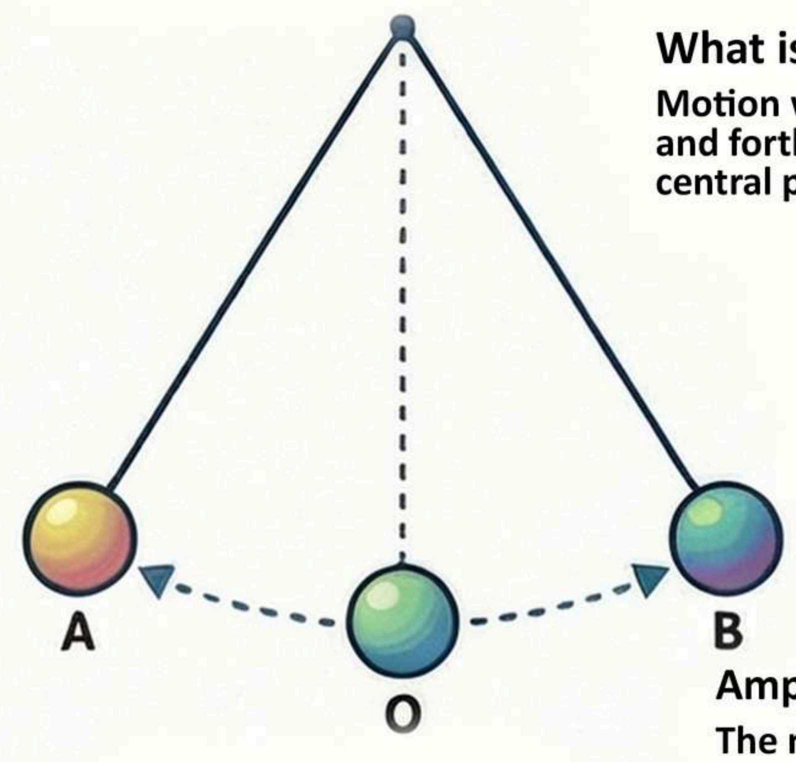
Excellency
The Experience

Subject Expo

Sound and Waves

1. The Basics of Oscillation (To-and-Fro Motion)



What is Occillation?
Motion where an object moves back and forth repeatedly around a central position (like a swing)

What is One Complete Gacillation?
Starting from center 0, moving to A, then to B, and returning to O

Amplitude (a):
The maximum distance the object moves to one side from its central position. Its SI unit is the meter (m).

Everyday Examples
Motion of a playground swing, Pendulum of a grandfether clock.

2. How We Measure Oscillation

Period (T):
The fime it takes to complete one full oxillation. SI unit is the second (s).

Frequency (f):
The number of oscillations that happen in one second. 51 unit: Hertz (H1).

The Link Between Period and Frequency:
They are inversely related.

$$\text{Frequency (f)} = \frac{L}{\text{Period (T)}}$$

As one goes up, the other goes down.

Length and Frequency:
For a pendulum, when length increases, frequency decreases (swings slower)

3. Vibrations: Natural, Forced, and Resonance

Natural Frequency:
The specific frequency at which an object will vibrate if disturbed and Vibratent

Forced Vibration:
When an external vibrating object forces another to vibrate. (e.g., A ronning mixer making a table vibrate)

Resonance:
When external forced frequency exactly matches the object's natural frequency, causing maximum maximum wiunction causing the object to vibrate with the maximum possible amplitude (maximum energy).

Resonance in Action:
Pushing a swing at the right moment (matching its natural frequency) makes it go higher.

4. Understanding Wave Motion

What is a Wave?
Transfer of energy through a medium by vibrations, without medium particles moving from their place

Two Main Types Of Waves

Mechinical Waves:
Need a medium to travel,
Examples:
- Sound Waves
- Selsmic (earthquake) waves.

Electromagnetic Waves:
Do not nedd a medium to travel.
Examples:
- Radio Waves
- Light

5. Longitudinal vs Transverse Waves

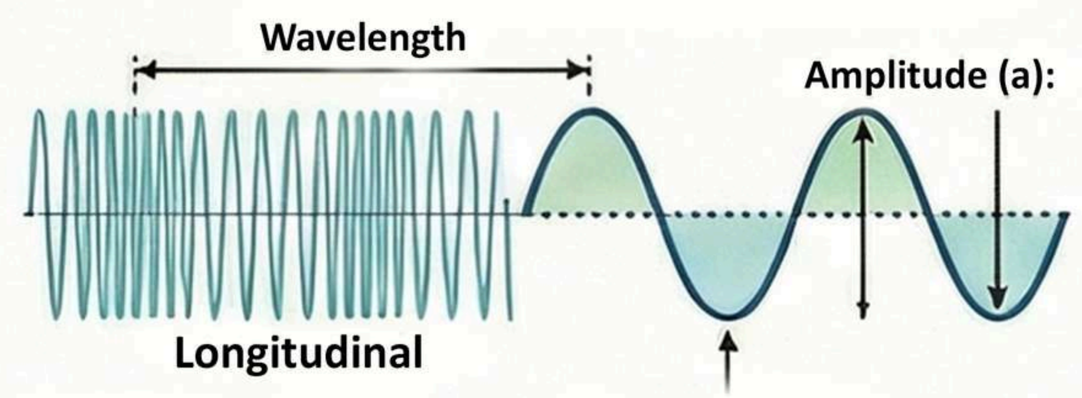
Longitudinal Waves:
Particles of the medium vibrate parallel to wave direction (eg., pushing a slinky).

Features:
Compressions (particles close, high (precture) & Rarefactions particles spread, low pressure) Sound is a longitudinal wave.

LTransverse Waves:
Particles of the medium vibrate perpendicular to wave direction (eg., shaking a rope).

Features:
Creats (Righest points) & Trought lowest pointt) Light is a transverse wave.

6. Key Characteristics of a Wave



Wavelength (λ):
Distance of one complete wave cycle. For transverse, distance between two conces or troughs. Unit: meter (m).

Amplitude (A):
Maximum height of a crest or depth of a trough from the central equilibrium position. Shows wave intensity/energy

Wave Speed Equation:
Speed (v) = Frequency (t) x Wavelength (λ).

7. The Behavior of Sound Waves

Reflection of Sound:
Sound waves hit a surface and bounce off (like light in a mirror). Smooth surfaces reflect best.

Echo:
Reffacted sound heard clearly after the original sound stops.

The Rule for Hearing an Eche:
Reflecting surface must be at least 27.5m away from sound source.

Reverberation;
Booming/prolonged sound in a large empty fiall caused by multiple reflections.

8. The Range of Hearing & Ultrasonics

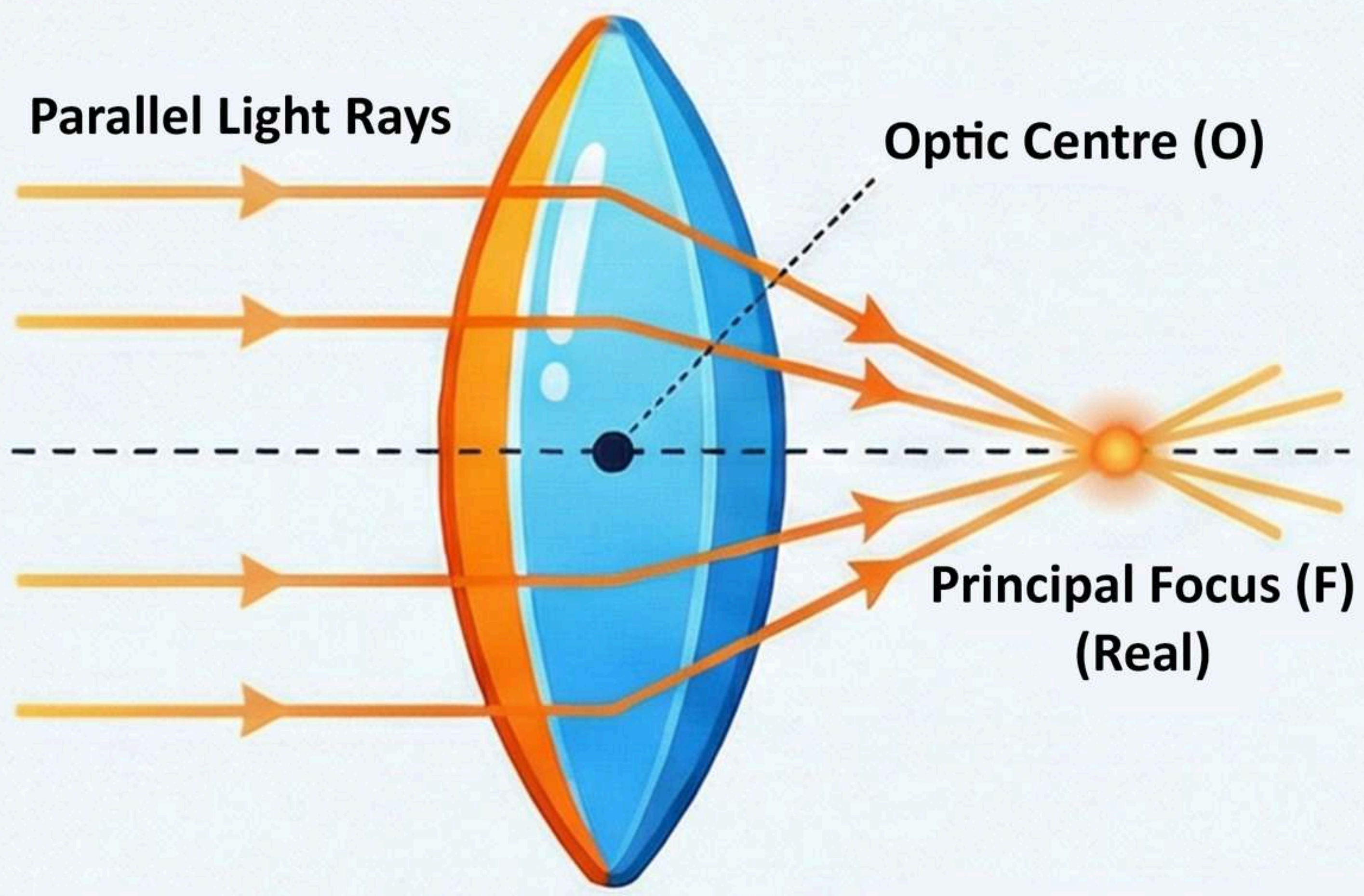
Human Hearing Range:
Normal hearing can hear wiunds between 20 Hz and 20,000 Hz (30 kHz).

Sounds We Can't Hear:
Infrasonic: Below 20 Hz (e.g., earthquake waves).
Ultrasonic: Above 20,000 Hz (used by bats and in medical scans).

Uses of Ultrasonic Waves:
Medicine (ultrasound scans, breaking kidney stones)
Technology (SONAB to map sea floer)
Cleaning delicate parts.

Lenses

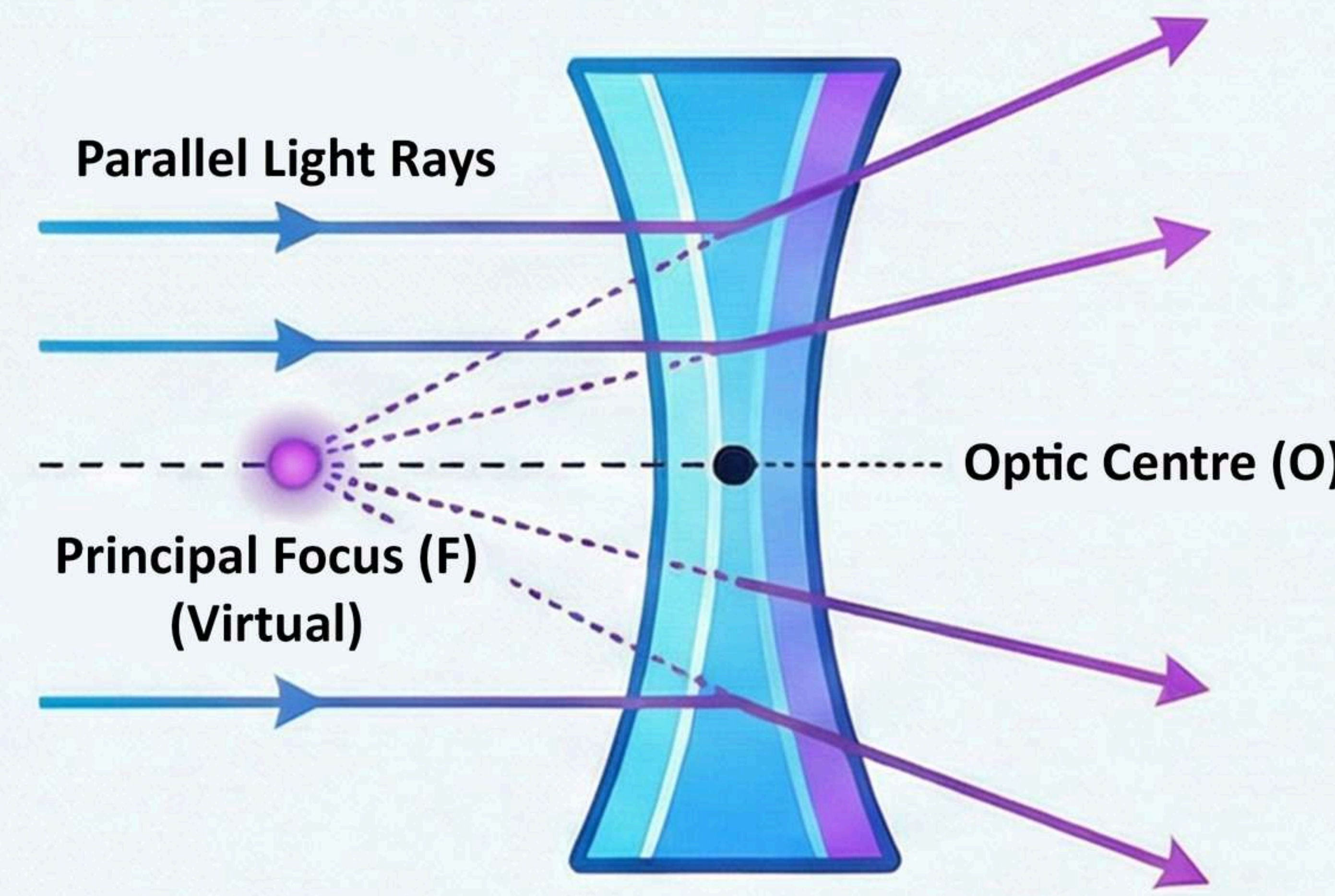
Understanding Convex and Concave lenses, Image Formation, and Essential Physics Formulas.



Convex Lens (Converging Lens): Thicker in the middle, brings parallel light rays together at a single point (Real Focus). Focal Length (f) is Positive (+).

Important Terms to Know

- **Optic Centre (O) :** The exact midpoint; light passes straight without bending.
- **Principal Focus (F) :** Point where parallel rays meet (convex) or appear to come from (concave)
- **Focal Length (f) :** The distance between Optic Centre (O) and Principal Focus (F).
- **Real Image :** Can be projected onto a screen; always inverted.
- **Virtual Image :** Cannot be projected, only seen through the lens; always erect.



Concave Lens (Diverging Lene): Thinner in the middle, spreads parallel light rays out (Virtual Focus). Focal Length (f) is Negative (-).

Image Formation by a Convex Lens

Usually forms REAL and INVERTED images.

	Object Position	Image Position	Image Characteristics
	Far away (Beyond 2F)	Between F and 2F	Real, Inverted, Diminished
	At 2F	At 2F	Real, Inverted, Same size
	Between F and 2F	Beyond 2F	Real, Inverted, Magnified
	At F	At infinity	Real, Inverted, Highly Magnified
	Between F and Optic centre (O)	Same side as object	Virtual, Erect, Magnified (Special Case: Magnifying Glass)

Image Formation by a Concave Lens

ALWAYS forms VIRTUAL, ERECT, and DIMINISHED images.

No matter where you place the object, the image is always formed between the optic centre (O) and the principal focus (F), on the same side as the object.

Formulas for Your Exam

The Lens Equation

$$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$$

(f=focal length, v=image distance, u=object distance)

Magnification (m)

$$m = \frac{\text{Height of Image}}{\text{Height of Object}} = \frac{v}{u}$$

(Negative m: Real & Invereted, Positive m: Virtual & Erect)

Power of a Lens (P)

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

(f must be in meters) Unit: Dioptre (D).

Physics of Light and Colour

HOW LIGHT SPLITS (DISPERSION)

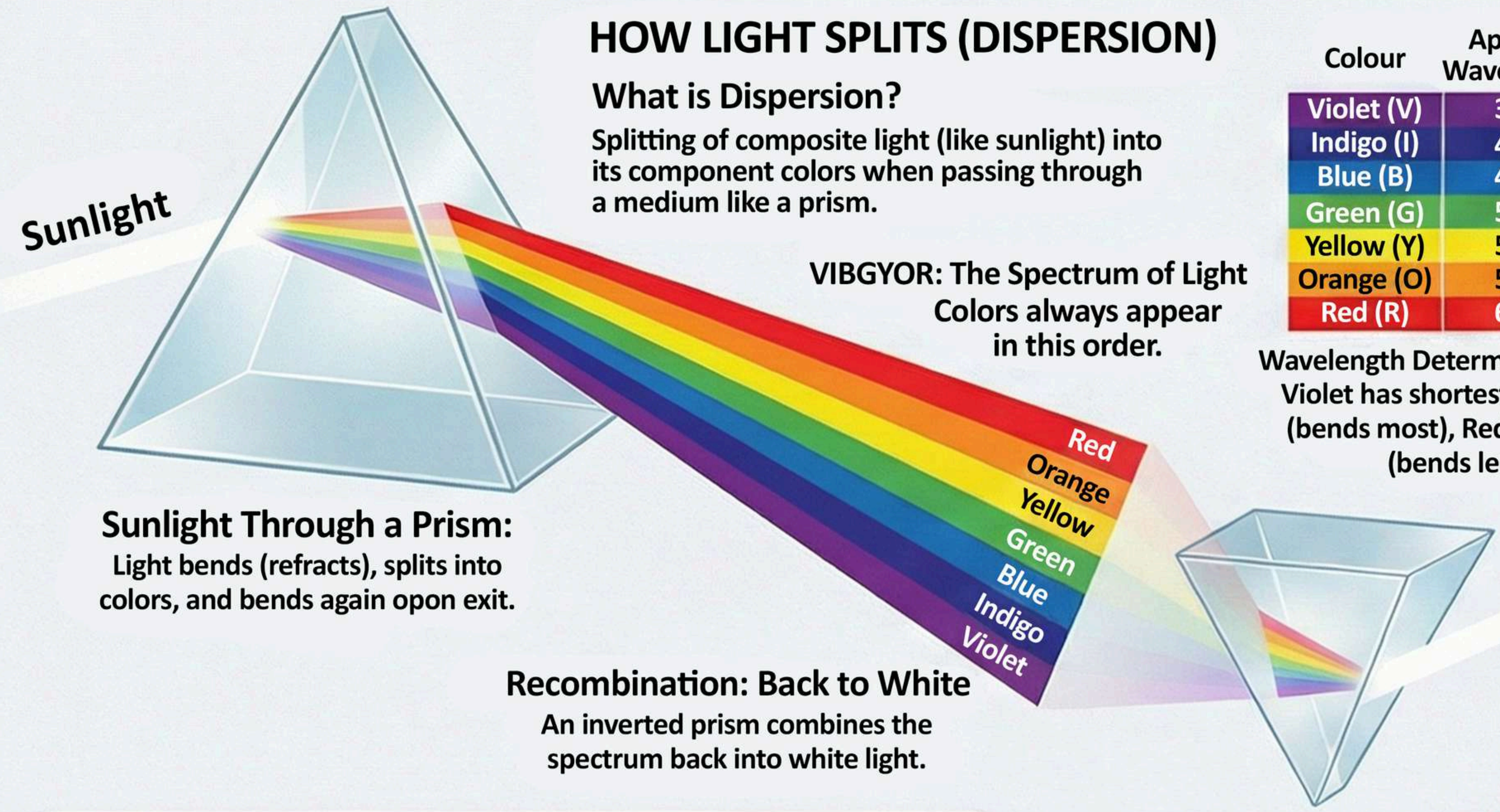
What is Dispersion?

Splitting of composite light (like sunlight) into its component colors when passing through a medium like a prism.

Colour	Approximate Wavelength (nm)
Violet (V)	350-440
Indigo (I)	440-450
Blue (B)	460-500
Green (G)	500-570
Yellow (Y)	570-600
Orange (O)	590-650
Red (R)	650-750

Wavelength Determines the Bend: Violet has shortest wavelength (bends most), Red has longest (bends least).

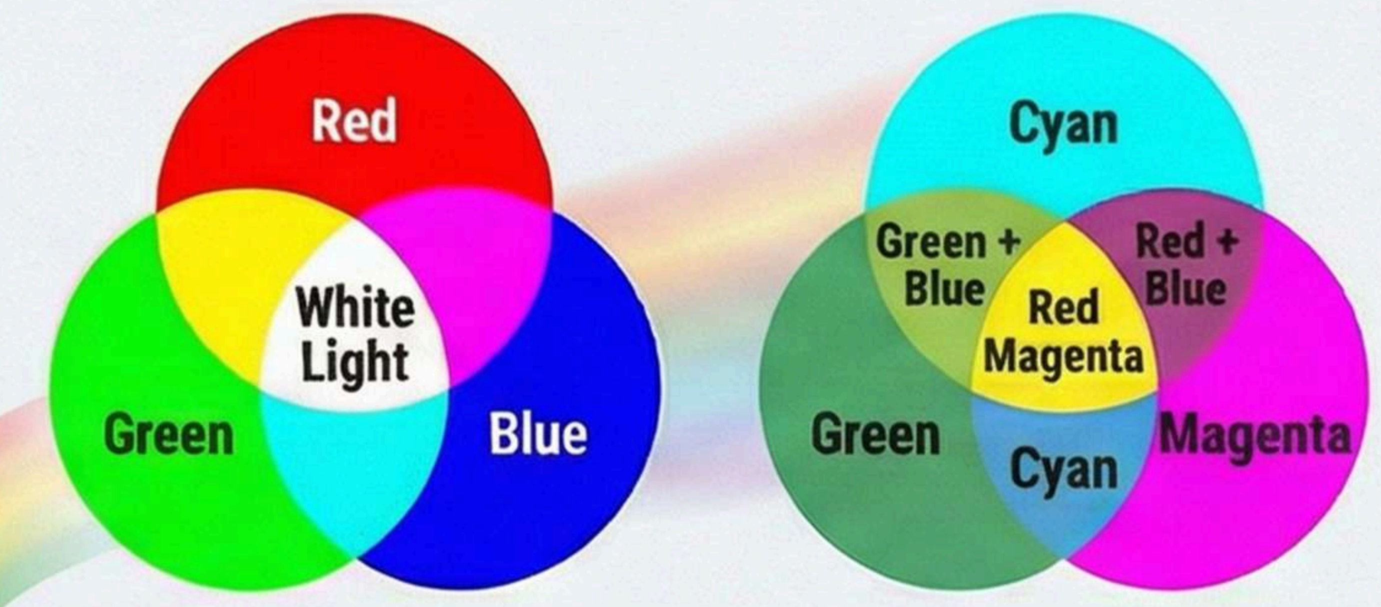
VIBGYOR: The Spectrum of Light
Colors always appear in this order.



Sunlight Through a Prism:
Light bends (refracts), splits into colors, and bends again opon exit.

Recombination: Back to White
An inverted prism combines the spectrum back into white light.

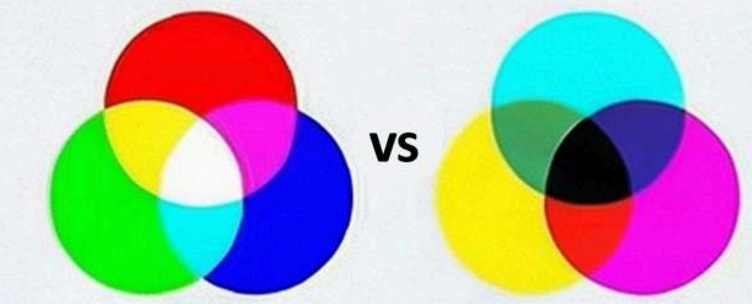
THE SCIENCE OF COLOR



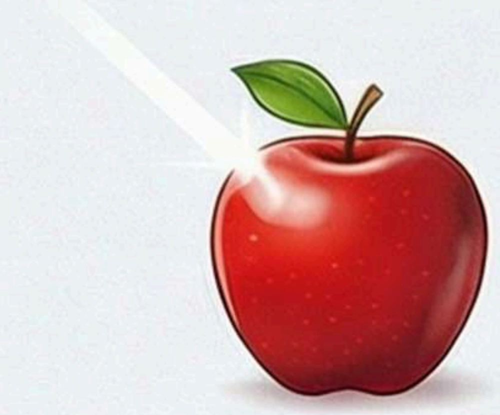
Primary Colors of LIGHT: Red, Green, Blue (RGB)
These mix to create all other colors.
Red + Green + Blue = White Light.

Secondary Colors of LIGHT: Cyan, Magenta, Yellow
Red + Green = Yellow
Green + Blue = Cyan
Red +Blue = Magenta

Colors of Light vs. Colors of Dyes (Pigments)



Light: RGB (Primary Colors)
Dyes/Paints: CMY (Secondary Colors)

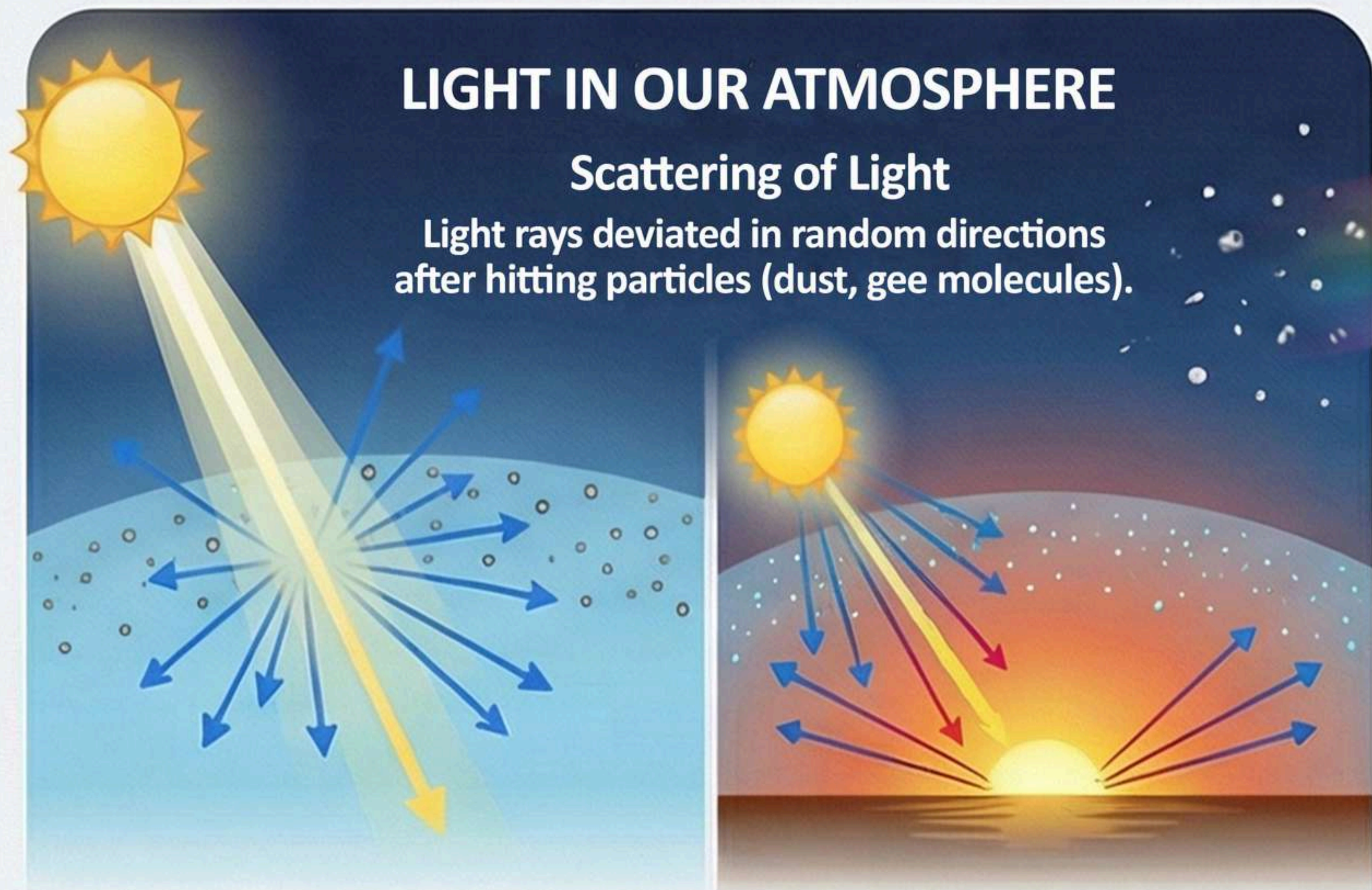


Seeing the Color of Objects
An object's color is the color of light it reflects. A red apple reflects red light and absorbs others. White reflects all colors.

LIGHT IN OUR ATMOSPHERE

Scattering of Light

Light rays deviated in random directions after hitting particles (dust, gee molecules).

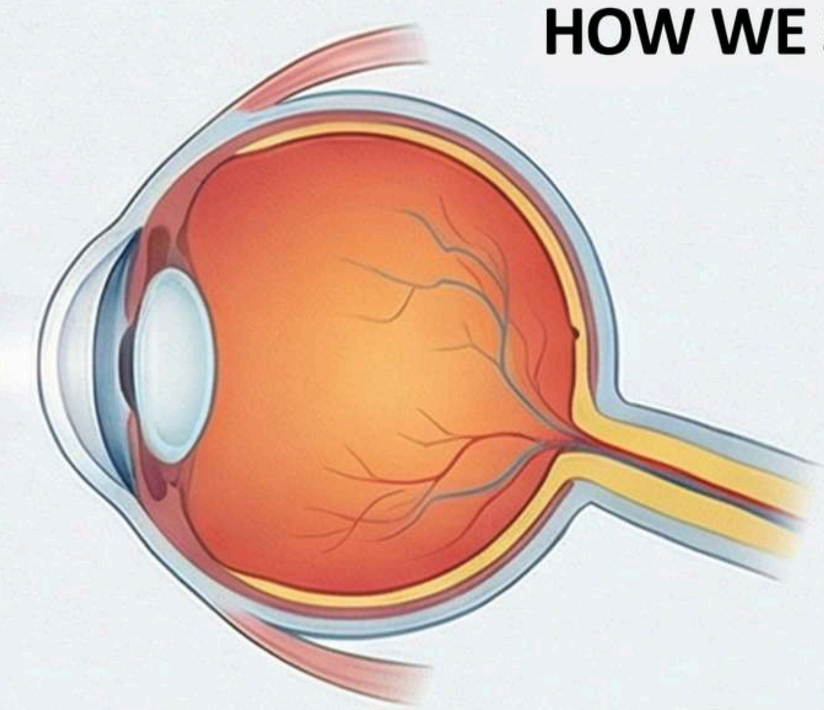


Why the Sky is Blue
Shorter wavelengths (blue, violet) are scattered much more than longer ones, making the sky blue

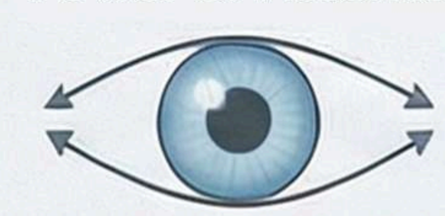
Why Sunsets are Red
At sunrise/sunset, light travels further. Blue light scatters away, leaving red, orange, yellow.

How Rainbows Form
Sunlight passes through raindrops (acting like tiny prisms), causing dispersion, refraction, and internal reflection.

HOW WE SEE (THE HUMAN EYE)

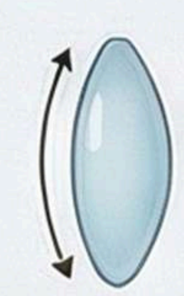


Power of Accomodation

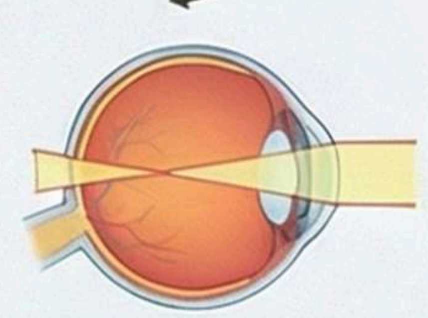


Near Point: 25 cm (closest clear vision)
Far Point: Infinity (farthest distance)

Persistance of Vision
The eye retains an image for ~1/16th second.
A fast-spinning color disc appears white.

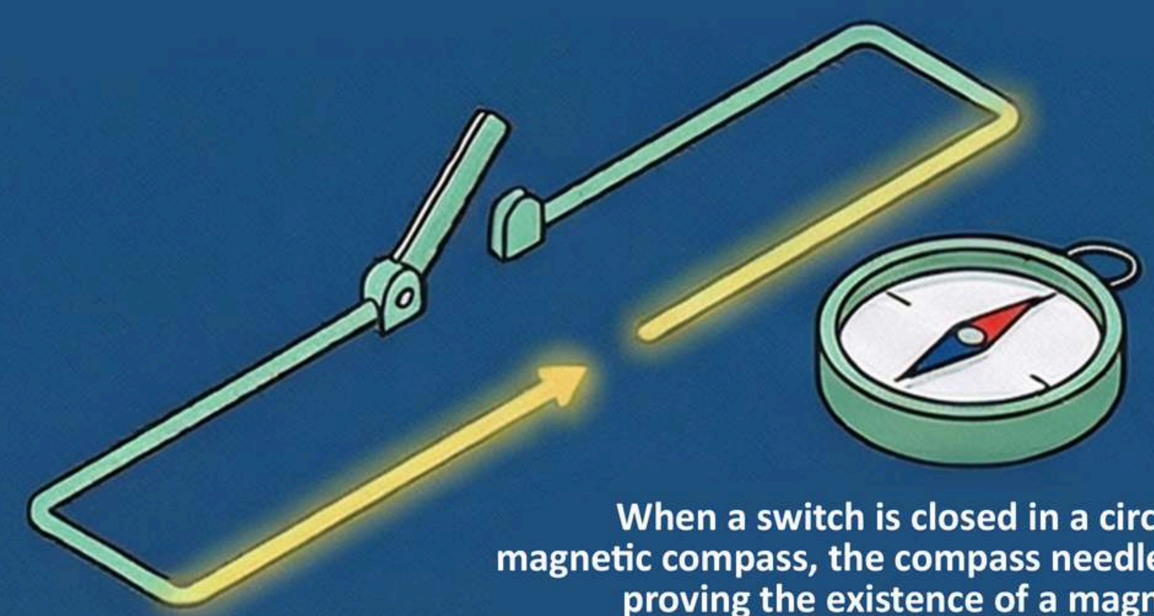


Power of Accomodation
Eye lens changes curvature (focal length) to focus clear images of near or far objects on the retina.



Myopia (Short - Sightedness)
Can see nearby objects clearly but not distant ones, image focuses in front of retina (eyeball too long or lens power too high).

MAGNETIC EFFECT OF ELECTRIC CURRENT



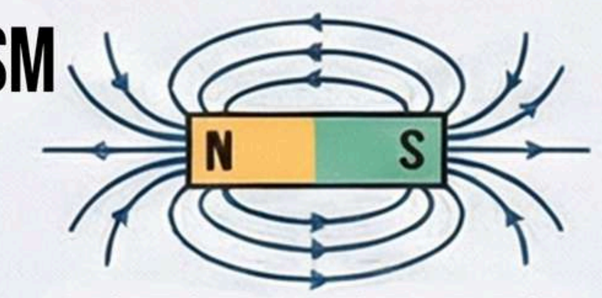
When a switch is closed in a circuit near a magnetic compass, the compass needle deflects, proving the existence of a magnetic field. This is the magnetic effect of clectricity.

OERSTED'S BIG DISCOVERY: ELECTRICITY CREATES MAGNETISM

An electric current flowing through a wire creates a magnetic field around it.

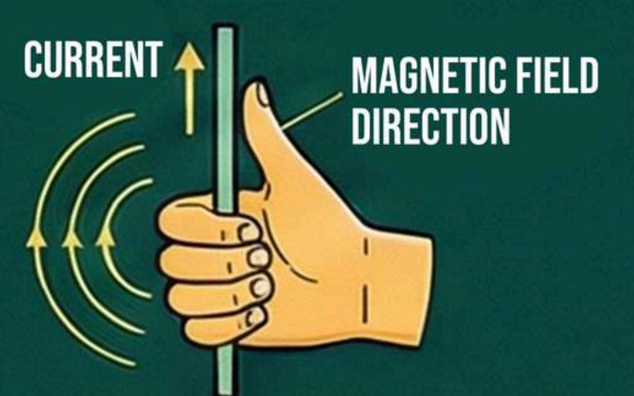
WHAT IS A MAGNETIC FIELD?

It's an area around a magnet or a current-carrying wire where a magnetic force can be felt. We visualize it with imaginary magnetic field lines.



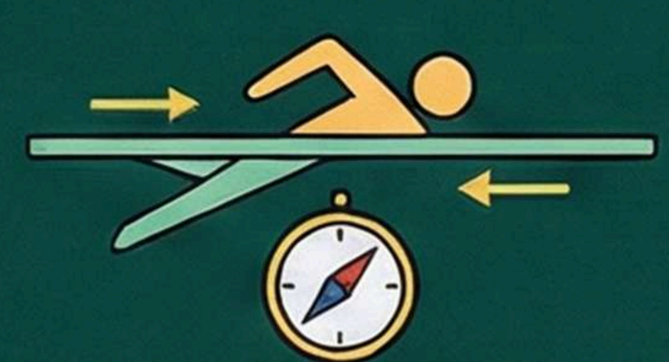
MAGNETIC FIELD LINES TRAVEL FROM NORTH POLE TO SOUTH POLE OUTSIDE A MAGNET

HOW TO FIND THE FIELD'S DIRECTION: THE RULES



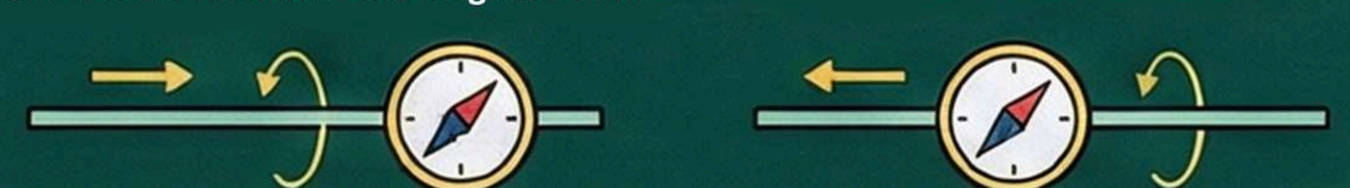
RIGHT HAND THUMB RULE

Imagine helding the wire with your right hand. If your thumb points in the direction of the current, your fingers sorting around the wire show the direction of the magnetic field.

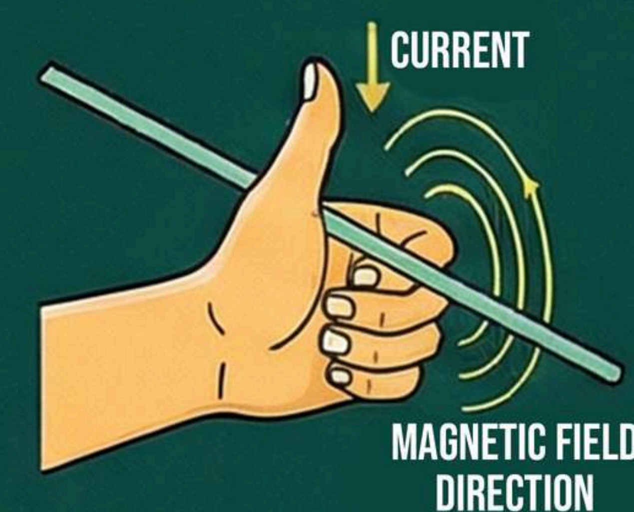


AMPERE'S SWIMMING RULE

If you change the direction of the current in the wire, the compass needle will deflect in the opposite direction



REVERSING THE CURRENT REVERSES THE MAGNETIC FIELD'S DIRECTION.



RIGHT HAND THUMB RULE

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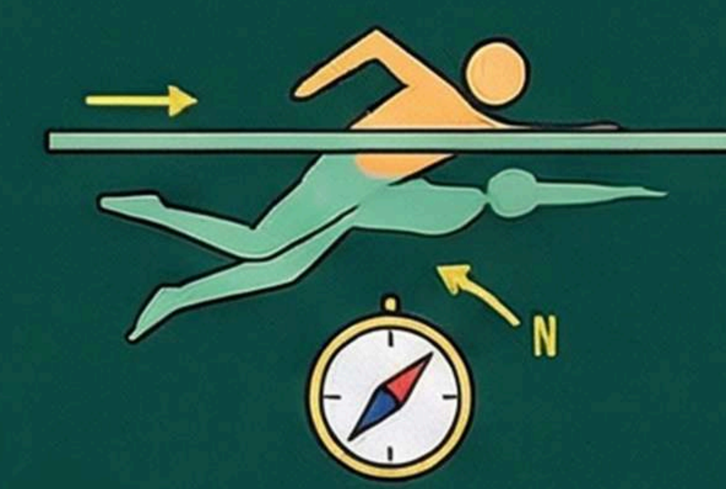
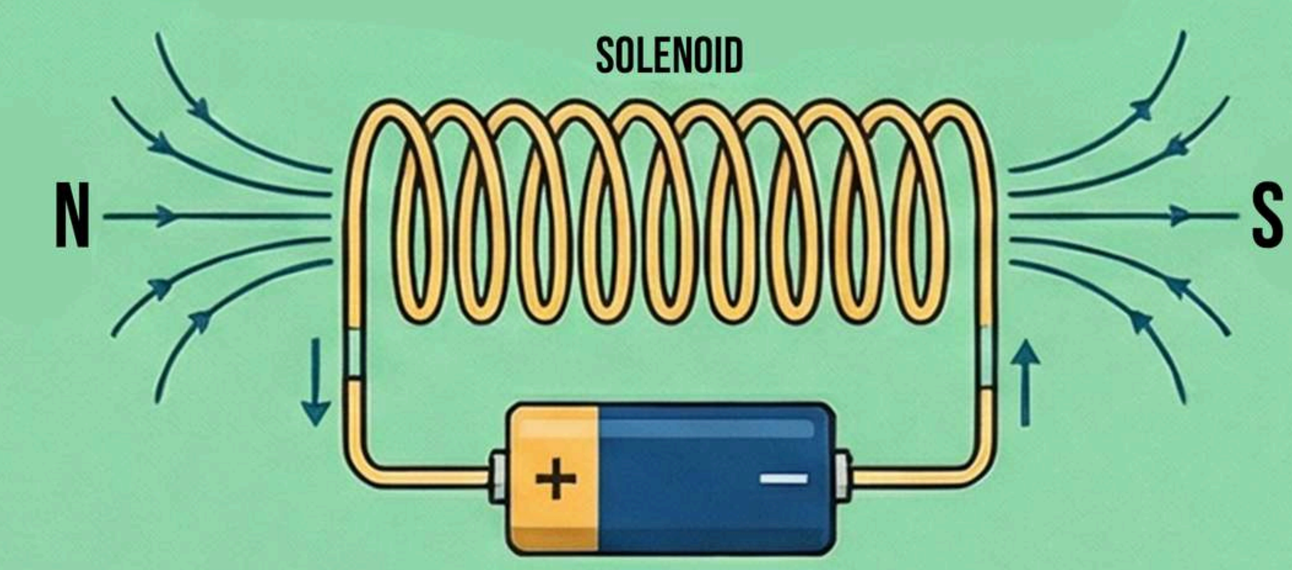


AMPERE'S SWIMMING RULE

Imagine a person swimming in the direction of the current. The north pole of a compass needle below the wire will deflect towards the swimmer's left hand.

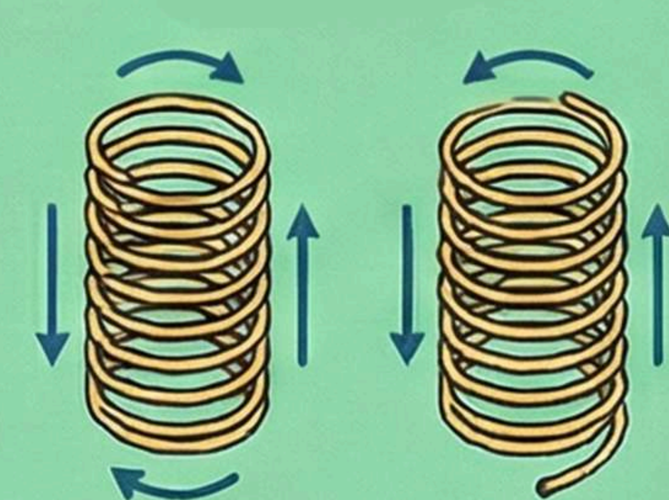
MAKING STRONGER MAGNETS: SOLENOIDS & ELECTROMAGNETS



WHAT IS A SOLENOID?

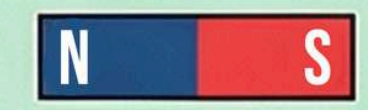
Look at a end of the coil. If the current flows in a clockwise direction, that end is a South pole. If it flows in an anti-clockwise direction, it's a North pole.

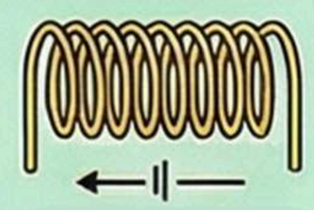
HOW TO FIND THE POLES OF A SOLENOID



3 WAYS TO INCREASE A SOLENOID'S MAGNETIC STRENGTH

- INCREASE THE NUMBER OF TURNS IN THE COIL
- INCREASE THE AMOUNT OF CURRENT FLOWING THROUGH IT
- PLACE A SOFT IRON CORE INSIDE THE SOLENOID



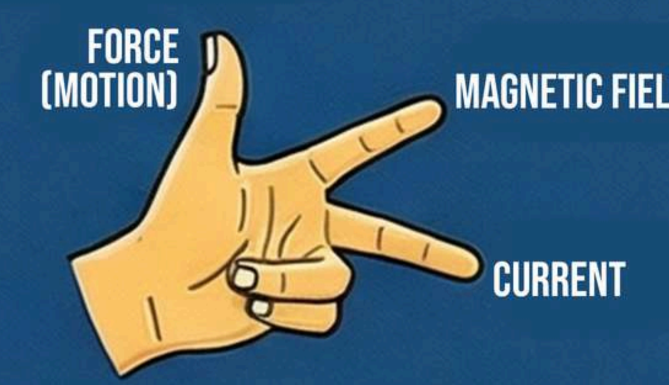


BAR MAGNET	CURRENT-CARRYING SOLENOID (ELECTROMAGNET)
MAGNETISM: PERMANENT (ALWAYS ON)	MAGNETISM: TEMPORARY (ONLY WHEN CURRENT IS ON)
STRENGTH: FIRED AND CONSTANT	STRENGTH: CAN BE CHANGED (UNAIRED)
POLARITY (N/S): CANNOT BE CHANGED	POLARITY (N/S): CAN BE CHANGED BY REVERSING CURRENT DIRECTION

THE MOTOR PRINCIPLE: MAKING THINGS MOVE

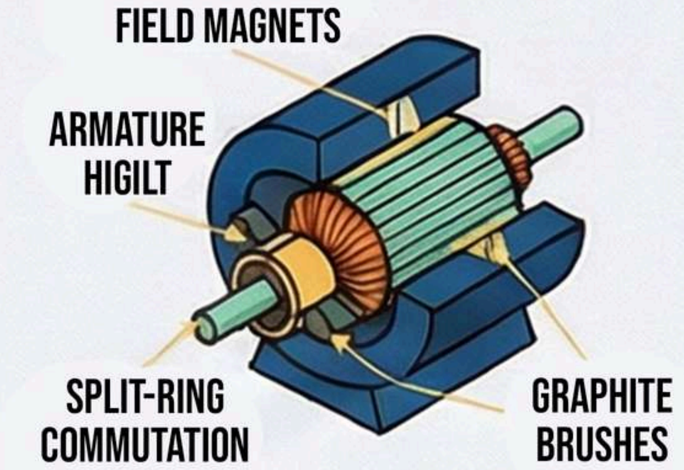
THE MOTOR PRINCIPLE

A conductor carrying a current will experience a force and move when it is placed in a magnetic field.



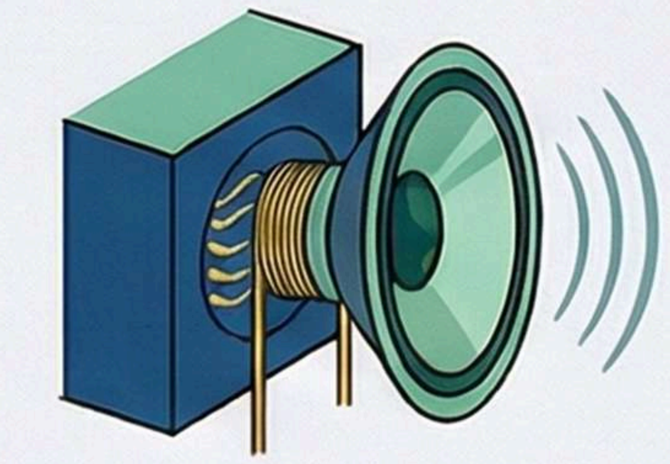
REVERSING THE CURRENT OR THE FIELD REVERSES THE MOTION.

REAL-WORLD APPLICATIONS



THE ELECTRIC MOTOR

A device that converts electrical energy into mechanical energy (movement). It uses the motor principle to make an armature (soll) rotate continuously.



MOVING COIL LOUDSPEAKER

Also works on the motor principle. Electric audio signals cause a voice soll attached to a diaphragm to move back and far in a magnetic field, creating sound waves.

Joules Law & Electric Power

1. THE HEATING EFFECT OF ELECTRICITY

Electrical energy converted into heat energy by appliances.

Common Heating Appliances

Electric Kettle | Electric Iron | Electric Heater

What is Joule Heating?

Scientific name for producing heat when electricity flows through a conductor.

2. NICHROME: THE SUPER-STAR HEATING MATERIAL

An alloy commonly used in heating coils.

High Resistivity – Strongly resists electricity flow, causing high heat.

Stays Hot Without Breaking – Stays red-hot for long without melting

High Oxidation Resistance – Doesn't rust or damage easily when very hot.

3. JOULE'S LAW: THE RULE OF HEAT

$$H = I^2Rt$$

Heat (H) Joule (J)

1. Current (I) – More current = much more heat.
2. Resistance (R) – Higher Resistance = more heat.
3. Time (t) – Longer flow = more heat.

Heat (H) is directly proportional to the square of Current (I), Resistance (R), and Time (t).

4. MORE WAYS TO CALCULATE HEAT (H)

Different Formulas for Different Problems

Using Ohm's Law (V = IR)

When knowing V & R: $H = \frac{V^2t}{R}$

When knowing V & I: $H = VIt$

5. UNDERSTANDING ELECTRIC POWER (P)

Rate at which an appliance uses energy.
High power faster energy use. Unit: Watt (W).

Formulas for Power (P)

$P = VI$ | $P = I^2R$ | $P = \frac{V^2}{R}$

The Simple Link Between Heat and Power:
Heat = Power x Time (H = Pt)

6. PAYING FOR ELECTRICITY: THE COMMERCIAL UNIT

Joules are too small for monthly use; we use a bigger unit.

The Commercial Unit: kilowatt-hour (kWh) (also called "units")

How much is 1 kWh? = Energy of 1000 W appliance for 1 hour = 3,600,000 Joules

How to Calculate Your Energy Use in Units:

$$\text{Energy (kWh)} = \frac{\text{Power (W)} \times \text{Time (hours)}}{1000}$$

7. BE AN ENERGY-SMART STUDENT!

Look for the Star Rating – More stars = more efficient = lower bills.

Beat the Peak Hours! – Electricity can cost more. Use high-power appliances during off-peak times.

High-Power Appliances: Electric Iron, Grinder

Try to use them between 6 am and 6 pm.

Simple Machines

What Are Simple Machines?

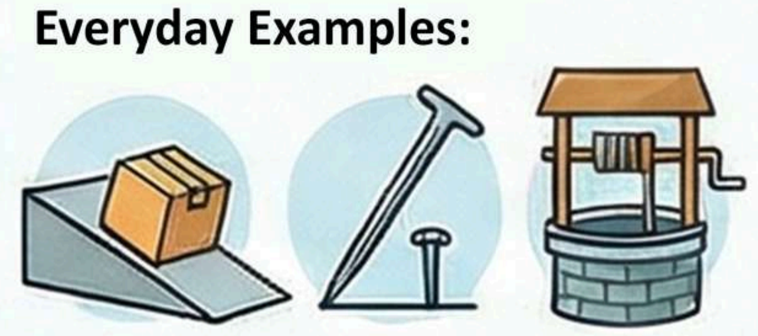
Tools That Make Work Easier

Simple machines are devices that change the size or direction of a force to make a tack easier.

How Do They Help?

They help in two main ways, by increasing the effect of the force you apply, or by changing the direction of your force.

Everyday Examples:

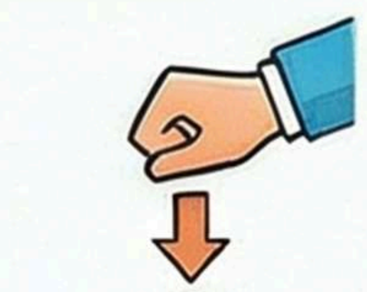


Examples include ramps (inclined planes), nail pullers (levers), and drawing water from a well with a rope and wheel (pulley).

The Science of Force: Key Terms

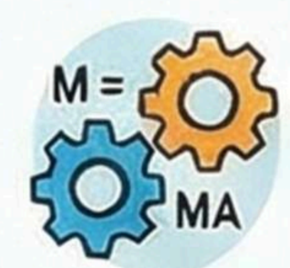
Effort (E)

This is the force that YOU apply to the simple machine. For example, the force you use to press down on a lemon squeezer.



Load (L)

This is the force that the simple machine meat suarcome. For example, the resistance from the lemon you are squeezing.



Mechanical Advantage (MA)

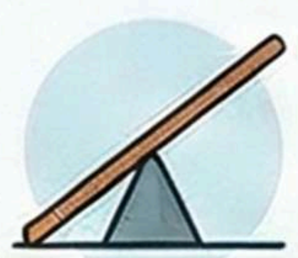
This is a number that take you how many times the machine multiples your effort. A higher time means the work feels much easier.

Calculating Mechanical Advantage

$$MA = \frac{Load}{Effort}$$

It is a simple ratio and has no units.

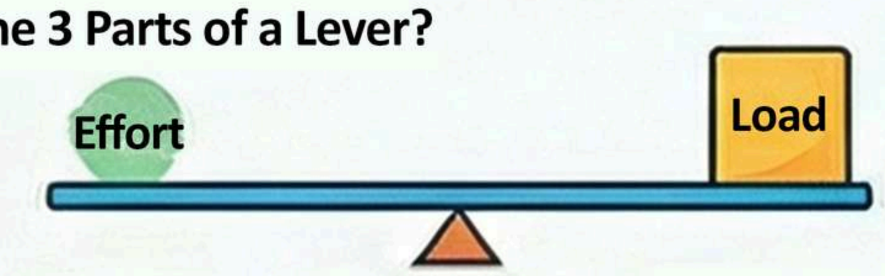
Levers: The Balancing Act



What is a Lever?

A lever is a strong, right nut that can turn or rotates around a pivot point called a fulcrum.

The 3 Parts of a Lever?



Fulcrum (the pivot point) — Effort (where you apply force) — Load (the object you are moving)

The Principle of Levers

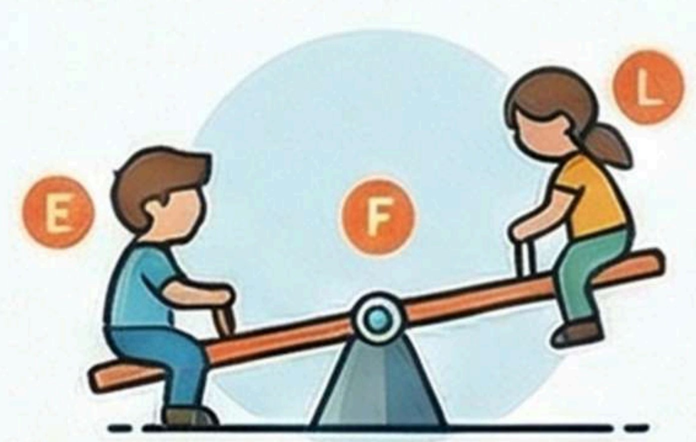
When a lever is balanced:
Load=Load arm=Effort + Effort arm
The "arm" is the distance from the fulcrum.

Mechanical Advantage of a Lever

For levers, $MA = \frac{\text{Effort Arm}}{\text{Load Arm}}$

A longer effort arm gives you a greater mechanical advantage.

The Three Orders of Levers

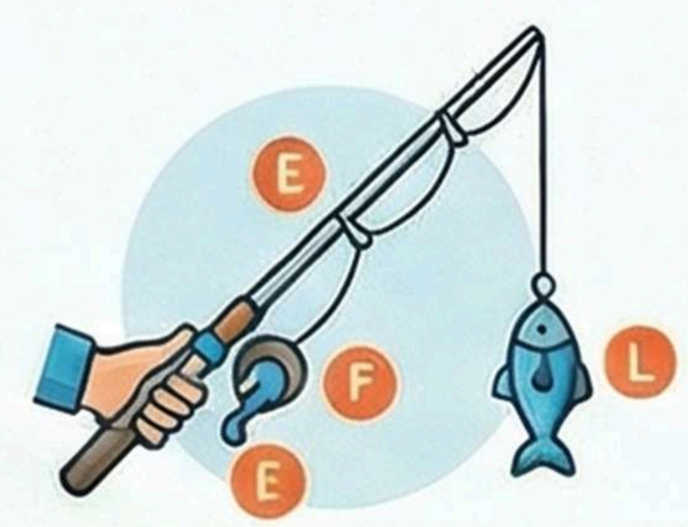


First Order Lever: Fulcrum is in the Middle

The Fulcrum is located between the Effort and the Load (E-F-L)
MA can be greater than, less than, or equal to 1.
Examples: Seesaw, Scissors, Crowbar

Second Order Lever: Load is in the Middle

The Load is located between the Effort and the Fulcrum (C-L-F)
MA is ALWAYS greater than 1.
Examples: Hoterscker, Bottle opener, Lemon squeezer.



Third Order Lever: Effort is in the Middle

The Effort is located between the Load and the Fulcrum (L-E-F)
MA is ALWAYS less than 1. Its main advantage is ease of use, not force multiplication.
Examples: Tongs, Forcepa, Fishing pole

Pulleys: Changing Direction

What is a Fixed Polley?

A fixed pulley is a wheel with a rope that rotates around an axis that does not move.

How It Works

A fixed pulley acts like a first order lever where the Effort Arm and Load Arm are equal (they are both the radius of the wheel).

Mechanical Advantage is 1

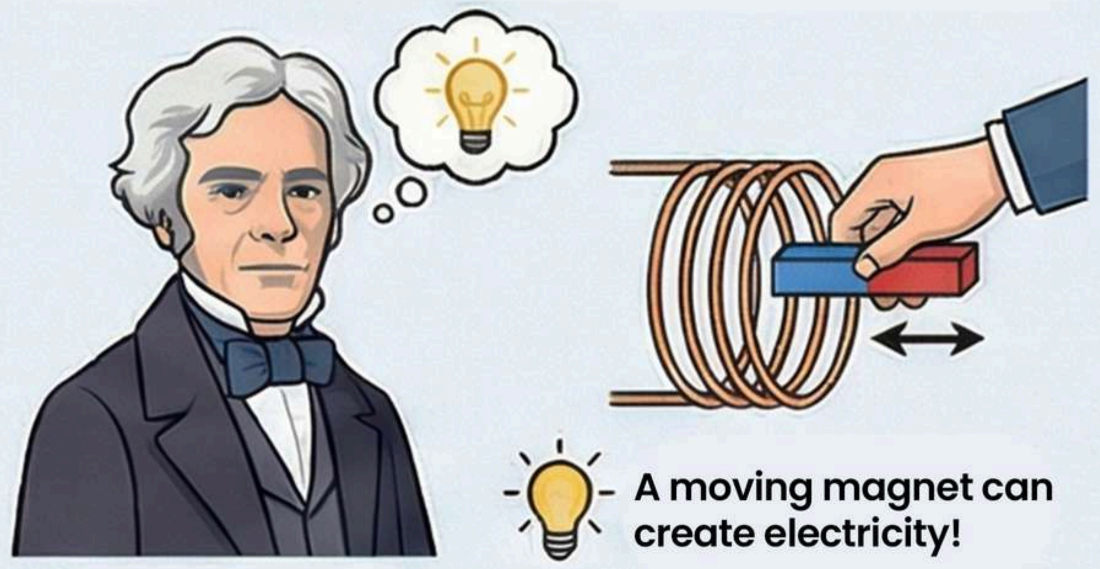
Since the effort arm equals the load arm, the MA of a single fixed pulley is 1. It does not multiply your force.

Main Benefit: Convenience

The biggest advantage of a fixed pulley is first it changes the direction of the lever. it's often easier to pull down on a rope than to pull up.

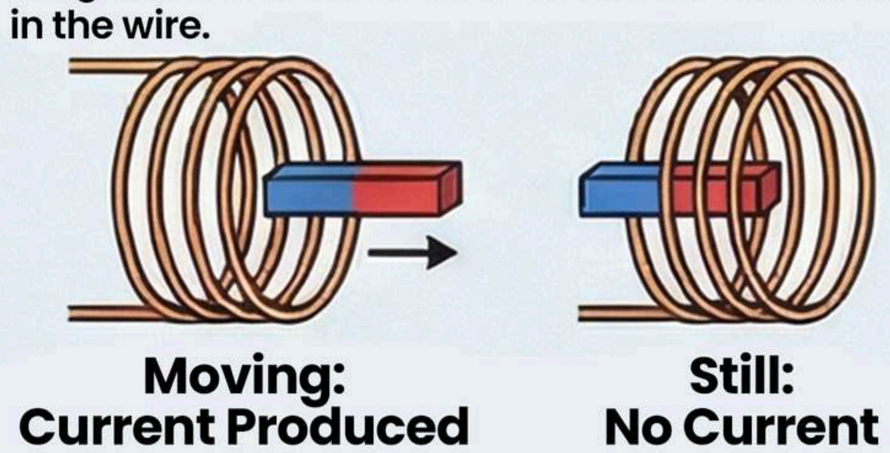
Electromagnetic Induction

1. The Big Idea: Electromagnetic Induction (EMI)



What is Electromagnetic induction?

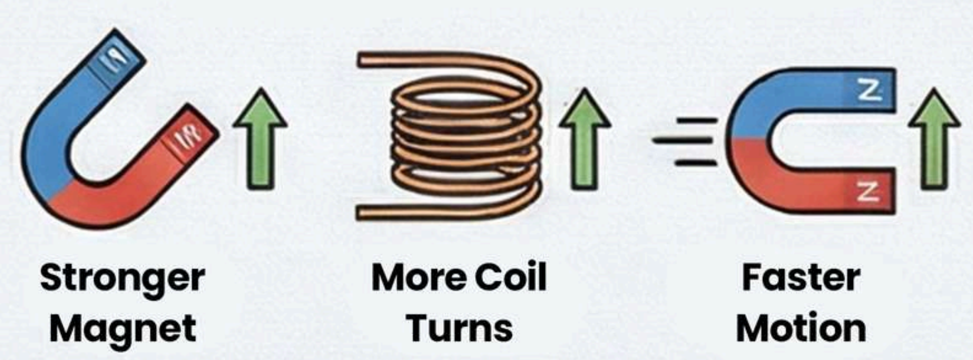
Scientist Michael Faraday discovered that if you move a magnet near a coil of wire, an electric current is created in the wire.



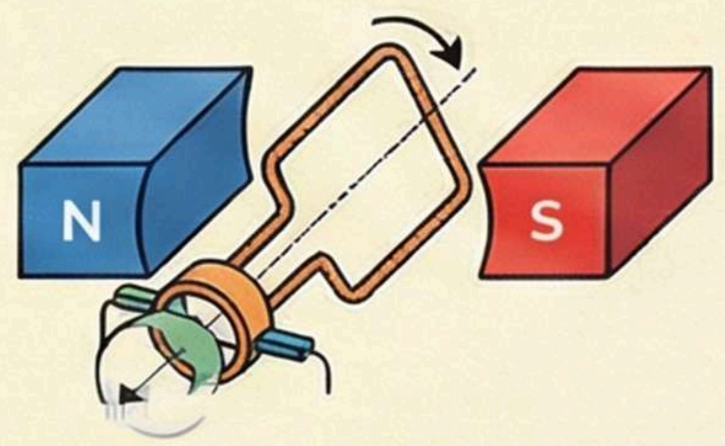
How It Works: The Rule of Motion

Electricity is generated ONLY when the magnet and the coil of wire are moving relative to each other.

3 Ways to Get More Power!



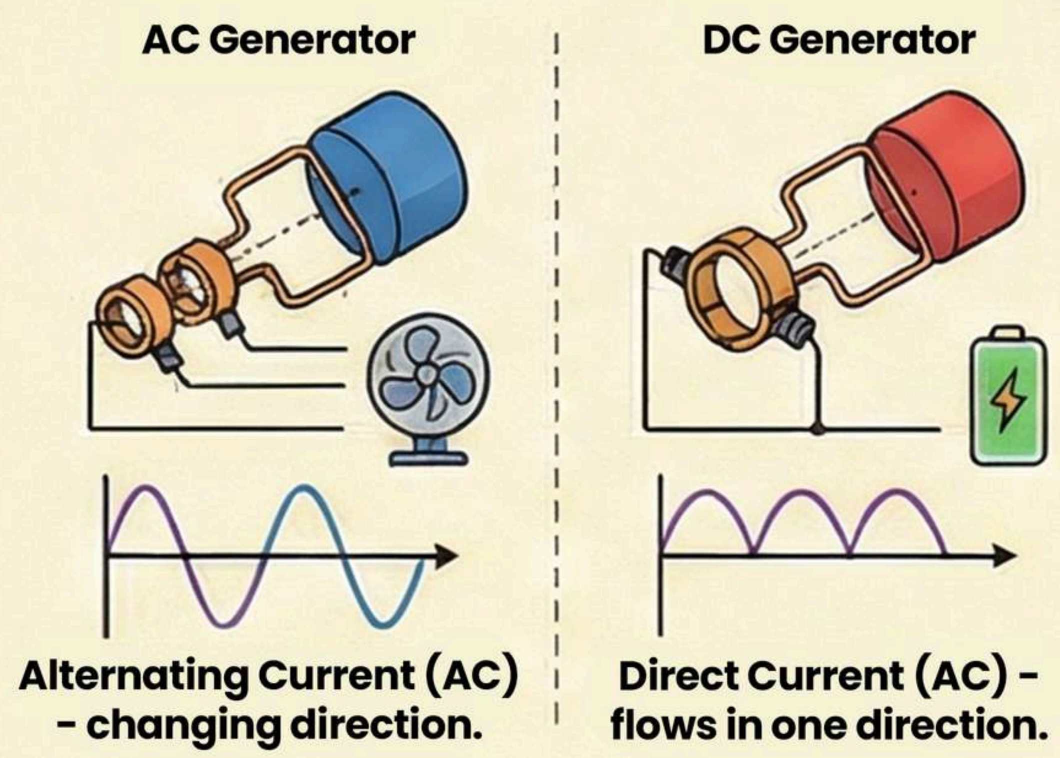
2. Making Electricity: The Generator



What is a Generator?

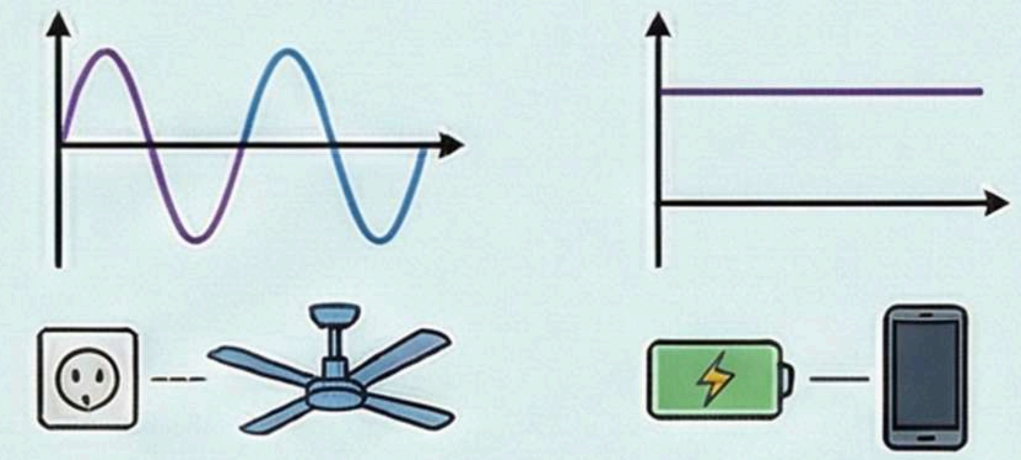
A generator is a machine that uses electromagnetic induction to convert mechanical energy (motion) into electrical energy.

AC vs DC Generators



Key Part	Function of Key Part
Slip Rings	Allows the current to change direction continuously.
Slip Ring Commutator	Reserves the direction of current to the external circuit every half rotation to keep it flowing in one direction.

3. The Two Types of Current



Alternating Current (AC)
The current continuously changes its direction at regular intervals. Used for most home appliances like mixers and fans.

Direct Current (DC)
The current flows in only one direction. Found in batteries and used to power electronics like mobile phones.

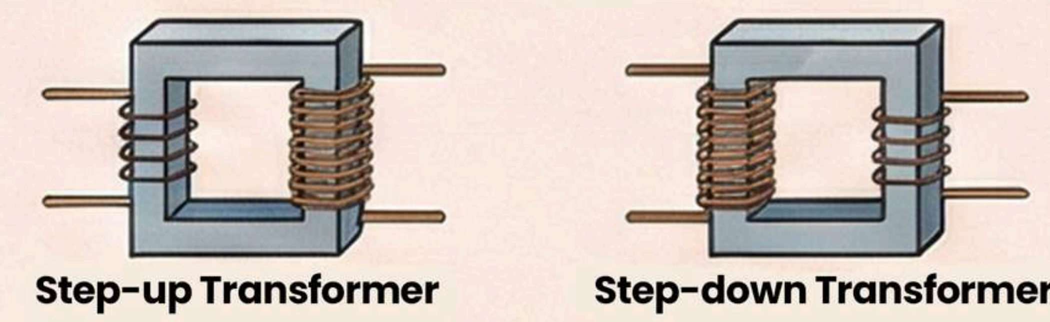
4. The Transformer: Changing Voltage

What is a Transformer?

A device that increases or decreases AC voltage without changing power. It works on the principle of mutual induction.

Power In = Power Out

In an ideal transformer, if you increase the voltage, the current decreases by the same proportion, and vice versa. ($V_p \times I_p = V_s \times I_s$)



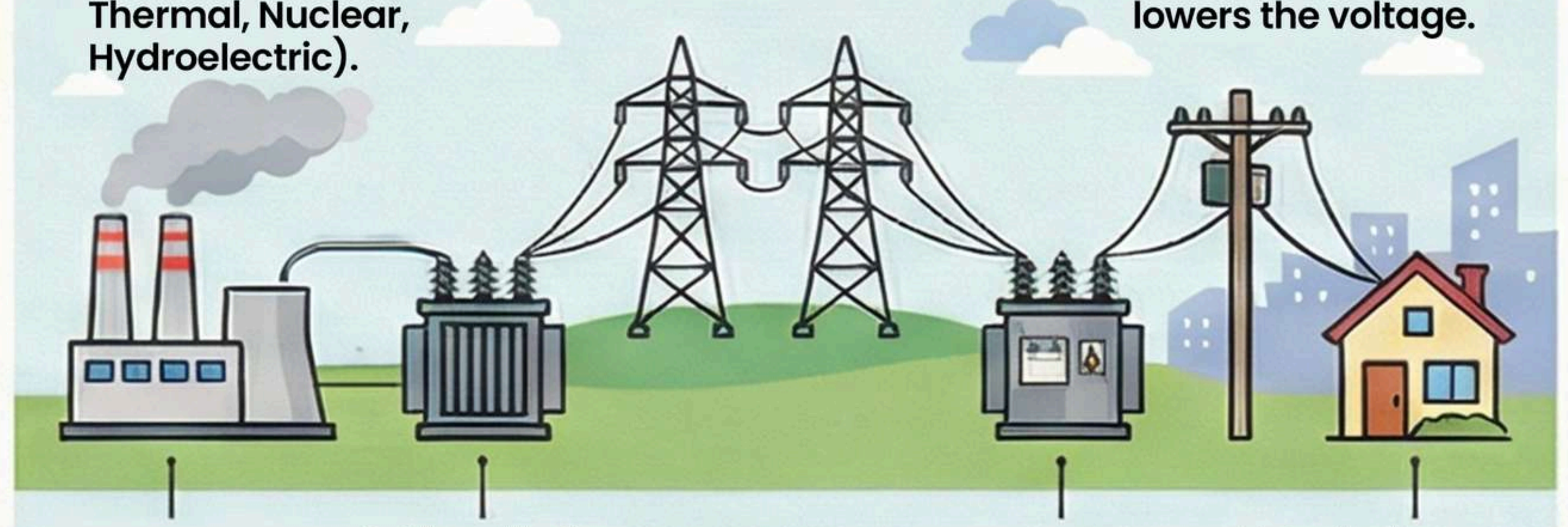
Purpose	Increase AC Voltage	Decrease AC Voltage
Effect on Current	Decreases Current	Increass Current
Coil Design	More turns in the Secondary Coil	Fewer turns in the Secondary Coil

5. Journey of Electricity: From Power Plant to Your Home

1. Generation at Power Station
Electricity is produced at about 11,000 Volts (11 kV) in power stations (eg., Thermal, Nuclear, Hydroelectric).

3. Long Distance Travel
High-voltage electricity travels through thick transmission lines.

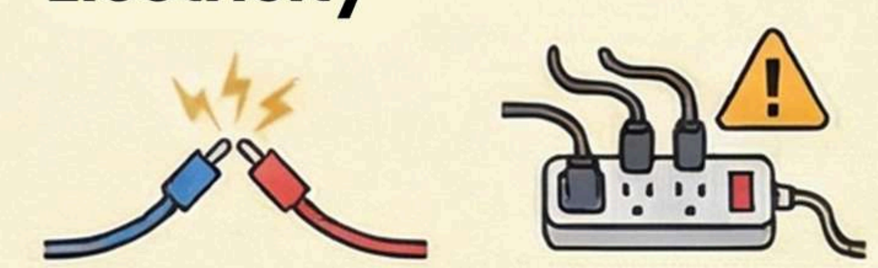
4. Step-Down for Distribution
At substations near towns and cities, a step-down transformer lowers the voltage.



2. Step-Up for Transmission
Increases voltage to a very high level (eg., 230,000 V) to reduce current and heat loss

5. Arrival at Your Home
Lowers the voltage to 230 V, which is safe for household use.

6. Staying Safe with Electricity



Danger 1: Short Circuit Happens when the five wire and neutral wire touch directly, creating a huge flow of current that can start a fire.

Danger 2: Overloading occurs when you connect too many high-power appliances to one chord, drawing more current than the wire can hold.

Your Safety Guardians

Your home has several devices to protect you from excess current.

Safety Fuse
A film wire that melts and breaks the circuit if the current is too high

MCB
A switch that trips and can be reset

ELCB & Earthing
ELCB detects leaks and cuts off power. Earthing provides a safe path for leakage.