Waves:

Particles oscillate & transfer energy between each other when they travel through a MEDIUM

E.g. dropping a twig in the ocean = ripples form (twig doesn't move so only energy is transferred)

Features of a wave:

Amplitude: max displacement from rest
Wavelength: distance from one wave to the next (trough to trough)
Frequency: waves passing through a point/sec (measured in Hz)

T = 1/f

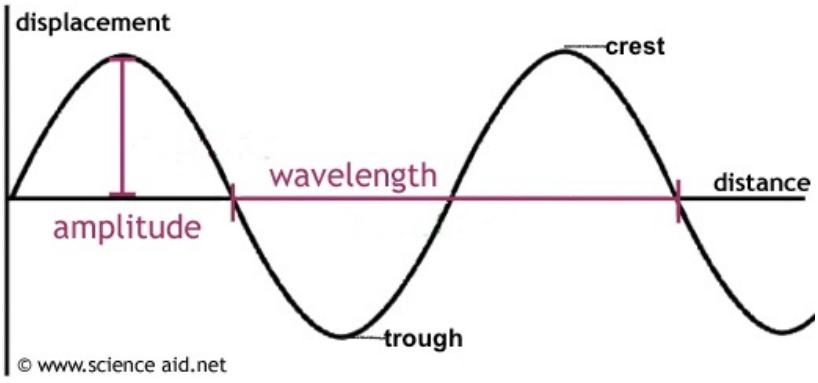
Time in seconds
Frequency in Hertz

Wave speed: rate of energy transfer

$$V = f \times \lambda$$

WAVE SPEED = FREQUENCY X WAVELENGTH
(m/s) (Hz) (m)

Wave speed in m/s
Frequency in Hertz
Wavelength in m

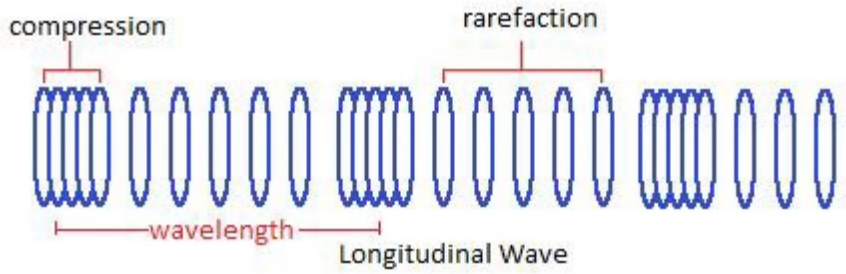


Transverse waves:

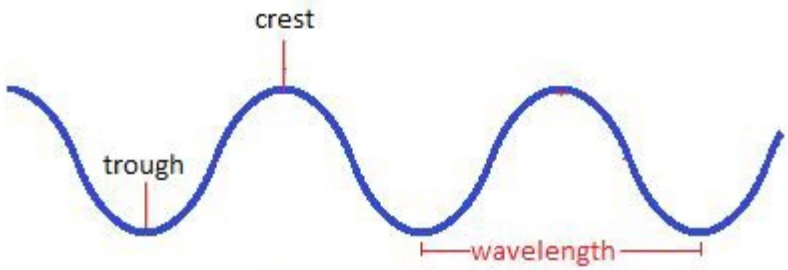
Oscillations are PERPENDICULAR to the direction of energy transfer
E.g. EM waves, ripples in water, a wave on a string

Longitudinal waves:

Oscillations are PARALLEL to the direction of energy transfer
E.g. sound waves & seismic waves



Longitudinal Wave



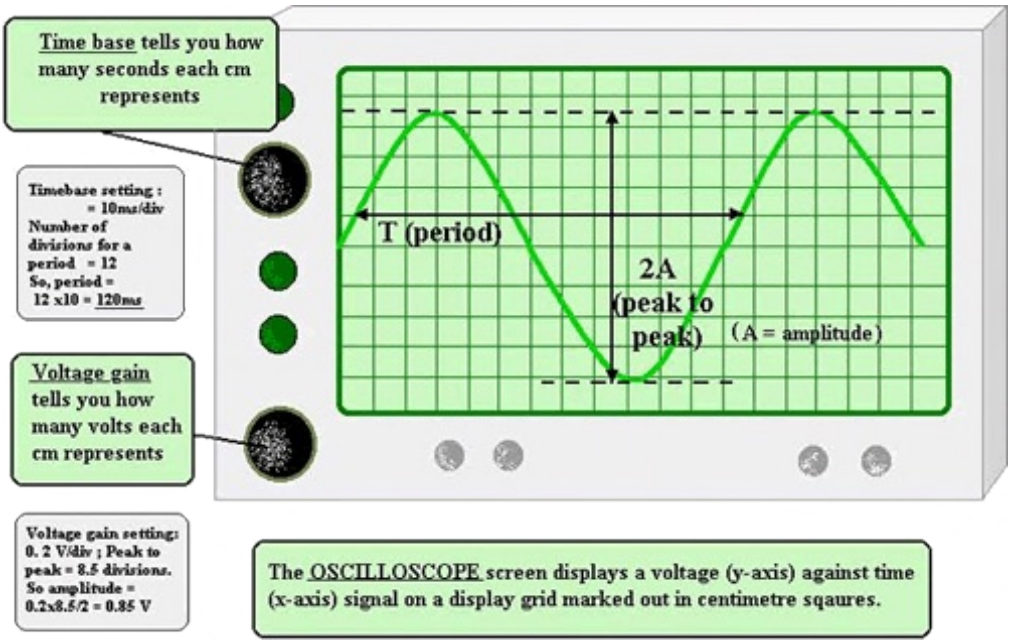
Transverse Wave

Oscilloscopes:

Measure speed of sound waves

Method:

1. Set up oscilloscope so detected waves are shown as separate waves
2. Put 2 microphones next to the speaker, slowly move 1 away until 2 waves on the display align & have moved 1 wavelength apart
3. Measure distance between the microphones = 1 wavelength
4. Use: wave speed = frequency x wavelength
5. Speed of sound in air = 330m/s approx



Reflection:

When waves arrive at a boundary between 2 materials they can be:

Absorbed: energy is transferred to the material's energy stores
Transmitted: waves travel through the material until they refract
Reflected in 2 ways: specular or diffuse

The normal = a dotted line perpendicular to the surface at the point of incidence (where the wave hits the boundary)

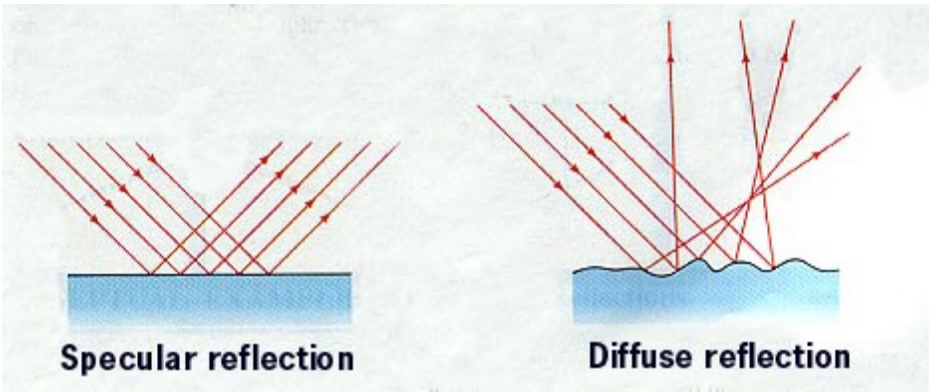
Angle of incidence = Angle of reflection

Incidence: angle between incoming wave & the normal
Reflection: angle between the reflected wave & the normal

Reflection types:

Specular: wave is reflected in 1 direction by a Smooth surface (Specular = Smooth!)
E.g. light reflected by a mirror

Diffuse: waves reflect in Different directions by a rough surface (Diffuse = Different directions!)
Because: the normal is different for each incoming ray (angle of incidence, thus angle of reflection is different for each ray)
Surface appears matte with no clear reflection of objects



Infrared radiation:

Emitted from the surface of an object continually
Hotter object = emits more IR
Cooler object = absorbs more IR (from warmer surroundings)

Constant temperature = object is emitting & absorbing the SAME amount of IR

Matte black surfaces absorb IR better than shiny white ones

Sound waves:

Caused by vibrating objects
Vibrations pass through mediums via compressions & refractions

Sound travels faster in solid objects (closely packed particles) so they vibrate

Sound cannot travel in space, as it's a vacuum (no particles move/vibrate)

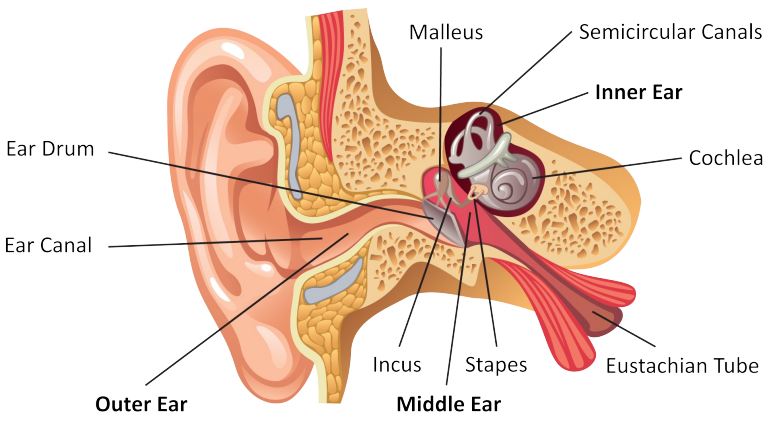
Sound waves reaching ears:

1. Sound waves reach the ear drum & it vibrates
2. Vibrations are passed to the ossicles through semicircular canals & to the cochlea
3. Cochlea turns vibrations into electrical signals the brain detects

Human hearing range: 20 Hz -> 20 kHz
Hearing is limited by: ear drum size & structure

Reflection of sound waves:
By hard, flat surfaces (echoes = reflected sound waves)

Refraction of sound waves:
Entering different media e.g. a denser material = wave speed increases (wave length decreases but frequency stays the same)



Ultrasound:

Electrical oscillations converted into mechanical vibrations (beyond 20,000 Hz) by electrical devices
At boundaries (between 2 media), waves reflected are detected

Ultrasound waves:

1. Wave passes through 2 media = wave is partially reflected off of the boundary, some is refracted too
2. Thus at boundaries, ultrasound is reflected back partially and this is detected
3. Time for wave to reach detector = measures distance of the boundary

Uses:

Pre-natal foetus scanning:

1. Wave is partially reflected & detected at the boundary between 2 media: the womb fluid & the foetus skin
2. Timing and distribution of echoes are processed and displayed = video image is produced

Industrial imaging:

1. Ultrasounds are usually reflected by the far side of the material
2. If there's a crack in an object, they are reflected sooner

Exploring structures using waves:

Studying properties & paths of waves is an indicator of the structure of things underground

Earthquakes:

Seismic waves are detected via seismometers
Seismic waves reach different media (materials) in the earth = some waves are absorbed, some are refracted
Curved paths are caused when waves are refracted (they change speed gradually)

P-waves vs S-waves:

P-waves: travel through earth's core, S- waves CANNOT

P-waves: longitudinal waves, faster, travel through solids & liquids
S-waves: transfer waves, slower, travel through gases & liquids (so we know inner core is solid as s-waves don't pass through it)