Pulses Waves & Sound
and
Electromagnetic Waves

Name : _____

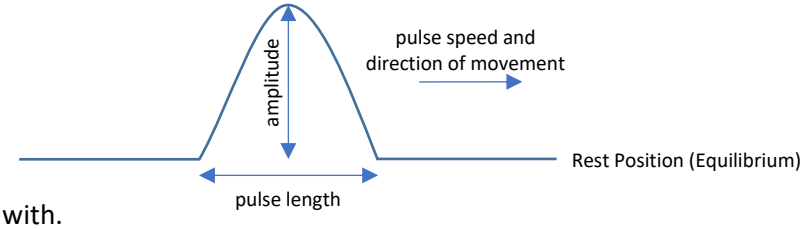
Cell:_____

PULSES, WAVES, SOUND EN ELECTROMACNETIC WAVES

Definitions

Word/Concept	Definition/Meaning
Pulse	A single distortion (knock, vibration, back and forth movement or oscillation), than moves from one point to another in though a medium.
Reflection	The return of a pulse in the same medium, in the opposite direction, after it have reached a fixed point.
Position of Rest	The default position of an undistorted wave.
Crest	A "*Positive pulse*"; the highest point of a wave; a pulse in one direction relative to the position of rest.
Trough	'n "*Negative pulse*"; the lowest point of a wavef; a pulse in the opposite direction relative to the position of rest.
Amplitude	The maximum displacement of a particle in a medium from the position of rest. Measured in in meter (m).
Superposition.	This is the algebraic sum of the amplitudes of individual pulses that meet
Interference	When two or more pulses in the same space at the same time interact
Destructive Interference	This is the superposition of two pulses to the opposite sides of the rest position (a crest and a trough)
Wave	A series of successive pulses (crests and troughs)
Wavelength	The distance between two *consecutive* points in a phase. Measured in meter (m).
Frequency	The number of wholes waves that moves past a fixed point, in one second. Measured in Hertz (Hz).
Period	The time it takes a wave to move past a point. Measured in seconds (s).
Speed	The distance traveled by a wave per unit of time. Measured in meter per second ($m \cdot s^{-1}$).
Transverse Wave	A wave of witch the particles of the medium moves *perpendicular* to the direction of the waves movement.
Longitudinal Wave	A wave of witch the particles of the medium moves *parallel to* the direction of the waves movement.
Compaction	Part of a longitudinal wave where the particles have moved closer to each other.
Dilution	Part of a longitudinal wave where the particles have moved further to each other (spreading).
Pitch	Auditory sensation of how high "or" low "a sound is.
Loudness	Auditory sensation of the intensity of a sound.
Electromagnetic Wave	A wave that is caused by the acceleration of electrical charges and that is propagated by the periodic variation of intensity of perpendicular electric and magnetic field.
Electromagnetic Spectrum	Continuum or arrangement of types of electromagnetic waves from low to high frequencies in one direction, and little to long wavelengths in the other.
Photon	'A particle that represents a quantum or other electromagnetic radiation.

Pulses and Waves



Medium

- Can be a solid, liquid or gas.
- Does NOT create the pulse/wave.
- Is NOT the wave.
- Only carries the pulse, ∴ doesn't move with.
- Partials has mechanical energy (E_m).

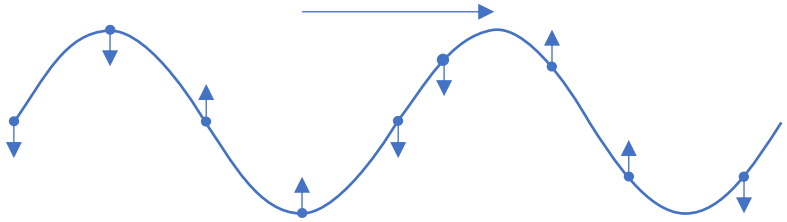
Pulse

- Produced by the source.
- Moves along in the medium.
- Has no frequency, ∵ a pulse that is only one distortion.

$$v = \frac{\Delta d}{\Delta t}$$

Movement of particles

- Particles move perpendicular to movement in a transverse pulse.
- Particles move parallel to the direction of propagation in a longitudinal pulse.
- To determine the detection of movement, simply look at the displacement (crest or trough) that is coming up. E.g.:



Superposition and Interference of a Pulse

Principal of Super positioning

When two pulses meet simultaneously, at the same point a medium; is the immediate displacement of interaction of the algebraic sum of the displacements of each pulse at that time.

Before interaction

- Pulses has their own form and amplitude.
- Independently moves towards each other.

During interaction

- Amplitudes build on one another (summation) or cancels out.
- Resultant pulse amplitude equals the sum of the independent amplitudes.

After interaction

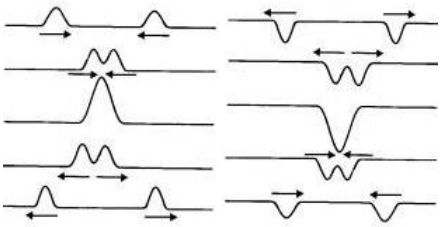
- Back to their own form and amplitude
- Pulses moves away from each other after interaction.

Interference

- The effect (result) of super positioning.

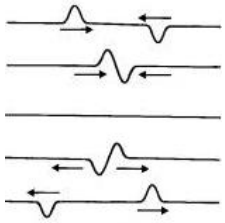
Constructive interference

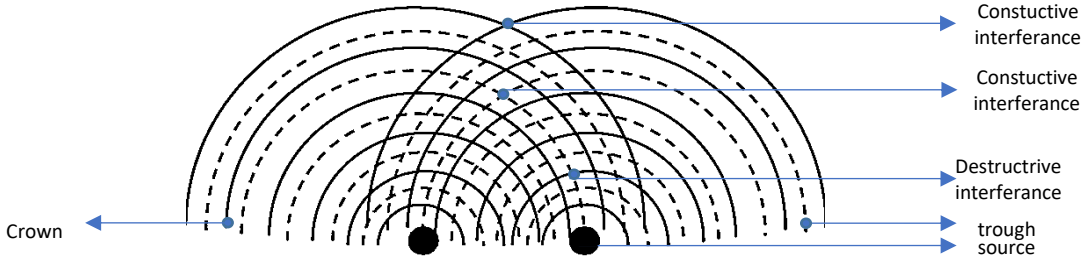
Building pulses during interaction to produce a larger pulse.



Destructive Interference

During interaction pulses breaks down, to more a smaller of eve no pulse at all.

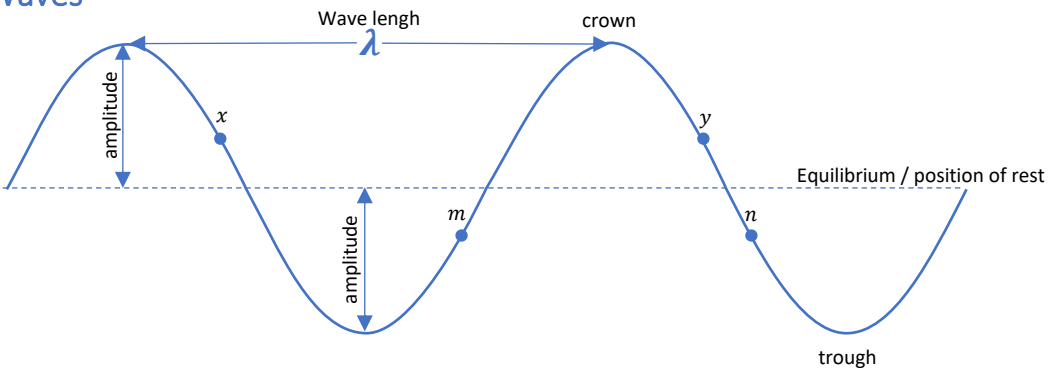




Waves

- Regular sequence of pulses.
- Way of energy transfer from one point to another.
- Types.
    - Transverse waves
        - To and fro
        - E.g.. Water waves, music strings, electromagnetic waves
    - Longitudinal waves
        - Back and forth
        - e.g.. Sound, pressure waves of explosions, earthquakes

Transversal Waves



Points in phase

- Points on different waves.
- Moves in the same direction, at the same speed.
- The same displacement from equilibrium.
- Any two crowns or two troughs are always in phase.
- Point $\boldsymbol{x}$ and point $\boldsymbol{y}$ is in phase.
- Point $\boldsymbol{m}$ and $\boldsymbol{n}$, and point $\boldsymbol{x}$ and $\boldsymbol{m}$ is not I phase (out phase).

Wavelength

- $\boldsymbol{\lambda}$ “lambda”.
- Two consecutive crests or two troughs is a wavelength.

Frequency

- $\boldsymbol{f}$
- Equal to the frequency of the generator that produces the waves.
- Inversely proportional to the period.

$$f = \frac{1}{T}$$

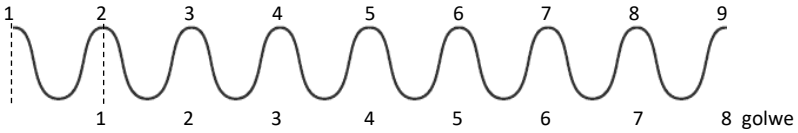
Period

- $\boldsymbol{T}$
- The reciprocal (inverse) of frequency.
- Inversely proportional to the frequency.

$$T = \frac{1}{f}$$

Number of crows and troughs

- 5 crowns = 5 - 1 waves = 4 waves



The wave equation

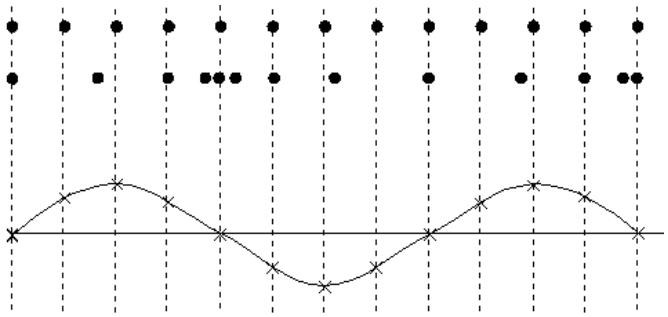
- The speed of the wave is how far (m) a wave travels in a specific time (s).
- Amount of wave lengths (λ) in meter per period (T) in seconds.

$$\therefore v = \frac{\lambda}{T} = \frac{1}{T} \cdot \lambda = f \cdot \lambda = f\lambda$$

$$v = f\lambda$$

Longitudinal Waves and Sound

- Pressure waves
- One wave length is:
  - The center of one compression to the center of the next, or
  - The center of one dilution to the center of the next.



Sound and hearing

Sound

- Created by vibration objects.
- Is longitudinal (pressure-) waves.
- Needs a medium to transfer energy, ∴ *cannot move through a vacuum* .
- The medium can be a solid, liquid or gas.
- The denser the medium (the closes the molecules/particles), The faster the wave moves. ∴ the wave will move faster in a solid than a gas.
  - The higher the temperature, the higher the speed of sound.
  - The higher the humidity, the higher the speed of sound.
- reflection
  - Sound waves can be reflected.
  - Softer material absorbs the waves energy, where harder materials absorbs less of the waves energy and thus the waves energy is reflected better.
- Echoes
  - The reelection of sound on such a way that the that the original waves is heard on different times.
  - Ensamples where echoes play a role:
    - Acoustic of halls and theatres.
    - Stereoscopes and megaphones
    - Sonar

    - Geophysical Prospecting
    - Ultrasonic sound
- Interference of sound
    - Constructive interference make sound louder.
    - Destructive interference make sound softer.

$$E = hf$$
$$\text{with } h = 6,63\times10^{-34}$$

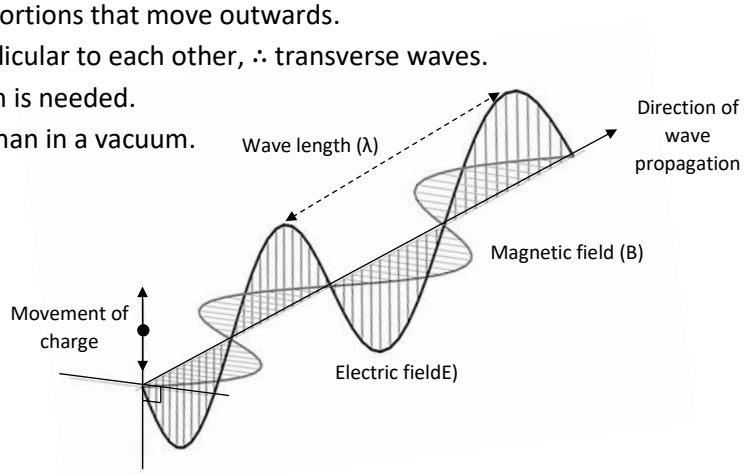
Hearing

- Frequency = pitch. Higher frequency = higher pitch
    - Humans can only hear sound between 30 – 20 000 Hz.
- Amplitude = loudness/intensity (dB). Greater amplitude = louder sound.
- Regular wave form = purer sound (better sound quality), while irregular wave form = noise.

Electromagnetic waves

- A changing magnetic field can induce(produce) a current in a conductor.
- Current (changing electric field) in a conductor, creates a magnetic field around the conducter.
- It is formed when electrical charges, e.g. an electron, is oscillating fast.
    - Position and velocity of charges changes continuously, changes the electric and magnetic field that is generated by the charge.
- Changes fields causes electromagnetic distortions that move outwards.
- Electric field and magnetic field is perpendicular to each other, ∴ transverse waves.
- *Can move through a vacuum,* ∴ no medium is needed.
- *Can move through a medium*, but slower than in a vacuum.
- Transfers energy.
- Moves at $\mathbf{3 \times 10^8}$ **m·s**$^{-1}$ (c)

$$c = f\lambda$$



Dual Nature of Electro Magnetic Waves

EM waves shows properties of waves and particles.

Wave model

undergo EM radiation:

- **Diffraction**, the spreading / bending of waves around an obstacle or through an opening.
- **interference**, when waves undergoes super positioning.
- **Polarization**, extinction of waves by cause of the wave only vibration to a certain level. Only travers waves can be polarized, ∴ EM radiation is a *transversal wave* movement.

Particle mode

- **Photo electric effect**, UV light causes electrons to emit from some metals.

Energy

Energy is emitted as separate “packets” of energy namely ‘quanta’ .

- Quantization means that a quantity of a specific amount, a quantum, exist that are not divisible.
- Light quanta is known as *photons* (particle model).
- Every quata has a spesific amout of energy (**E**), that is directly proportional to the frequency of radiation. $\therefore E \propto f$

- $\boldsymbol{h}$ is an universal , *Planck's constant* .
- But, $c = f\lambda \ \therefore f = \frac{c}{\lambda}$, so $\boldsymbol{E = h\frac{c}{\lambda}}$. $\therefore$ E indirectly proportional to λ.

Electromagnetic Spectrum

$$\boldsymbol{E = h\frac{c}{\lambda}}$$

Gamma-rays(γ-rays)

- High penetration ability
- Causes ionization
- Lots of energy
- Harmful

X-rays

- Wave length = diameter of atom
- Relatively high penetration ability
- Causes ionization
- Absorbed by denser material

Ultraviolet (UV) rays

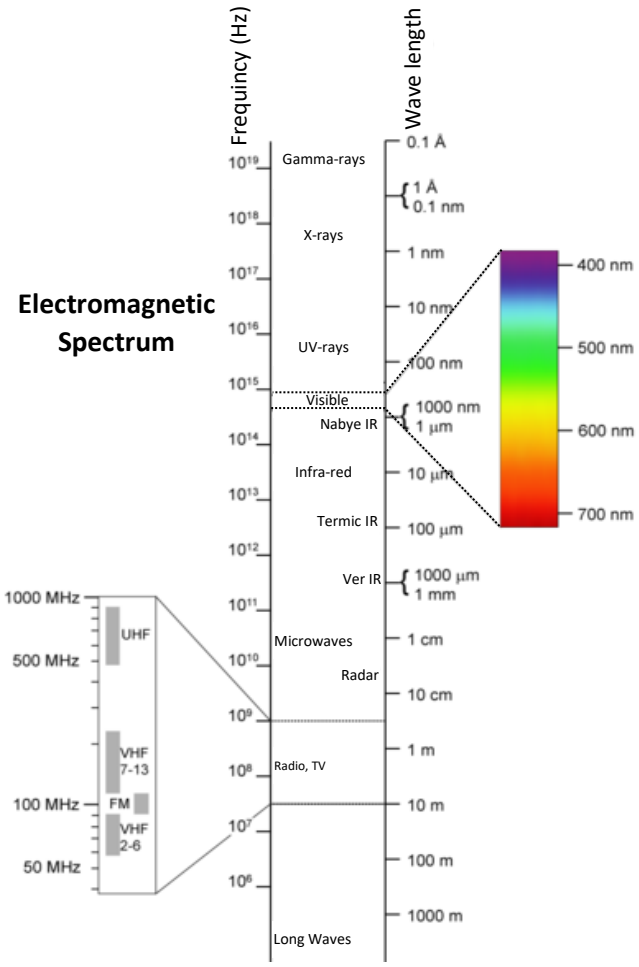
- From the sun
- Most is absorbed by the ozone layer
- Harmful (skin deceases, cancer)

Visible light

- Wave lengths of 0.4–0.7 µm
- Emitted by the sun
- Is not noticeably absorbed by the atmosphere

Infra-red

- Wave length of 0.7 µm – 1 mm
- Not visible
- Absorption of IR causes an increase in temperature.
- Radiation causes a heat sensation
- Causes global warming



Micro waves

- Used for FM, TV, cellphone communication as well as radar.
- From a few millimeters to a few meters.
- Does not bend easily around/over hills and buildings. Antennas is mounted high to maintain line of sight.

Radio waves

- Long radio waves– breaks around hills.
- Short radio Waves – reflects against electrical charged, top layers of the atmosphere. The change in layers has an effect on the reception of the waves.