Energy Transformations

Thursday, January 19, 2012
2:11 PM

When	X = +/- x_0	X = 0	X =/= 0_1 +/- x_0
KE	0	(1/2)mv^2	(1/2)mv^2
PE	(1/2)kx^2	0	(1/2)kx^2
Total	(1/2)kx_0^2	(1/2)mv^2	(1/2)mv^2 + (1/2)kx^2 = const

If there are no dissipative forces, mechanical energy of the system in free oscillations is constant.

Components of Mechanical Energy of Mass on String:

Potential energy (of the spring)	PE = (1/2)kx^2
Kinetic energy (of the mass)	KE = (1/20 mv^2

(1/2)kx_0^2 =(1/2)mv_0^2
Cross out 1/2
V_0^2 = (k/m)x_0^2
V_0^2 = sqrt(k/m)x_0 = ωX_0

Forced oscillations and resonance

Second Newton's Law:

|F(el)| = ma(?)

Hooke's law: F(el) = (-)kx

When x = x_0, a = (-a_0)

$Kx_0 = ma_0$
a_0 = (k/m)x_0 = $\omega^{2}x_0$

If there are dissipative forces, they turn free oscillation into damped oscillations

If looking at graph of positions, crest/trough get closer every time

The amplitude of damp oscillations decrease over time.

"exponential decay"

Resonance

Tuesday, January 24, 2012
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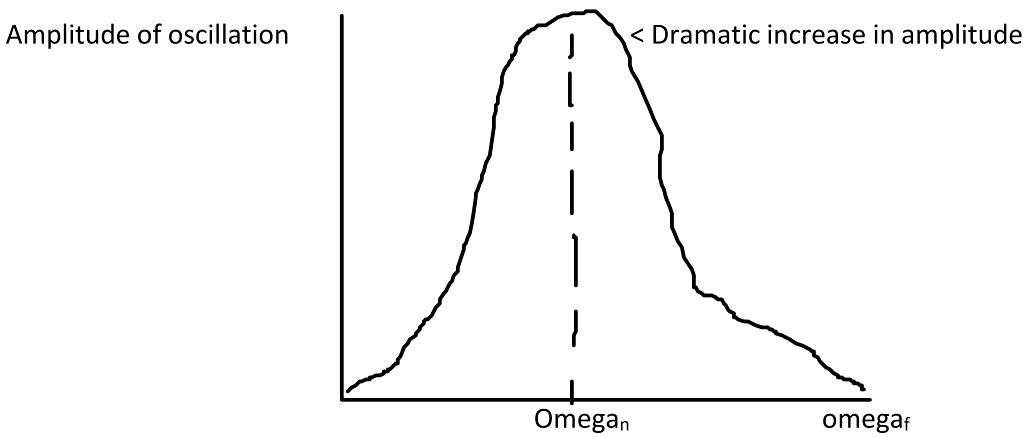
Forced oscillations in a system that can exhibit its "own" free oscillation; external force is periodic

Resonance is drastic increase of the amplitude of an oscillator (in forced oscillations) where the frequency of applied force, $omega_f$, is approaching (one of) natural frequency(ies) of the oscillator, $omega_n$



Wave phenomena

Thursday, January 26, 2012
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Interference: amplification (constructive) or reduction (destructive) of total displacement in the regions where waves pass through each other

To find the cumulative effect/result of interference, we are lucky when we can apply the superposition principle
Reflection
Refraction: deviation of waves from straight pattern while traveling in transparent medium with varying properties (namely, speed of wave)
Diffraction: bending of waves around edges of non-transparent obstacles
Dispersion:

During one period T, the wave travels distance = λ

Speed of wave = distance/time = $\lambda/T = \lambda F$

Wave phenomena cont

Friday, January 27, 2012
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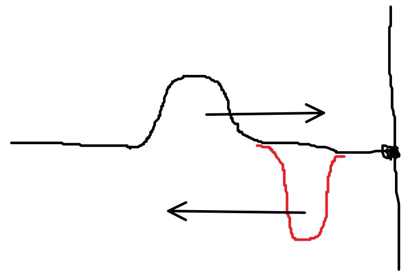
Standing waves

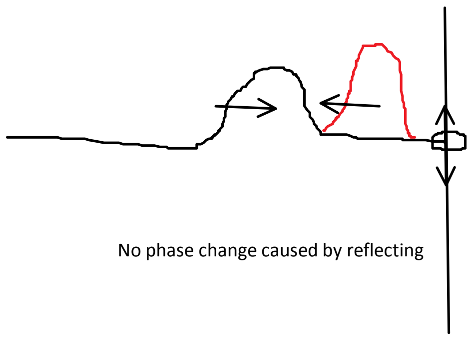
- Exist--and go "back and forth" in some limited (part of the) medium

These waves are reflected at the boundaries of the allowed space

The way they are refracted depends on boundary conditions



End is attached and cannot move



Free moving end

No phase change caused by reflecting

If two waves are a complete cycle out of sync, the phase shift is pi

During reflection, the phase of the wave switches to the opposite, i.e. changing by pi

Weee more oscillations

Monday, January 30, 2012
1:46 PM

Function(ωt + initial phase)

"Helper" for standing waves

Nodes must always be on the left

First node:
L = (1/2)λ
$\lambda = 2$L

Second node =
L = λ

Third node:
L = (3/2)λ

So then the nth node =
λ_N = (2L)/n

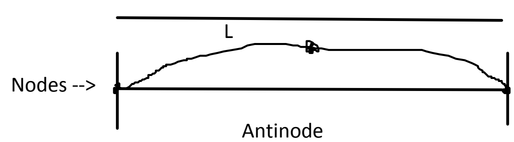
Where n is an integer

Overtones create timbre

Standing waves for different boundary conditions

1. Both ends are fixed/attached --> cannot move

Nodes: where nothing moves
Antinode: where difference is the greatest



Frequency!

= velocity/wavelength

One node = v/2L

So then F_n = n(v/2L)

Frequency of the second node is twice the first one
Third is three times the first one

Lowest possible frequency = first harmonic aka fundamental ferquency
Twice the frequency = second harmonic

Nth harmonic or (n-1)st overtone

When both ends can move: