Lecture 25 Announcements

1. Exam 4 results…
   a. Exams can be picked up in the normal boxes
   b. Last page not yet graded (TA got them yesterday)
2. Final exam info
   a. Take in Testing Center any time during Finals week
   b. Four hour time limit (-1/2 point after 4:05)
   c. No calculator, no note card
   d. The first page of final with list of equations will be posted to the class website soon
   e. I plan approx 40 questions
      i. approx 10 on new stuff (Chap 13 & 14)
      ii. approx 30 on Chapters 1-12
   f. Last year's exam posted to website
      i. 71% average, 76% median, 2 hour ave time
3. **Clicker quiz:** Class survey, vote for an option
   a. Final will count 20% of grade, as in syllabus
   b. Final will count 20% of grade, plus it will replace your lowest midterm exam score (if higher), 11% of grade
      i. …but will be a little more difficult than last year's exam…
4. Instructor/course evaluations due before Dec 13
   http://studentratings.byu.edu
   Please take both the ratings and the comments seriously

"Simple harmonic motion"

→*Sinusoidal vibrations*

Demo: weight on spring

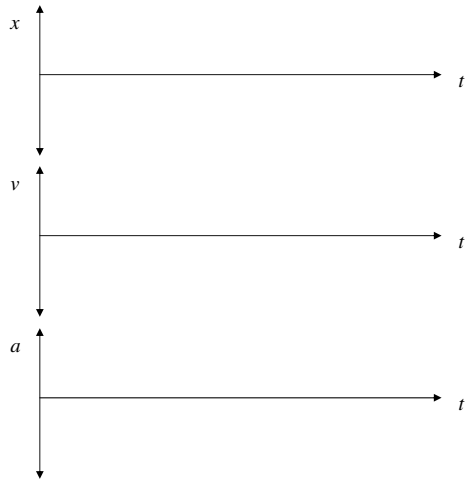
Occurs when an object has a **spring-like** restoring force:

F ~ displacement

Result: $x=A\cos(\omega t)$

→ or $x=A\sin(\omega t)$ or $x=A\cos(\omega t+\phi)$ ...what's the difference?

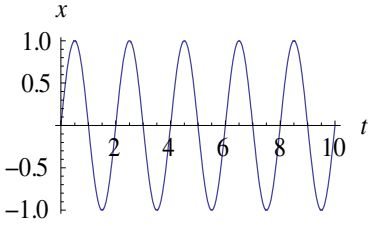
A = "amplitude", how far from origin it travels



Quick proof, using simple calculus (sorry):

Start with F ~ -x

Reading info from graph:



Amplitude A= _____

Period T = _____ sec

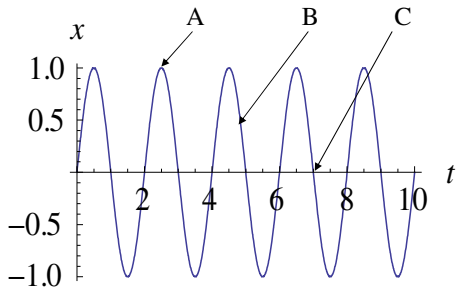
Frequency f = _____ cycles/sec (Hz)

Angular frequency ω =_____ rad/sec

$$f = \frac{\omega}{2\pi}$$

Angular frequency?? Where's the angle?

Demo: SHM/Circular motion analogy



Clicker quiz 1: Where does it have the most kinetic energy?

a. position A
b. position B
c. position C

Clicker quiz 2: Where does it have the most potential energy?

a. position A
b. position B
c. position C

Clicker quiz 3: Where does it have the largest acceleration?

a. position A
b. position B
c. position C

Springs

Demo: spring with mass

Frequency, period:

Pendulums

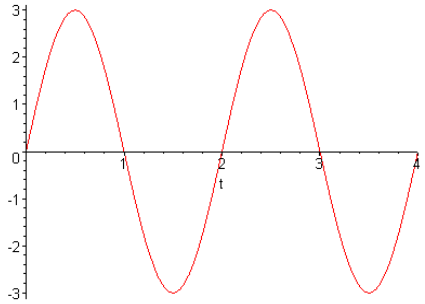
Demo: pendulum

Frequency, period:

Clicker quiz: Does period depend on amplitude?

a. yes
b. no
c. it depends

Clicker quiz: Given the oscillation picture below,



what's the correct equation to describe the position vs. time?

a. $x(t) = 6\cos(t)$
b. $x(t) = 3\sin(2t)$
c. $x(t) = 6\sin(2t)$
d. $x(t) = 3\sin(\pi t)$
e. $x(t) = 3\cos(\pi t)$

Worked Problem: A 70 kg trapeze artist swings on a long trapeze and takes 5 seconds to return to his starting spot.

How long will it take a woman of mass 50kg to make the same swing? _____ sec

How long will it take for the 70 kg man to swing from his starting place to when he first reaches the bottom?
_____ sec

How long is the rope? _____ m

Waves

→ Oscillating motion that transfers ***energy*** but not mass

Direction: where the energy is going

Medium: what is doing the "waving"

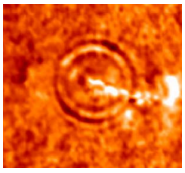
Oscillation: how the medium is moving

Transverse—Oscillation is ⊥ to the direction of the wave
Longitudinal—Oscillation is // to the direction of the wave

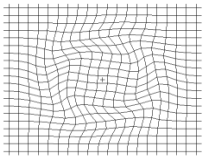
Web Demo: http://www.gmi.edu/~drussell/Demos/waves/wavemotion.html

Examples:

Slinky (demo)
Rope (demo)
"Shive wave machine" (demo)
Sound
Earthquake (P & S)
Water
Light?

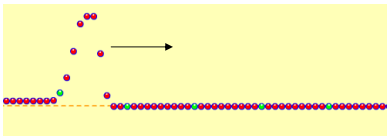


surface of the Sun



Wikipedia: "S-wave" (spherical)

Reflections



Clicker quiz: What happens when an upward pulse hits the end and turns around?

a. the wave reflects back, upward
b. the wave reflects back, downward
c. it depends

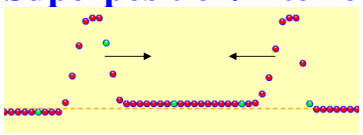
Web Demo:
http://www.colorado.edu/physics/phet/simulations/stringwave/stringWave.swf

Boundaries

Rope: Light rope meets heavy rope
Sound: Thin air meets dense air
Light: Air meets glass

In all cases: _____

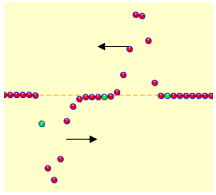
Superposition/Interference



Clicker quiz: What happens if two pulses, one from each end, meet in the middle? Do they pass through or reflect back when they meet?

a. pass through
b. reflect off of each other

What about this case?



Review:

What gets transported by the wave?

What does the transporting?

Speed, frequency, wavelength

m/s wave/s m/wave

$$v = f\lambda$$

Worked Problem: AM 1320 broadcasts the Utah Jazz games ☺ at a frequency of 1320 kHz. Radio waves travel at the speed of light, 3×10^8 m/s. (a) What is the wavelength of the AM1320 radio waves? (b) What is the period?

What will changing the **tension** do?

(Web demo, continued)

$$v = \sqrt{\frac{T}{\mu}}$$ For waves on a rope/string/etc

(book uses symbol *F* for tension)

What happens when you increase the wave speed while keeping the wavelength constant?

Demo: violin

Review problems

Clicker quiz: Two guitar strings of the same length have the same tension, but one has four times the mass of the other. The speed of a wave on the heavier guitar string is _____ that of the lighter string.

a. ¼
b. ½
c. the same as
d. 2×
e. 4×

Clicker quiz: A boy shakes a rope, moving his hand up and down. He sends a wave crest out every 0.5 seconds. He sees the wave crests move away with a distance between them of 25 cm. How fast is the wave moving?

a. 0-10 cm/s
b. 10-20 cm/s
c. 20-30 cm/s
d. 30-40 cm/s
e. more than 40 cm/s