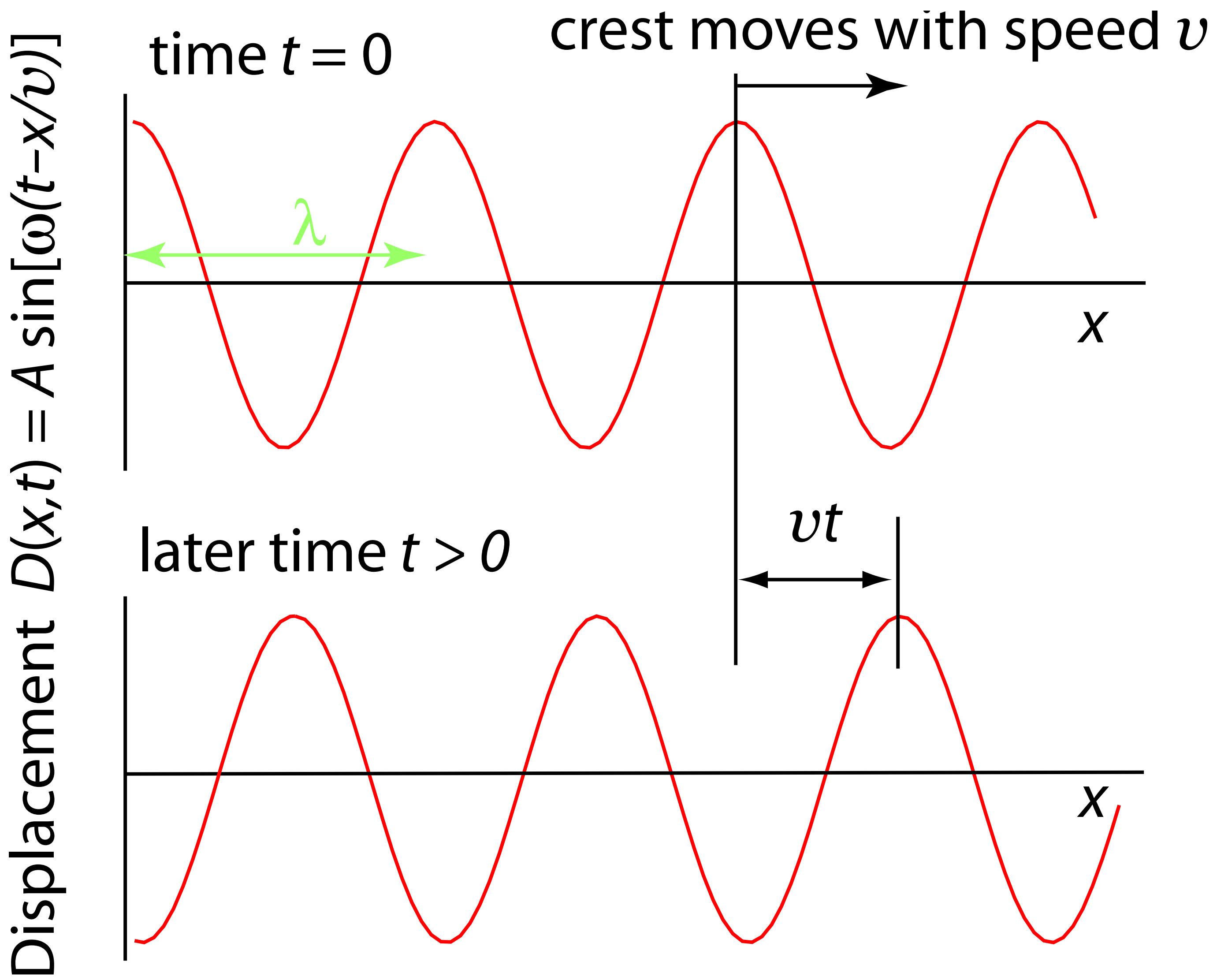
and

$$\frac{\partial^2 D}{\partial t^2} = f''\left(t - \frac{x}{v}\right).$$

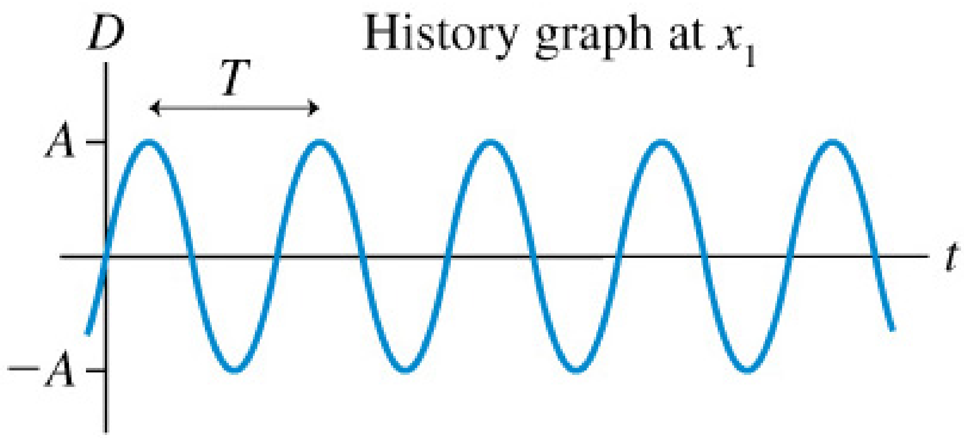
Types of Waves

- traveling waves
- standing waves

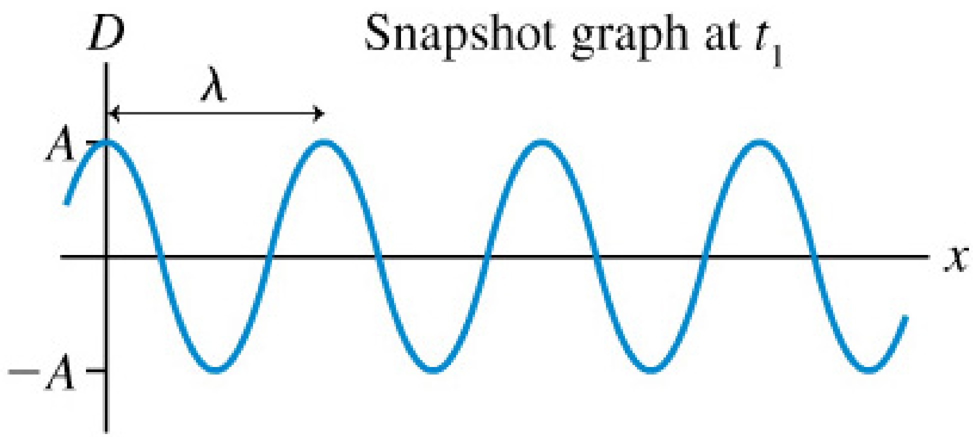
Traveling Wave



$$D(x,t) = A\sin(kx - \omega t + \phi)$$

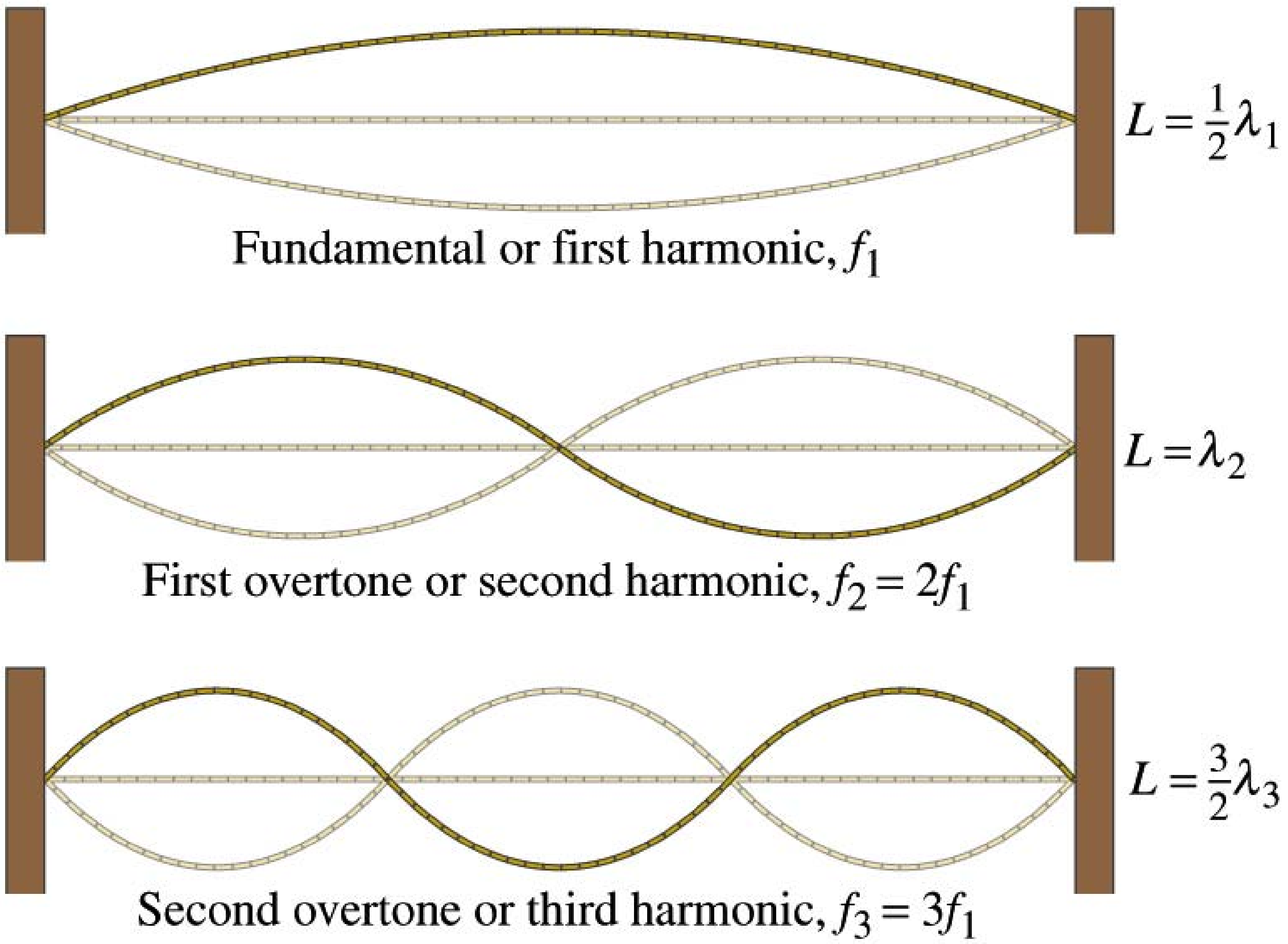


"history" graph:
plot $D(x,t)$ vs. t
for fixed x.



"snapshot" graph:
plot $D(x,t)$ vs. x
for fixed t.

Standing Waves



Announcements

There will be a review session tonight at 7:00 pm in LL 270.