Announcements

1. Start thinking about Exam 4
   a. Covers chapters 9-12
   b. Starts Dec 7, a week from tomorrow!

2. Instructor/course evaluations before Dec 13
   http://studentratings.byu.edu

Review of Last Lecture

$W_{on\ gas}$ = area under curve in P-V diagram
(= $-P\Delta V$ for constant pressure process)

U depends only on T; often it's strictly proportional
(= 3/2 nRT for monatomic ideal gas)

Visualizing isothermal contours in P-V diagrams helps understand changes in temperature—and hence U

1st Law: $\Delta U = Q_{added} + W_{on\ system}$

Engines: transform heat to work
2nd Law: …but not all of the heat!

$Q_h = |W_{net}| + Q_c$

efficiency = $|W_{net}|/Q_h$

Carnot Theorem:
max efficiency = $e_C = 1 - \frac{T_c}{T_h}$

Song:
http://www.uky.edu/~holler/CHE107/media/first_second_law.mp3

The end of Exam 4 material!

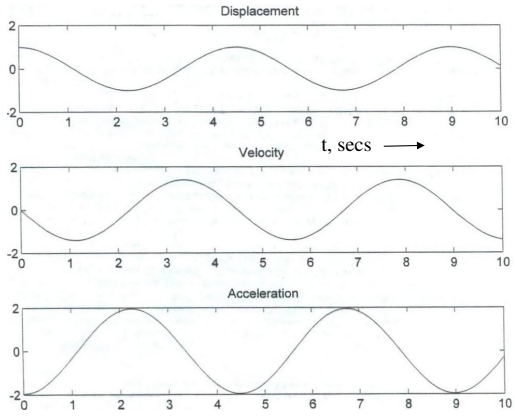
Simple harmonic motion →*Sinusoidal vibrations*

Demo: weight on spring

Occurs if the force on a mass is **spring-like**: F = -k×displacement

Displacement x=Acos(ωt) or x=Asin(ωt) or x=Acos(ωt+ϕ)

Example:



Amplitude A= _____, (from 0 to max)
Period T = _____ sec
Frequency f = _____ cycles/sec (Hz)
Angular frequency ω =_____ rad/sec

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

Demo: Circular motion/SHM analogy

Kinetic and potential energy vs time?

Mass and spring

Frequency, period:

Pendulum

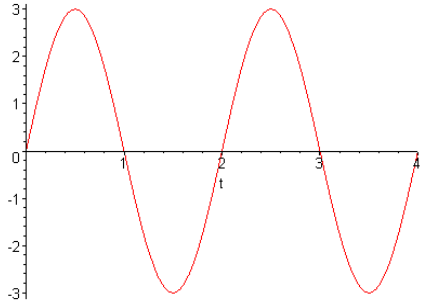
Frequency, period:

Demo: pendulum

Does period depend on amplitude?

Simple Problem: The position of a mass vibrating on a spring is
x(t)= 4cm cos(8 t).
What's the amplitude and frequency (*f*) of oscillation?

Q4. What's the period of oscillation in the graph below?



a. 1 s b. 2 s c. 3 s d. 4 s

Q5. What's the correct equation for the above oscillation?

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

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

Types of Waves

Transverse—The disturbance is ⊥ to the direction of the wave
Longitudinal—The disturbance is along the direction of the wave

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

The medium of the wave:

slinky
Demo: slinky

rope

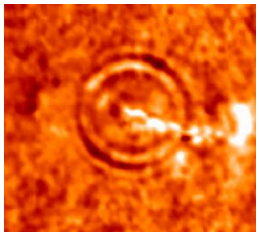
sound
gas
solid
earthquake P & S waves

Mnemonic: "S" for "shear"

light

water

Solar surface wave



What's "moving" locally as a wave goes by?
Demo: Shive wave machine
Demo: Sinewave animation:
http://www.colorado.edu/physics/phet/simulations/stringwave/stringWave.swf

What gets transported by the wave?

Speed, wavelength and frequency $v = f\lambda$

Worked Problem: One of my favorite radio stations is AM 1320, 1320 kHz (Go Jazz!). Radio waves travel at the speed of light, 3×10^8 m/s. What is the wavelength of these radio waves? What is the period?

Why do some waves go **faster** than others?

Wave speed on string, rope or cable: $v = \sqrt{\frac{T}{\mu}}$

Tension T (book uses F)

mass per length μ

Demo: surgical tubing

String instruments

Demo: violin

Q6. 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×

Q7. 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

Reflection

➢ What happens when a pulse hits the end and turns around? Does it return on the same side of the rope or does it invert?

heavy and light ropes.

light, sound

Superposition

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

Web Link:
http://www.kettering.edu/~drussell/Demos/superposition/superposition.html