Physics M2 Summary

Wave Behaviour

Wave :

- is a disturbance that carries energy through matter or space without transferring energy.

Types of waves :

1. **Transverse Waves** : Oscillations are perpendicular to wave direction; energy moves sideways.
- Examples: Light waves, water waves, seismic S-waves.

2. **Longitudinal Waves** : Oscillations are parallel to wave direction; energy compresses and rarefies.
- Examples: Sound waves, seismic P-waves, pressure waves in fluids.

Principle of Superstition :

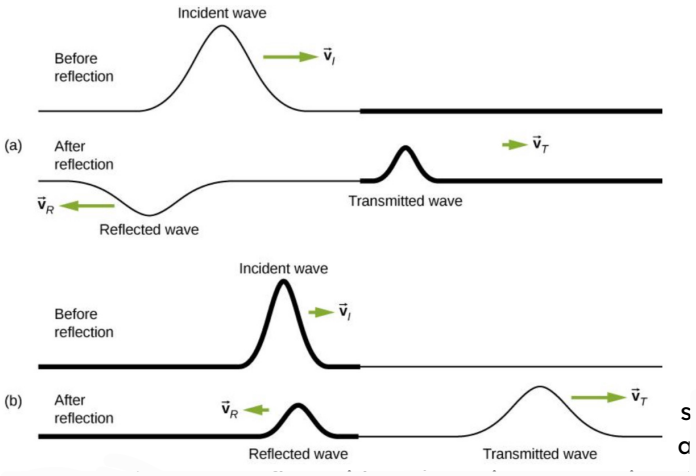
- It states that when 2 or more waves meet at a point, the resultant displacement at that point is equal to the sum of displacement of the individual waves at that point.

- You can think of these 2 waves as being fixed values that will have a displacement if you added both values. (can be positive and negative numbers)

Wave Behaviours :

1. **Reflection :** is the bouncing back of light, sound, or other waves when they hit a surface.
2. **Diffraction :** is the bending and spreading of waves(light or sound), as they pass around obstacles or through openings.
3. **Refraction :** is the bending of light rays as they pass from one medium to another.

- **Incident Wave** : the wave that strikes a boundary or surface; the initial wave.
- **Reflected Wave** : the wave that bounces back after hitting a surface.
- **Transmitted Wave** : the wave that passes through a boundary into a new medium.



Pulses at different ends :

No Boundary : Waves continue indefinitely, maintaining shape and energy.
Fixed End : Waves are reflected & inverted, maintaining amplitude but reversing phase.
Loose End : Waves reflect without inversion, preserving phase and amplitude.

Physics M2 Summary

Wave Behaviour (Interference)

- **Interference** (in waves) occurs when two or more waves meet and combine, resulting in a new wave pattern.

Constructive Interference :

- It is a phenomenon that occurs when 2 or more waves overlap in such a way that their amplitudes combine to produce a wave of greater amplitude.

Destructive Interference : *crest & trough and vice versa

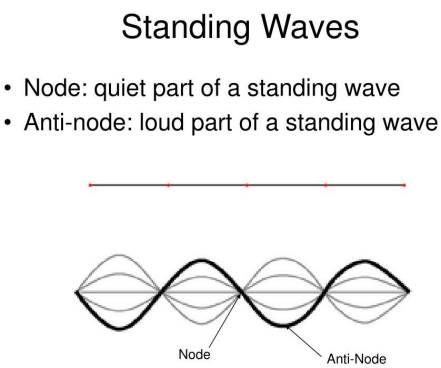
- It is a phenomenon that occurs when 2 or more waves overlap in such a way that their amplitudes combine to produce a wave of lesser amplitude, or even cancel each other out completely.

Standing Wave : *points which are "nodes" and "antinodes"

- It's a wave that appears to be ***stationary***, resulting from interference of 2 waves traveling in opposite directions.
- wave that oscillates in time but does not move in space, with nodes and antinodes at fixed points.

Phase waves : *just to know

- **In-phase** : is when crest is falling on crest and vice versa.
- **Out-of-phase** : is when crest is falling on trough and vice versa.



Physics M2 Summary

Sound

Sound level : *indicates loudness or softness of audio

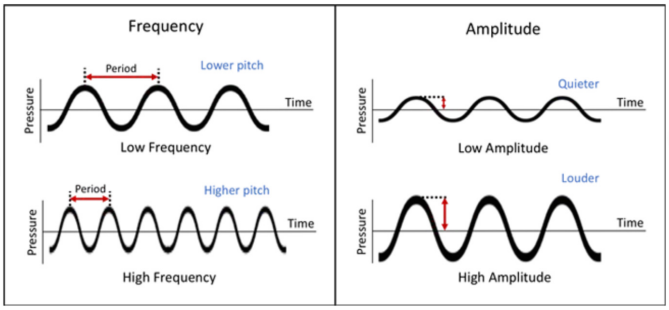
- It is a measure of the intensity of sound, usually expressed in decibels (dB).
- It quantifies how loud a sound is perceived by the human ear compared to a reference level.

How sound is perceived :

- Sound is perceived through a complex process involving the ***generation***, ***transmission***, and ***interpretation*** of sound waves by the human auditory system

In sound waves :

- **Loudness** : intensity of sound; influenced by amplitude.
- **Pitch** : frequency of sound; determining high or low tone.
- **Decibel** (dB): a unit that measures sound strength..

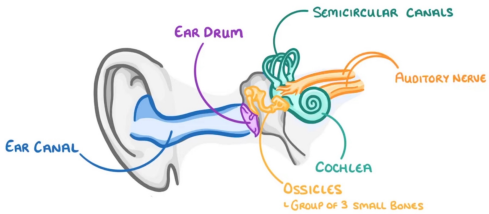


Explain how the human ear hears and interprets sound :

1. Outer Ear (Captures Sound)

- **Pinna (Auricle):** Funnels sound waves into the ear canal.
- **Ear Canal:** Directs sound waves toward the eardrum.
- **Eardrum (Tympanic Membrane):** Vibrates when sound waves hit it, converting air vibrations into mechanical vibrations.

2. Middle Ear (Amplifies Sound)



- **Ossicles (Tiny Bones):**
  - **Malleus (Hammer)**
  - **Incus (Anvil)**
  - **Stapes (Stirrup)**

  These bones amplify and transmit vibrations from the eardrum to the inner ear.
- **Eustachian Tube:** Balances pressure between the middle ear and throat.

3. Inner Ear (Converts Vibrations to Nerve Signals)

- **Cochlea:** Spiral-shaped, fluid-filled structure where vibrations cause tiny hair cells (cilia) to move, generating electrical signals.
- **Auditory Nerve (Cochlear Nerve):** Transmits signals from the cochlea to the brain for processing.

4. Brain (Processes Sound)

- The **auditory cortex** in the brain interprets these signals, allowing us to recognize sounds, speech, and direction.

Physics M2 Summary

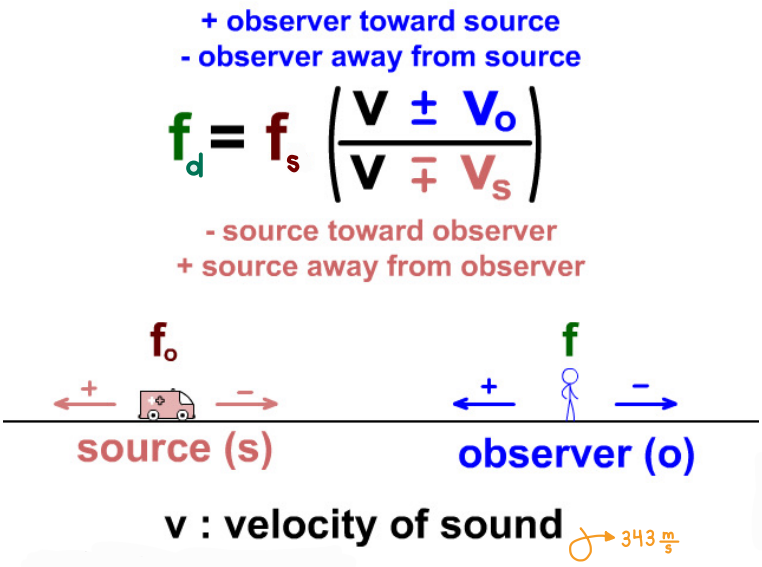
Doppler's Effect

Doppler's Effect :

- The change in frequency of sound caused by the movement of either the source, the detector or both.

- When a (wavelength) becomes shorter, frequency increases (vice versa).
- When a source moves towards the observer, (wavelength) becomes shorter (vice versa).

Formula :



Challenge : A dolphin is swimming toward a stationary fish at a speed of **8.50 m/s**. It emits a **4.00 MHz** ultrasound wave. What frequency does the fish detect? Assume the speed of sound in water at that depth is **1500 m/s**.

Physics M2 Summary

The Physics of Music

Vibrating Surfaces :

- These are physical surfaces that undergo oscillatory motion, (moving back & forth or up & down) around an equilibrium position.

- This motion is caused by various factors , inducing mechanical forces, sound waves, or external energy inputs.

- **Examples** : Gongs, Cymbals, Drums, Guitar strings, & piano str(ing)?.

1. **Resonance** : it is a phenomenon that occurs when the matching vibrations of another object increase the amplitude of an object's oscillations.

- when amplitudes(vibrations) collide, causing an increase in amplitude → constructive interference.
- Resulting in the breaking of the object by waves

2. **Fundamental frequency** : It is the lowest (f) of oscillation in a periodic waveform or system.

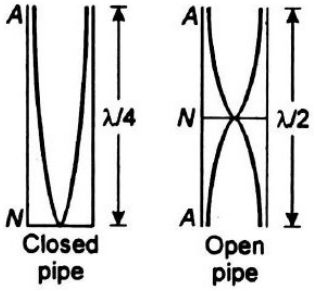
3. **Harmonics** : These are specific frequencies that are integer multiples of a fundamental (f) in a periodic wave or oscillation.

2 Types of Resonators :

1. **Open Pipe Resonator** : *resulting in "Low-pressure reflection"
   - It is a resonating tube with both ends open that will resonate with a sound source.

2. **Closed Pipe Resonator** : *resulting in "High-pressure reflection"
   - A resonating tube with one end closed to air.

- When they enter, they enter at high pressure.



- You'll be asked to draw or identify them in the exam

Open Pipe	Closed Pipe
Nodes at the center; antipodes at the end	Nodes at the end; antinodes at the center.

Physics M2 Summary

Closed Pipe Resonance :

- It is a phenomenon that occurs in a closed or stopped pipe, where standing wave/s are formed due to the reflection of sound waves.

Formula :

Open End	**Closed End**
$f = n * (v/2L)$ f : *frequency (Hz)* n : *number of harmonics* L : *length of the pipe (m),*	$f = n * (v/4L)$ f : *frequency (Hz)* n : *number of harmonics* *(in odd multiples)* L : *length of the pipe (m)*

Physics M2 Summary

Electromagnetic Induction

Electromotive Force (EMF) : *unit: volts (V)

- it's the electrical potential generated by a source that causes current to flow.
- EMF represents the potential difference that drives electrical current through a circuit.

Electromagnetic Induction : *EMF production

- It's the production of electromotive force (**EMF**) across an electrical conductor in a changing magnetic field.
- **Changing the magnetic field generates EMF**, which then produces the current needed in a circuit.
- **If the magnet moves but does not cause a change in the magnetic field within the ammeter**, no current will be generated.
- **Since no external voltage is applied, the current is measured using an ammeter**, which detects the induced current due to electromagnetic induction.

Formula/s :

$$EMF = BLv\,(\sin\theta)$$

Where:
$EMF - induced\ EMF; volts\ (V)$
$B - strength\ of\ the\ magnetic\ field; Tesla\ (T)$
$L - length\ of\ the\ wire; meter\ (m)$
$v - velocity\ of\ the\ wire; \frac{m}{s}$

Note: No EMF is induced in a length of wire that moves parallel to a magnetic field because $\sin 0^{\circ} = 0$.

Parallel = 0° ; Perpendicular = 90°

$$I = \frac{EMF}{R}$$

Where:
$I - current; Ampere\ (Amps)$
$EMF - induced\ EMF; volts\ (V)$
$R - resistance; ohms\ (\Omega)$

Physics M2 Summary

Electric Current & Potential Difference

- **RMS** : Root Mean Square

Effective Current : (RMS current)

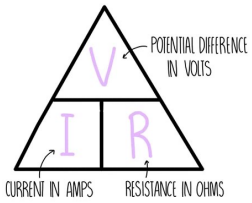
- It is the value of the direct current that would produce the same heating effect in a resistor as the alternating current does over one complete cycle.
- Denoted by : I_{eff}

Effective Potential Difference : (RMS voltage)

- It is the actual voltage available ta do work in a circuit, accounting for any voltage drops across components.
- Denoted by : V_{eff}

Formula/s :

$$I_{eff} = \left(\frac{\sqrt{2}}{2}\right) I_{max} \qquad V_{eff} = \left(\frac{\sqrt{2}}{2}\right) V_{max}$$



Electric Motor and Electrical Generator :

Feature	Electric Motor	Generator
Function	Converts electrical to mechanical energy	Converts mechanical to electrical energy
Energy Conversion	Electromagnetism	Electromagnetic induction
Input	Electrical energy	Mechanical energy
Output	Mechanical energy	Electrical energy
Applications	Fans, pumps, electric vehicles	Power plants, portable generators

- Increasing the frequency of an electric generator can be accomplished mainly by increasing the rotational speed, modifying the number of poles, or using electronic controls.

Physics M2 Summary

Application of Induced Current

Lenz's Law : *what causes the production of EMF

- It's states that the direction of an induced electromotive force(EMF) and the resulting current in a *closed loop* is such that it opposes the change in magnetic flux that produced it.

- **Magnetic flux** : the flow of a magnetic field through a surface.

- The current will oppose the poles(*NS*), which'll make the permanent magnet attract to the magnet itself.

- If the loop is *apen*, there will be no influence of Lenz's law; because current will not be transferred around (ex)the coil.

Transformer :

- It is an electrical device used to transfer electrical energy between two or more circuits through electromagnetic induction.

Types of Transformer/s :

- A **step-up transformer** increases the voltage from the primary coil to the secondary coil.

- A **step-down transformer** decreases the voltage from the primary cail to secondary coil.

Formula/s :

$$\frac{I_s}{I_p} = \frac{V_p}{V_s} = \frac{N_p}{N_s}$$

p = primary coil
s = secondary coil