

Physics in everyday life

Free study notes · 7 notes · 25 Oct 2026

Free study material from Medha AI. For notes, practice, mock tests and previous papers for your exam, start free at **app.medhaai.in**.

1. Units, motion, Newton's laws and gravitation
2. Work, energy, pressure and fluids: Pascal, Archimedes and Bernoulli
3. Heat: temperature scales, expansion and modes of heat transfer
4. Sound and waves: echo, ultrasound, Doppler effect and the electromagnetic spectrum
5. Light: reflection, refraction, lenses and defects of the eye
6. Dispersion and scattering: rainbow, blue sky and mirages
7. Electricity and magnetism: Ohm's law, household circuits, motors and transformers

1 Units, motion, Newton's laws and gravitation

Motion is described by speed, velocity and acceleration, caused by force according to Newton's three laws, and the force of gravity between masses explains falling bodies, weight, tides and satellite orbits.

Core facts

- **Seven SI base units:**

Quantity	Unit	Symbol
Length	metre	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Temperature	kelvin	K
Amount of substance	mole	mol
Luminous intensity	candela	cd

- **Scalar** has magnitude only (mass, speed, distance, energy). **Vector** has magnitude and direction (velocity, force, displacement, acceleration, momentum).
- **Speed** = distance / time. **Velocity** = displacement / time. **Acceleration** = change in velocity / time; unit **m/s²**.
- **Newton's laws:**
 1. **First (inertia):** a body stays at rest or in uniform motion in a straight line unless an external force acts.
 2. **Second:** force = mass x acceleration (**F = ma**); the rate of change of momentum is the force.
 3. **Third:** every action has an equal and opposite reaction (on different bodies).
- Unit of force: **newton (N)** = kg m/s². **Momentum** = mass x velocity (kg m/s).
- **Mass** is the amount of matter (kg, same everywhere). **Weight** is the force of gravity on the body (**W = mg**, in newton) and changes with place.
- **g = 9.8 m/s²** on Earth's surface. On the Moon, g is about **one-sixth** of Earth's.
- **Escape velocity** from Earth: **11.2 km/s**. From the Moon: about **2.4 km/s**.
- Gravitational constant **G = 6.67 x 10⁻¹¹ N m²/kg²**. Measured by **Cavendish** (1798).

Explained

Equations of motion (uniform acceleration, initial velocity u, final v, time t, distance s)

- $v = u + at$

- $s = ut + \frac{1}{2}at^2$
- $v^2 = u^2 + 2as$

Everyday examples of the laws

- First law: passengers lurch forward when a bus brakes; dust falls off a beaten carpet.
- Second law: a heavier object needs a bigger force for the same acceleration; a cricketer draws back the hands while catching to lengthen the stopping time and reduce the force.
- Third law: a gun recoils when fired; a rocket moves up as exhaust gases are pushed down; swimmers push water backwards.

Conservation of momentum. In an isolated system, total momentum before and after a collision is the same. This explains gun recoil and rocket propulsion.

Universal law of gravitation (Newton). Every two masses attract with a force proportional to the product of the masses and inversely proportional to the square of the distance: $F = G \frac{m_1 m_2}{r^2}$.

Variation of g

- g is **greater at the poles** than at the equator (Earth is slightly flattened and spinning).
- g **decreases with height** above the surface and also with **depth** below it; it is **zero at the centre** of Earth.
- All bodies fall with the same acceleration in a vacuum. On the Moon in 1971 an Apollo 15 astronaut showed a hammer and a feather landing together.

Kepler's laws of planetary motion

1. Planets move in **elliptical orbits** with the Sun at one focus.
2. A line joining planet and Sun sweeps **equal areas in equal times** (planets move faster near the Sun).
3. The **square of the orbital period** is proportional to the **cube of the semi-major axis**.

Circular motion. A body moving in a circle needs a **centripetal force** towards the centre. Gravity provides it for planets and satellites. Centrifugal force is an apparent (pseudo) force felt in the rotating frame; cream separators and washing-machine dryers use it.

Weightlessness. An astronaut in orbit is in continuous free fall with the spacecraft, so feels no weight although gravity still acts. Mass does not change.

Common traps

✗ "Mass of an astronaut is zero in orbit." ✓ Mass is unchanged; only the **apparent weight** is zero.

✗ "g is greatest at the equator." ✓ g is greatest at the **poles**, least at the equator.

✗ "Weight is measured in kilograms." ✓ Weight is a force, in **newton**; kg measures mass.

✗ "Action and reaction cancel because they are equal and opposite." ✓ They act on **different bodies**, so they do not cancel.

✗ "Escape velocity depends on the mass of the projectile." ✓ It depends on the planet's mass and radius only.

✗ "Velocity and speed are the same." ✓ Velocity is a vector; average velocity can be zero while speed is not.

Quick revision

- Seven SI base units: m, kg, s, A, K, mol, cd.
- $F = ma$; unit newton = kg m/s^2 .
- Newton's first law = inertia; third law = action-reaction on different bodies.
- Momentum = mv ; conserved in isolated systems.
- $g = 9.8 \text{ m/s}^2$; Moon about one-sixth; highest at poles.
- Escape velocity: Earth 11.2 km/s; Moon about 2.4 km/s.
- $G = 6.67 \times 10^{-11} \text{ N m}^2/\text{kg}^2$; measured by Cavendish.
- Kepler: ellipse, equal areas, T^2 proportional to a^3 .
- Weightlessness in orbit = free fall, not zero gravity.

2 Work, energy, pressure and fluids: Pascal, Archimedes and Bernoulli

Work transfers energy, energy is conserved, and fluids obey three working rules: Pascal (pressure transmits equally), Archimedes (buoyant force equals weight displaced) and Bernoulli (faster flow, lower pressure).

Core facts

- **Work** = force x displacement in the direction of force. Unit: **joule (J)**. No displacement means no work.
- **Kinetic energy** = $\frac{1}{2}mv^2$. **Potential energy** (gravitational) = mgh .
- **Power** = work / time. Unit: **watt (W)** = 1 J/s. **1 horsepower = 746 W**.
- **1 kilowatt-hour (kWh)** = 3.6×10^6 J; it is the "unit" on an electricity bill.
- **Law of conservation of energy**: energy can be changed from one form to another but neither created nor destroyed.
- **Pressure** = force / area. Unit: **pascal (Pa)** = N/m². Same force on a smaller area gives more pressure (needle, knife).
- **Atmospheric pressure** at sea level: about **1.013×10^5 Pa = 760 mm of mercury = 1 atm**. Measured by a **barometer** (invented by **Torricelli**, 1643).
- **Pascal's law**: pressure applied to an enclosed fluid is transmitted equally in all directions. Used in the **hydraulic lift** and **hydraulic brakes**.
- **Archimedes' principle**: a body in a fluid feels an upward buoyant force equal to the **weight of fluid displaced**.
- **Bernoulli's principle**: where the speed of a fluid is higher, its pressure is lower.
- **Density** = mass / volume. Water: **1000 kg/m³** (1 g/cm³) at 4 °C.

Explained

Energy forms and transformation

Device	Conversion
Electric generator	mechanical to electrical
Electric motor	electrical to mechanical
Microphone	sound to electrical
Solar cell	light to electrical
Battery (discharging)	chemical to electrical

- **Efficiency** = useful output energy / input energy. No machine is 100% efficient.
- **Levers** and other simple machines trade force for distance; they do not give extra energy.

Atmospheric pressure in daily life

- Pressure falls with altitude, so water boils at a lower temperature on mountains; a **pressure cooker** raises the pressure so water boils above 100 °C and cooks faster.
- Drinking through a straw and a dropper work because of pressure difference with the atmosphere.
- A **manometer** measures gas pressure; a **sphygmomanometer** measures blood pressure.

Floating and sinking

- A body floats if its average density is less than the fluid's; it sinks if more.
- Ice floats on water because its density (about 917 kg/m³) is lower than water's.
- A steel ship floats because its hollow shape displaces a large weight of water.
- A **submarine** dives by filling ballast tanks with water and rises by expelling it.
- The **Plimsoll line** on a ship's hull shows the safe loading limit for different waters.
- Swimming is easier in sea water than in a river, and easiest in the **Dead Sea**, because denser water gives a larger buoyant force.
- **Hydrometer** measures the density of liquids; **lactometer** checks the purity of milk.

Bernoulli in practice: aircraft wing lift (air faster over the curved top, lower pressure above), spray bottle and atomiser, and the pull of a passing train on a person standing too close.

Common traps

✗ "Kilowatt-hour is a unit of power." ✓ It is a unit of **energy** (3.6×10^6 J); kilowatt is power.

✗ "Carrying a heavy load while standing still is work in physics." ✓ No displacement means **zero work**.

✗ "Pascal's law is about buoyancy." ✓ Buoyancy is **Archimedes**; Pascal is about transmission of pressure.

✗ "Barometer was invented by Pascal." ✓ **Torricelli** (1643).

✗ "Ice floats because it is lighter in mass." ✓ It floats because its **density** is lower.

✗ "Bernoulli says faster fluid has higher pressure." ✓ Faster fluid has **lower** pressure.

Quick revision

- Work in joule; power in watt; 1 hp = 746 W.
- 1 kWh = 3.6×10^6 J (energy).
- $KE = \frac{1}{2}mv^2$; $PE = mgh$.
- Pressure in pascal; 1 atm = 760 mm Hg = 1.013×10^5 Pa.
- Barometer: Torricelli.
- Pascal: hydraulic lift and brakes.

- Archimedes: buoyancy = weight of fluid displaced.
- Bernoulli: faster flow, lower pressure; aircraft lift.
- Lactometer: milk; hydrometer: liquid density.

3 Heat: temperature scales, expansion and modes of heat transfer

Heat is energy that flows because of a temperature difference, by conduction, convection or radiation, and substances differ in how much heat they need to warm up, expand or change state.

Core facts

- **Heat** is energy in transit (unit **joule**; also calorie, 1 cal = 4.18 J). **Temperature** measures hotness (SI unit **kelvin**).
- Reference points:

Point	Celsius	Fahrenheit	Kelvin
Ice melts	0	32	273.15
Water boils	100	212	373.15
Absolute zero	-273.15	-459.67	0

- Conversion: **$F = 1.8C + 32$** ; **$K = C + 273.15$** . **-40** is the same on Celsius and Fahrenheit.
- **Clinical thermometer** (mercury, with a kink to hold the reading) reads **35 to 42 °C** (94 to 108 °F). Normal body temperature: **37 °C (98.6 °F)**.
- **Three modes of heat transfer:**
 - **Conduction:** through solids by contact (metals are good conductors).
 - **Convection:** by movement of fluids (liquids and gases).
 - **Radiation:** by electromagnetic waves; needs **no medium** (Sun's heat reaches Earth).
- **Water has maximum density at 4 °C.** This is why ponds freeze from the top and aquatic life survives below.
- **Water has a high specific heat capacity** (about 4200 J/kg per K).

Explained

Specific heat and latent heat

- **Specific heat capacity:** heat needed to raise 1 kg by 1 K. Water's high value makes it a good coolant and moderates coastal climates.
- **Land and sea breeze:** by day land heats faster than sea, so cooler air flows **from sea to land** (sea breeze); at night the direction reverses (land breeze).
- **Latent heat:** heat absorbed or released during change of state without change in temperature. For water: fusion about **336 kJ/kg**, vaporisation about **2260 kJ/kg**. Steam burns are worse than boiling water burns because steam releases this latent heat on condensing.
- **Evaporation causes cooling:** sweating, and earthen pots (matka) keeping water cool.

Thermal expansion

- Solids, liquids and gases generally expand on heating. Railway tracks and bridges have gaps for expansion.
- A **bimetallic strip** (two metals, different expansion) bends on heating; used in thermostats and fire alarms.
- Gases expand most, then liquids, then solids.
- **Anomalous expansion of water** between 0 and 4 °C: it contracts on heating.

Mode of transfer: examples

- Conduction: a metal spoon in hot tea; woollen clothes trap air (poor conductor) and keep us warm.
- Convection: boiling water circulates; sea breeze; hot air rising from a heater; cooling coil of a refrigerator at the top of the freezer.
- Radiation: dark, rough surfaces absorb and radiate best; white clothes reflect heat, so are worn in summer.
- **Thermos (Dewar) flask**: double-walled glass with vacuum between (stops conduction and convection) and silvered walls (reduce radiation).

Mercury and alcohol thermometers: mercury freezes at about -39 °C, so alcohol is used for very low temperatures.

Common traps

X "Heat and temperature are the same." ✓ Heat is energy; temperature is its measure of hotness.

X "Water is densest at 0 °C." ✓ Water is densest at **4 °C**.

X "Radiation needs a medium." ✓ It travels through vacuum.

X "The clinical thermometer reads -10 to 110 °C." ✓ It reads only about **35 to 42 °C**.

X "Sea breeze blows from land to sea by day." ✓ By day it blows **from sea to land**.

X "Water boils at 373 K at all heights." ✓ 100 °C (373.15 K) is at **sea-level pressure**; it falls with altitude.

Quick revision

- Heat in joule; temperature in kelvin; 1 cal = 4.18 J.
- $F = 1.8C + 32$; $K = C + 273.15$; -40 is common.
- Body temperature 37 °C = 98.6 °F.
- Conduction, convection, radiation; radiation needs no medium.
- Water densest at 4 °C.
- Water's specific heat is high: coastal moderation, sea breeze by day.
- Thermos flask: vacuum plus silvered walls.

- Absolute zero = 0 K = -273.15 °C.

4 Sound and waves: echo, ultrasound, Doppler effect and the electromagnetic spectrum

Sound is a mechanical, longitudinal wave that needs a medium, while light and the rest of the electromagnetic spectrum are transverse waves that travel through vacuum at the same speed.

Core facts

- **Sound needs a medium** (solid, liquid or gas). It cannot travel in a vacuum.
- Sound is a **longitudinal wave** (compressions and rarefactions). Light and all EM waves are **transverse**.
- Speed of sound is greatest in **solids**, less in liquids, least in gases. Approximate values: air about **340 m/s** (at room temperature), water about **1,500 m/s**, steel about **5,000 m/s**. It rises with temperature.
- **Audible range** for humans: **20 Hz to 20,000 Hz**.
 - **Infrasound**: below 20 Hz (elephants, whales, earthquakes).
 - **Ultrasound**: above 20 kHz (bats, dolphins, porpoises).
- **Pitch** depends on frequency; **loudness** on amplitude (measured in **decibel, dB**); **quality (timbre)** distinguishes two sounds of the same pitch and loudness.
- **Echo**: reflected sound heard separately; needs a reflector at least about **17 m** away (the ear retains a sound for 0.1 s).
- **Uses of ultrasound**: SONAR, ultrasonography (scanning), cleaning delicate parts, welding, detecting flaws in metal.
- **Doppler effect**: apparent change in frequency when source and observer are in relative motion.
- **EM spectrum, in order of increasing frequency**: radio waves, microwaves, infrared, visible light, ultraviolet, X-rays, gamma rays.
- All EM waves travel at **3×10^8 m/s** in vacuum.

Explained

Noise and its limits. Noise Pollution (Regulation and Control) Rules, 2000 set ambient standards:

Area	Day (6 am-10 pm)	Night
Industrial	75 dB	70 dB
Commercial	65 dB	55 dB
Residential	55 dB	45 dB
Silence zone	50 dB	40 dB

- Normal conversation is about 60 dB; prolonged exposure above about 85 dB can damage hearing.

Reflection of sound in practice. Echoes are used in SONAR; **reverberation** (persistence from repeated reflections) is controlled in halls by curtains, carpets and curved ceilings. Stethoscopes, megaphones and horns use reflection.

SONAR (Sound Navigation and Ranging) sends ultrasound and times the echo to find depth of sea, shoals and submarines. **RADAR** uses radio waves and microwaves, not sound.

Doppler effect in use: police speed guns, **Doppler weather radar**, medical blood-flow scans, the redshift of receding galaxies.

Electromagnetic spectrum and uses

Region	Use / fact
Radio	broadcast, mobile and TV communication
Microwave	radar, microwave oven, satellite links
Infrared	remote controls, night vision, heat
Visible (about 400-700 nm)	vision
Ultraviolet	sterilisation, vitamin D synthesis; absorbed by ozone
X-rays	medical imaging, airport security
Gamma rays	cancer therapy, sterilisation

Sonic boom: an object moving faster than sound (Mach number above 1) produces a shock wave heard as a boom.

Common traps

✗ "Sound travels fastest in air." ✓ Fastest in **solids**, slowest in gases.

✗ "Ultrasound is below 20 Hz." ✓ **Infrasound** is below 20 Hz; ultrasound is above 20 kHz.

✗ "Sound is a transverse wave." ✓ It is **longitudinal**.

✗ "RADAR uses ultrasound." ✓ RADAR uses **radio/microwaves**; SONAR uses ultrasound.

✗ "Gamma rays have the longest wavelength." ✓ They have the **shortest**; radio waves are the longest.

✗ "Loudness is measured in hertz." ✓ Loudness in **decibel**; hertz is frequency.

Quick revision

- Sound: mechanical, longitudinal, needs a medium.
- Audible 20 Hz to 20 kHz; infrasound below, ultrasound above.
- Speed: solid > liquid > gas.

- Echo needs about 17 m distance.
- Loudness in dB; pitch is frequency.
- SONAR = sound; RADAR = radio waves.
- EM order (low to high frequency): radio, microwave, IR, visible, UV, X-ray, gamma.
- All EM waves 3×10^8 m/s in vacuum.

5 Light: reflection, refraction, lenses and defects of the eye

Light bends and bounces according to simple laws, which lets mirrors, lenses, optical fibres and spectacles form and correct images, and the human eye works like a camera with a convex lens.

Core facts

- **Laws of reflection:** angle of incidence = angle of reflection; incident ray, reflected ray and normal lie in the same plane.
- **Plane mirror image:** virtual, erect, same size, laterally inverted.
- **Concave mirror** (converging): used in shaving mirrors, dentist's mirrors, torches and headlights, solar cookers. **Convex mirror** (diverging): used as vehicle **rear-view** mirrors because it gives a wide field of view with an erect, diminished image.
- **Focal length $f = R/2$** (R = radius of curvature).
- **Refraction:** bending of light on passing from one medium to another. **Snell's law:** $\sin i / \sin r = \text{constant}$ (the refractive index).
- **Refractive index n** = speed of light in vacuum / speed in medium. Water about **1.33**, glass about **1.5**, diamond about **2.42**.
- **Convex lens** converges light; **concave lens** diverges light.
- **Power of a lens $P = 1/f$** (f in metre). Unit: **diopetre (D)**. Convex is positive; concave is negative.
- **Total internal reflection (TIR):** light going from a denser to a rarer medium at an angle greater than the **critical angle** is fully reflected.
- **Eye defects:** **myopia** (short-sightedness) corrected by a **concave** lens; **hypermetropia** (long-sightedness) by a **convex** lens; **presbyopia** by bifocal lenses; **astigmatism** by a cylindrical lens.

Explained

Mirror and lens formulas

- Mirror: $1/v + 1/u = 1/f$. Lens: $1/v - 1/u = 1/f$. Magnification $m = \text{image height} / \text{object height}$.
- A convex lens forms real, inverted images for objects beyond its focus; as a magnifying glass (object inside focus) it forms an erect, enlarged, virtual image.

Total internal reflection in use

- **Optical fibre:** light is carried along a glass thread by repeated TIR; used in telecommunication and in **endoscopy**. **Charles Kao** received the 2009 Nobel Prize in Physics for fibre optics.
- Sparkle of a **diamond** (small critical angle, about 24.4 degrees), prisms in binoculars and periscopes, and **mirages**.

Parts of the human eye

Part	Function
Cornea	transparent front; does most of the bending of light
Iris and pupil	iris controls pupil size, hence light entering
Lens	fine focusing (ciliary muscles change its curvature: accommodation)
Retina	screen with rods (dim light, no colour) and cones (bright light, colour)
Optic nerve	carries signals to the brain

- The image on the retina is real and **inverted**; the brain interprets it upright.
- **Blind spot**: where the optic nerve leaves; no receptors.
- Normal near point: about **25 cm**; far point: infinity.

Defects of vision

- **Myopia**: distant objects blurred; image forms in front of the retina (eyeball too long or lens too curved).
- **Hypermetropia**: near objects blurred; image falls behind the retina.
- **Presbyopia**: loss of accommodation with age.
- **Cataract**: clouding of the lens, treated by surgery with an intraocular lens.
- **Colour blindness**: inherited, mostly in males (sex-linked recessive on the X chromosome). **Night blindness** results from vitamin A deficiency.

Common traps

X "Myopia is corrected by a convex lens." ✓ Myopia needs a **concave** lens; hypermetropia needs convex.

X "Rear-view mirrors are concave." ✓ They are **convex**.

X "Image on the retina is erect." ✓ It is **inverted**.

X "Rods detect colour." ✓ **Cones** detect colour; rods work in dim light.

X "Power of a concave lens is positive." ✓ It is **negative**.

X "Optical fibres work by refraction." ✓ They work by **total internal reflection**.

Quick revision

- Reflection: $i = r$; plane mirror image virtual and laterally inverted.
- Concave mirror: shaving, headlight; convex mirror: rear-view.
- Refractive index $n = c/v$; Snell's law.
- Lens power $P = 1/f$ in dioptre; convex $+$, concave $-$.
- TIR: optical fibre, diamond, mirage.

- Myopia: concave; hypermetropia: convex.
- Rods: dim light; cones: colour.
- Laser: coherent, monochromatic; Maiman 1960.

6 Dispersion and scattering: rainbow, blue sky and mirages

White light splits into colours in a prism and in raindrops, and the atmosphere scatters short wavelengths more than long ones, which explains the blue sky, red sunsets, twinkling stars and mirages.

Core facts

- **Dispersion:** splitting of white light into its colours by a prism. Shown by **Newton**.
- Seven colours, **VIBGYOR**: violet, indigo, blue, green, yellow, orange, red.
- **Violet bends most, red least** in a prism. Red has the longest wavelength, violet the shortest of the visible colours.
- **Rainbow:** formed by dispersion, refraction and **internal reflection** of sunlight in water droplets. The Sun must be **behind the observer**.
- **Scattering:** light is redirected by particles in its path. **Rayleigh scattering** is stronger for short wavelengths (proportional to $1/\text{wavelength}^4$), so blue scatters more than red.
- **Blue sky:** scattered blue light reaches the eye from all directions.
- **Red sunrise and sunset:** the sun's rays travel a longer path through the atmosphere, so most blue light is scattered out and red reaches the eye.
- **Danger signals are red** because red is scattered least and can be seen from far away.
- **Tyndall effect:** scattering of light by colloidal particles makes the path of a beam visible (sunlight through a forest canopy, a torch beam in mist).
- **Stars twinkle** but **planets do not**.
- **Mirage:** an optical illusion in hot deserts and on tar roads on summer days.

Explained

Rainbow details

- Primary rainbow: red on the outside, violet inside; seen at about 42 degrees from the line joining the Sun's opposite point to the observer.
- Secondary rainbow: fainter, colours reversed, formed by two internal reflections.
- A rainbow appears when the Sun shines while rain is falling in the opposite direction, so it is common after showers.

Why the sky is blue and the Sun looks white at noon. The shorter wavelengths are scattered, while the remaining mix looks white at midday. At the **Moon** or in space, with no atmosphere to scatter light, the sky appears **black**. Clouds appear white because large water droplets scatter all wavelengths nearly equally.

Atmospheric refraction

- Starlight passes through layers of air of changing density and bends; the star's apparent position flickers, so it **twinkles**. Planets are nearer and act as extended sources; the flicker averages out.

- The Sun appears **about 2 minutes before** it actually rises and remains visible **about 2 minutes after** it sets.
- The Sun's disc looks flattened at sunrise and sunset.

Mirage. On a hot day the layer of air next to the ground is hotter and less dense. Light from the sky bends away from the normal and, at a large angle, undergoes total internal reflection, so a distant object appears inverted below, like a pool of water. This is an **inferior mirage**. Over cold surfaces (polar seas) a **superior mirage** lifts images upward.

Colours

- Primary colours of **light**: red, green, blue (additive). Primary **pigments**: cyan, magenta, yellow (subtractive).
- A red rose looks red because it reflects red and absorbs the others.

Common traps

✗ "The sky is blue because it reflects the sea." ✓ It is blue due to **Rayleigh scattering** of sunlight.

✗ "Red light is scattered most." ✓ Blue/violet scatters most; red is scattered **least**.

✗ "Stars twinkle because they are flickering." ✓ Twinkling is from **atmospheric refraction**.

✗ "Planets twinkle." ✓ They do not, since they are near enough to behave as extended sources.

✗ "Rainbow can be seen with the Sun in front of the observer." ✓ The Sun must be **behind**.

✗ "Raman received the Nobel Prize in 1928." ✓ The discovery was **1928**; the prize was **1930**.

Quick revision

- Dispersion: Newton's prism; VIBGYOR; violet bends most.
- Rainbow: dispersion + refraction + internal reflection.
- Blue sky: Rayleigh scattering; sunset red: long path.
- Red used for danger signals: least scattered.
- Tyndall effect: scattering by colloids.
- Stars twinkle, planets do not.
- Sun seen about 2 minutes early; mirage from total internal reflection.
- Raman effect 1928; Nobel 1930; National Science Day 28 February.

7 Electricity and magnetism: Ohm's law, household circuits, motors and transformers

Electric current is flowing charge governed by Ohm's law, a current makes a magnetic field and a changing magnetic field makes a current, which is how motors, generators and transformers work.

Core facts

- **Electric charge:** unit **coulomb (C)**. **Current** = charge / time; unit **ampere (A)**, measured with an **ammeter** (connected in series).
- **Potential difference:** unit **volt (V)**, measured with a **voltmeter** (in parallel).
- **Ohm's law:** $V = IR$ at constant temperature. **Resistance** unit: **ohm**.
- Resistance of a wire rises with length and falls with thicker cross-section. **Resistivity** depends on material and temperature.
- **Series:** same current; resistances add. **Parallel:** same voltage; reciprocal sum. **Household wiring is parallel.**
- **Electric power** $P = VI$ (watt). **Heating effect (Joule's law):** $H = I^2Rt$.
- **Fuse:** thin wire of low melting point in the **live** wire; it melts if current exceeds the safe limit. **MCB** is a resettable switch.
- **Earthing:** the metal body of an appliance connects to the ground through the earth wire, so leakage current flows away and prevents shock.
- Indian supply is AC, about **230 V at 50 Hz**. Traditional colour code: **red (live), black (neutral), green (earth)**.
- **Oersted** (1820) showed a current produces a magnetic field. **Faraday** (1831) discovered electromagnetic induction.
- **Motor:** electrical to mechanical energy. **Generator (dynamo):** mechanical to electrical energy.
- **Transformer:** changes AC voltage; works on AC only.

Explained

Circuits and appliances

- A bulb filament is of **tungsten** (high melting point, about 3,400 °C), in an inert gas. Heater coils use **nichrome**, a high-resistance alloy. Fuse wire is tin-lead.
- Appliances of high power (geyser, air conditioner) need thick wires and a separate circuit.
- Electrical energy is billed in **kilowatt-hour**: $1 \text{ kWh} = 1 \text{ "unit"} = 3.6 \times 10^6 \text{ J}$.

Magnetism basics

- Like poles repel, unlike attract. Field lines emerge from the north pole and enter the south pole outside the magnet, forming closed loops; they never cross.
- Earth acts like a bar magnet; a freely suspended magnet settles in the north-south direction (compass).

- Right-hand thumb rule gives field direction around a current-carrying wire. A **solenoid** with soft iron core forms an **electromagnet** (cranes, electric bells).

Rules for direction

- **Fleming's left-hand rule:** force on a current-carrying conductor in a magnetic field (**motor**).
- **Fleming's right-hand rule:** direction of induced current (**generator**).

Electromagnetic induction. Moving a magnet near a coil, or changing the field through it, induces a current in the coil. AC generators produce alternating current; DC generators use a split-ring commutator.

Transformer

- Based on **mutual induction**: $V_s/V_p = N_s/N_p$.
- **Step-up**: more turns in the secondary. **Step-down**: fewer turns.
- Power is transmitted at **high voltage** so that current, and thus I^2R heat loss, is small; it is stepped down near homes.

Common traps

✗ "Ammeter is connected in parallel." ✓ **Series**; voltmeter is in parallel.

✗ "House circuits are in series." ✓ They are **parallel**, so each appliance gets full voltage.

✗ "Transformer works on DC." ✓ AC only; DC gives no changing flux.

✗ "Fuse is placed in the neutral wire." ✓ It goes in the **live** wire.

✗ "Motor and generator use the same Fleming rule." ✓ Motor: **left-hand**; generator: **right-hand**.

✗ "Faraday discovered that current makes magnetism." ✓ That was **Oersted**; Faraday found induction.

Quick revision

- $V = IR$; unit of resistance ohm.
- Ammeter in series; voltmeter in parallel.
- Household wiring parallel; supply about 230 V, 50 Hz.
- Fuse in live wire; earthing prevents shock.
- $1 \text{ kWh} = 1 \text{ unit} = 3.6 \times 10^6 \text{ J}$.
- Motor: left-hand rule; generator: right-hand rule.
- Oersted 1820; Faraday 1831.
- Transformer: AC only; high-voltage transmission cuts loss.