Physics 20: Waves Cheat Sheet

by Diana D (dianadavis) via cheatography.com/134628/cs/27831/

Formulas

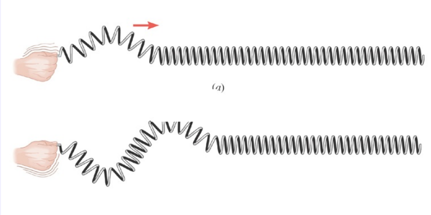
$l = v\Delta t$	Where l is the pulse length, v is the speed, and Δt is the time to create a complete pulse
$v = f\lambda$	Where v is the speed, f is the frequency in Hertz, and λ is the wavelength
$L = (1/2)\ \lambda$	Where L is the length of each node and λ is the wavelength

Bold formulae are not given on the Physics 20 formula sheet

Definitions

Wave	Travelling disturbance that carries energy
Electromagnetic Waves	Do not require a medium to travel (light)
Mechanical Waves	Require a medium to travel (air, water, string, etc.)
Transverse Waves	The particles in the medium vibrate (or are displaced) perpendicular to the direction of motion of the wave
Longitudinal Waves	The particles in the medium vibrate parallel to the direction of motion of the wave
Constructive Interference	When waves in the same phase overlap, their amplitudes add together
Destructive Interference	When waves of different phases overlap, their amplitudes cancel
Nodes	Points of complete destructive interference
Antinodes	Points of complete constructive interference, largest amplitude

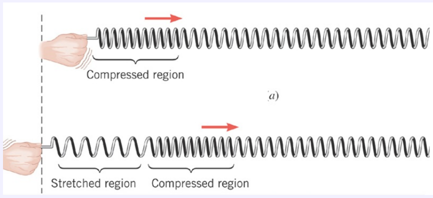
Transverse Waves



Along the pulse, energy is stored in both elastic potential and kinetic energy
- At max displacement, PE is at max and KE is zero
- At equilibrium, KE is at max

The greater the amplitude, the greater the energy of the wave

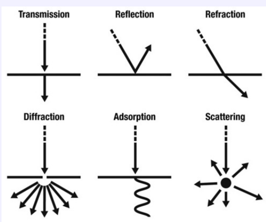
Longitudinal Waves



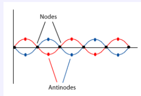
Examples of Wave Types

Wave Type	Example	Origin	Medium
Water Wave	Wake of boat	Boat moving	Water
Sound Wave	Stereo	Speaker vibrates	Air
Mechanical Wave	Bull whip	Arm whips	Leather
Seismic Wave	Earthquake	Shifting rock layers	Rock
Shock Wave	Atomic explosion	Nuclear fission	Air
Light Wave	Room light	Hot filament	None

Wave Behaviour



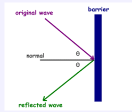
Standing Waves, Nodes & Antinodes



Standing Waves: when 2 wave trains with the same amplitude and wavelength move through each other, the resulting interfering pattern results in a standing wave, it appears to be standing still in a constance position
- The frequencies at which standing waves exist are the natural or fundamental resonant frequency

Nodes: points of complete destructive interference
Antinodes: points of complete constructive interference

Wave Behaviours: Reflection



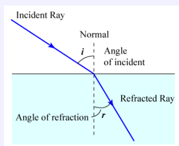
Reflection: straight waves "bounce" off a surface such that the outgoing angle (angle of reflection) or reflection wave equal the incoming angle (angle of incidence) or incident wave

Angles are measure from the normal line (line perpendicular to the surface)

Wave Train: a series of waves linked together in phase (moving with identical motion)

Wave fronts are reflected by a barrier

Wave Behaviours: Refraction



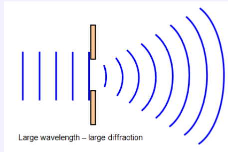
When a wave passes from one medium to another through a boundary, the waves bends and changes direction (and speed) at the interface

If the medium on the other side is 'thicker'

Reflection: When a wave reflects, it exhibits a phase change (crest -> trough or vice-v-ersa)
Refraction:
Diffraction:
Interference:

(n), then the wave will slow down and bend towards the normal line

Wave Behaviours: Diffraction



Diffraction: waves bend around a corner or opening

The amount of diffraction depends on the wavelength and the size of the opening

Waves lose amplitude, not speed or frequency

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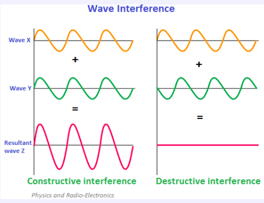
Wave Behaviours: Interference



Constructive: "in phase" waves produce larger amplitudes
Destructive: "out of phase" waves amplitudes cancel

Principle of Superposition: the two waves "-superimpose" and "interfere" with each other, creating a temporary waveform that is the sum of the two waves

Doppler Effect

$$f_o = f_s\left(\frac{V}{V - V_S}\right)$$

$$f_o = f_s\left(\frac{V}{V + V_S}\right)$$

Fo = observers frequency
Fs = emitted frequency
V = speed of sound
Vs = speed of object emitting sound

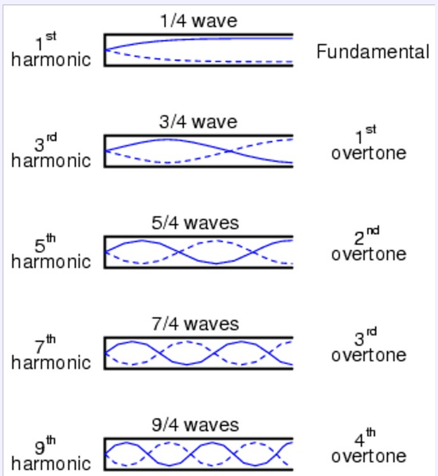
Subtract when the **source is moving towards the observer**
Add when the **source is moving away from the observer**

Doppler Effect Cont.

When the source is moving towards the observer with a velocity, the waves spread out in circles around the source, the frequency doesn't change but the waves crowd together, making the wavelength shorter.
When the source is moving away from the observer, the wavelength is lengthened and the detected frequency is lower

Stringed Resonator

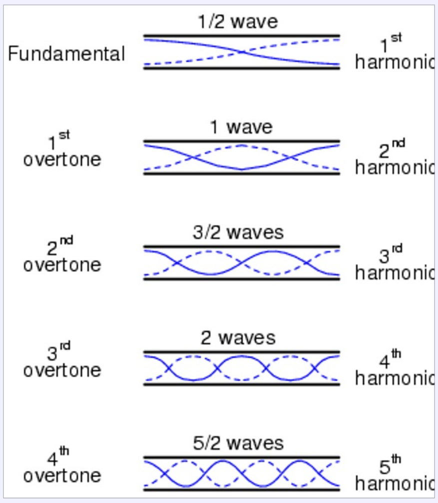
Closed-Pipe Resonator



Closed-Pipe Resonator: tube is closed at one end and open at another

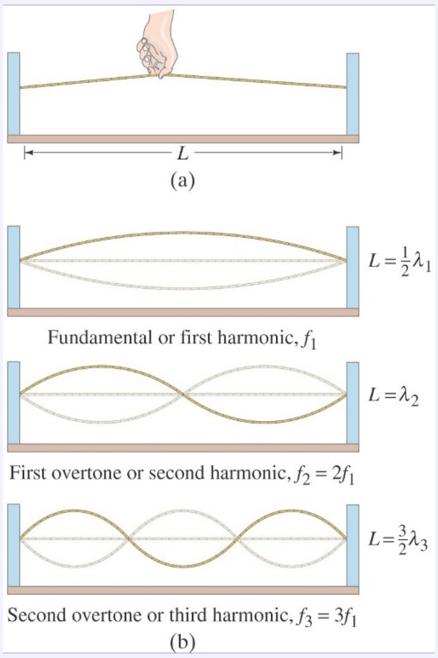
In a closed-tube, node at closed end and either node or antinode at open end.
IF antinode occurs at the open end, resonance occurs and the sound is amplified (louder).
IF a node occurs at the open end, resonance does not occur and almost no sound (hence only odd harmonics)

Open-Pipe Resonator



Open-Pipe Resonator: both ends of the tube are open

Musical Instruments & Resonance



Stringed Resonator: a resonating instrument that is fixed at both ends

Fundamental/1st Harmonic: the lowest frequency making up the sound
- Wave of frequencies that are whole number multiples of the fundamental are called harmonics (2nd, 3rd, 4th, etc)