Z

AQA GCSE PHYSICS NOTEBOOK

ALL THE KEY CONTENT IN 32 PAGES!

CONTENTS

ENERGY

ENERGY STORES & SYSTEMS

A system is an object or group of objects.

- Energy within a system can change when the system changes.

Systems can be:

- Open → Energy and matter can enter or leave.
- Closed → Only energy can enter or leave.
- Isolated → Neither energy nor matter can enter or leave.

⚡ ENERGY STORES

- Energy is stored in different ways depending on the object's state:

1. Kinetic → Moving objects
2. Gravitational Potential → Raised objects in a gravitational field
3. Elastic Potential → Stretched or compressed objects
4. Thermal → Hot objects
5. Chemical → Stored in fuels, food, batteries
6. Magnetic → Interacting magnets or magnetic materials
7. Electrostatic → Interacting electric charges
8. Nuclear → Energy within atomic nuclei

🔄 ENERGY TRANSFER PATHWAYS

Energy is transferred between stores through:

- Mechanically → By a force doing work (e.g. pushing, pulling)
- Electrically → By a moving charge (e.g. in circuits)
- Heating (by particles) → From ho cooler objects (conduction)
- Heating (by radiation) → By electromagnetic waves (e.g. light, infrared)

⚡ ENERGY TRANSFER EXAMPLES

🏐 OBJECT PROJECTED UPWARDS

Chemical store (muscles) → Kinetic store (moving ball) → Gravitati store (height increases)

🚗 MOVING OBJECT HITTI OBSTACLE

Chemical store (fuel) → Kinetic (moving car) → Thermal store (w surroundings, dissipated)

- Also: Friction → thermal (air, groun Sound → air v s

🚙 VEHIC RATING

Chemica uel) → Kine (speedin

🚗 VEHIC

Kinetic st → Thermal (brakes, grou

- Also: Friction → thermal | Sound → vibrations

💧 BOILING WATER IN A KETTL

Electrical store (mains) → Therm store (heating element) → Thermal store (water)

KINETIC ENERGY (E_k)

- Energy an object has due to its mass and speed.

Energy Transfer:

- Speeds up → energy transferred to kinetic store
- Slows down → energy transferred away from kinet store

📝 EQUATION:

- $E_k = 1/2 \times m \times v^2$
- E_k = Kinetic energy (Joules, J)
- m = Mass (kilograms, kg)
- v = Speed (metres per second, m/s)

🔍 EXAMPLE CALCU

Car travelling (2500 kg) m/s:

- $E_k = 1/2 \times 2500$ ... $=$ 500,000 J

Apple falling

- $E_k = 1/2$

📝 TIP:

- Squ eed → Co mi
- Rea key skill in regularly.

EL TIAL

- En d in a objec rk is done stretch ss it.

Transfer:

stic potent

- ased → Energy transferred m elastic potential

📝 EQUA

- $E_e = 1/2 \times$
- E_e = Elastic po ntial energy
- stant (Newtons /m)
- Extension (metres, m)

XAMPLE CALCULATIONS:

- Spring (3 N/m) stretched by 0.5 m:
- $E_e = 1/2 \times 3 \times 0.5^2 = 0.375$ J
- ring (5 N/m) compressed by 2 m:
- $E_e = 1/2 \times 5 \times 0.2^2 = 0.1$ J
- Spring (250 N/m) extended by 0.014 m:
- $E_e = 1/2 \times 250 \times 0.014^2 =$ 0.025 J (2 s.f.)

📝 TIP:

- Convert to metres if given in cm.
- Make sure the spring has not exceeded its limit of proportionality for this equation to be valid.

GRAVITATIONAL POTENTIAL ENERGY (E_p)

- gy stored in an object due to its ght in a avitational field.

gy Trans

- Lifted up gy transferred to ravita ential st
- nergy tr d away ional pot ore

📝 EQU

- $E_p = m$
- E_p = Gravita al energy (Joules, J)
- m = Mass (kilograms, kg)
- g = Gravitati field strength (Newtons per kilogra
- h = Height , m)

FIELD STRENGTH:

- g (less than Earth → easier to lift)
- Gas Giants (e.g. Jupiter): ~25 N/kg (more than Earth → harder to lift)

🔍 EXAMPLE CALCULATIONS:

- Man (70 kg) climbing 3 m stairs (g = 9.8 N/kg):
- $E_p = 70 \times 9.8 \times 3 = 2058$ J
- Cannonball (5 kg) lifted 56 m (g = 10 N/kg):
- $E_p = 5 \times 10 \times 56 = 2800$ J
- Book (0.5 kg) lifted 1.5 m (g = 10 N/kg):
- $E_p = 0.5 \times 10 \times 1.5 = 7.5$ J

📝 TIP:

- Use g = 9.8 N/kg unless stated otherwise.
- Remember to convert mass to kg if given in grams.

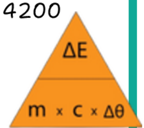
THERMAL ENERGY (ΔE)

Energy in the thermal store of an object, related to its temperature.

📝 SPECIFIC HEAT CAPACITY (c)

The amount of energy needed to raise the temperature of 1 kg of a substance by 1°C.

- Low Specific Heat Capacity: Heats up and cools down quickly (e.g. copper, 390 J/kg°C).
- High Specific Heat Capacity: Heats up and cools down slowly (e.g. water, 4200 J/kg°C).



📝 EQUATION:

- $\Delta E = m \times c \times \Delta\theta$
- ΔE = Change in thermal energy (Joules, J)
- m = Mass (kilograms, kg)
- c = Specific heat capacity (J/kg°C)
- $\Delta\theta$ = Temperature change (degrees Celsius, °C)

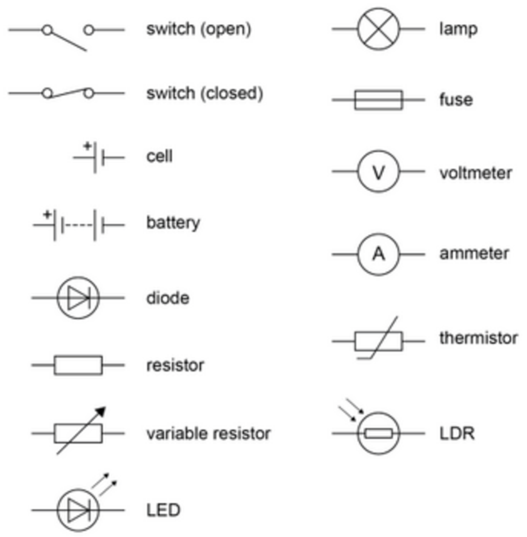
📝 EXAMPLE CALCULATION:

- Heat 2.00 kg of water from 10°C to 100°C (c = 4200 J/kg°C):
- $\Delta\theta = 100 - 10 = 90$°C
- $\Delta E = 2.00 \times 4200 \times 90 = 756{,}000$ J

📝 **TIP:** Units Matter: Always check that mass is in kg and temp. change is in °C.

- You do not need to memorise specific heat capacity values, they will be given in exams.

CIRCUIT DIAGRAMS



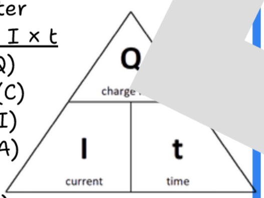
- Cell/Battery: Provides potential difference (battery = 2 or more cells)
- Switch: Turns circuit on (closed) or off (open)
- Fixed Resistor: Limits current, fixed resistance
- Variable Resistor: Adjusts resistance (e.g., volume controls, dimmer switches)
- Thermistor: Resistance changes with temperature (↓ temp = ↑ resistance)
- LDR: Resistance changes with light intensity (↓ light = ↑ resistance)
- Diode: Current flows in one direction only (used for AC to DC conversion)
- LED: Emits light when current passes throu (e.g., indicators)
- Ammeter: Measures current (connected in series)
- Voltmeter: Measures potential difference (connected in parallel)

CHARGE & CURRENT

⚡ **CURRENT AND CHARGE**

- Current = Flow of electric charge
- Measured in amperes (A) u an ammeter

Formula: <u>Q = I × t</u>



- Charge (Q) in coulombs (C)
- Current (I) in amperes (A)
- Time (t) in seconds (s)

📝 **WORKED EXAMPLE (CHARGE)**

- A current of ws through a wire for ch charge flow ?

Step 1: Write down t quantities

- Current (I
- Time

Step 2

- Q

Step citute th

- × 200 = 60

(V

- The e per unit charge acr Measured in vol (connecte

lts

- e (W) in J)
- C in coulombs (C)

E

NCE)

- s used to move 80 C of charge through a cuit, what is the potential nce?

own the known qu

- Wo W) = 400 J
- Charge = 80 C

e formula

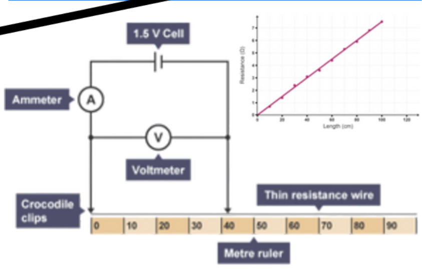
Q

ostitute the values

- V = 400 ÷ 80 = 5 V

🔄 **CONVENTIONAL CURRENT AND ELECTRON FLOW**

- Conventional current flows from positive to negative ➡️
- Electron flow (actual flow) is from negative to positive ⬅️
- Current is the same at all points in a closed loop (e.g. a series circuit)



CURRENT, RESISTANCE & POTENTIAL DIFFERENCE

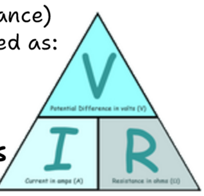
- 🔌 R ce - Opposition to cur
- S . Measure Ohms (Ω) Ohm volt per (1 V / A)
- rent (I) a nt dep its potential it.
- High ow current (e.g., thin, long w sulators)
- Low resistance - High current (e.g., thick, s wires, good condu

OHM'S

(Potential difference = Resistance)

rearranged as:

- R
- R = V / I



WORKED EXAMPLES

📝 Example 1:

- Problem: A resistor of 10 Ω has a current of 0.3 A flowing through it. What is the potential difference?

Calculation:

- V = I × R
- V = 0.3 × 10 = 3 V

📝 Example 2:

- Problem: A voltmeter reads 6.0 V and the resistor is 4.0 Ω. What is the current through the circuit?
- Calculation:
- I = V / R

TIP⚠️ Voltage and potential difference are the same thing - both are measured in volts (V).

ELECTRICITY

REQUIRED PRACTICAL

⚙️ **EQUIPMENT LIST**

- Power Supply → Source of potential d
- Wires → Connect all components in the ci
- Crocodile Clips → Connect different lengths of resistance wire
- Ammeter → Measure current (A)
- Voltmeter → Measure otential difference (V)
- Thin Resistance Wire at different lengths
- Metre Ruler → Meas

EFFECT OF WIRE LENGTH O NCE

🔍 **VARIABLES**

- Independent → Length of wir
- Dependent → Resistance (R)
- Control → Potential difference of p supply, wir erature

📝 **METHO**

1. Set up uit with pow mete voltm d resista
2. Attac ocodil d at a c m).
3. Recor rence (V) current (I
4. Move the second clip further alo re (e.g. 20 cm, 30 cm) and repe ments.
5. Calculate resistance using each length.
6. Plot a graph of resistance (y-a s) against wire length (x-axis).

PRACTICAL CONT.

📊 **ANALYSIS OF RESULTS**

- The graph should be a straight line through the origin → resistance is directly proportional to wire length.
- Longer wires have higher resistance as electrons collide more frequently with metal ions.

🔧 **EVALUATING THE EXPERIMENT**

- Systematic Errors → Ensure crocodile clip is at 0 cm to avoid zero error | Check meters start at 0
- Random Errors → Use low currents to avoid heating the wire | Allow wire to cool between readings | Repeat for reliable results

⚠️ **SAFETY CONSIDERATIONS**

- Avoid touching live wires – risk of burns if wire overheats
- Turn off power if burning is detected
- Keep liquids away from the equipment

SCALARS & VECTORS

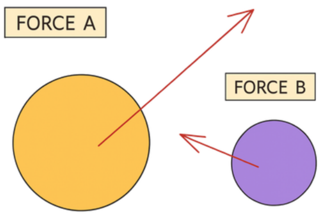
- Scalars → have magnitude only (e.g. speed, distance, mass)
- Vectors → have magnitude & direction (e.g. velocity, displacement, force)

Key comparisons

- Speed ⇔ Velocity | Distance ⇔ Displacement | Mass ⇔ Weight
- → Scalars = no direction | Vectors = include direction

VECTOR REPRESENTATION

- Vector shown as an arrow →
- Length = magnitude | Direction = direction of quantity
- E.g. Force A > Force B in magnitude | A points up-right, B points up-left



SCALAR VS VECTOR CONFUSION

- Displacement < Distance (displacement = straight line, distance = total path)
- Velocity ≠ Speed (same speed, different direction = different velocity)

RESULTANT FORCE – SAME DIRECTION

- Forces add if in same direction →
- E.g. 2 N + 3 N → Resultant = 5 N (same direction)

FORCES

RESULTANT FORCES

- Resultant force = single overall force from combining all individual forces on a body

Also known as → net forc

Balanced Forces:

- → Equal and opposite ment
- e.g. weight down = norm force → resultant force = 0

Unbalanced Forces:

- → Forces don't cancel → object a in direction of larger force
- e.g. Person lls 80 N left, Person 100 N ric tant = 20 N right

CALCULA SULTANT FO

- Sam on → add f
- Oppo ections
- If eq anc (balanc
- Always s de + directic N to the right)

FREE BODY DIAGRAMS

- Show all forces on an object
- Each force = arrow (→) scale magnitude → labelled → shows direction

CONTACT & NON-CONTACT FORCES

- A force = a push or pull due to interaction with another obje

TYPES OF FORCES

- ◆ Contact = objects mus → e.g. friction, tension, a resistance, reaction force
- ◆ Non-contact = no contact needed → e.g. gravity, electrostatic, magnetic

EFFECTS OF FORCES

- Forces can → c e speed | direction | sh

EXAMPLES OF CHA

- Thrust → changes spe
- Gravitational attraction → changes
- Comp hape

CONTA CE SUM

- Fr opposes r (s rub)
- → fr air
- strin
- Reaction a surface (norma

ORCE SUMM

active force

stat /repulsiv

ch

- Mag ractive/repulsive betwee

EWTON'S THIRD LAW)

- hen two objects interact → they qual and opposite forces on
- th (gravitational) | Cha d (contact)

ON MISTAKES

- gravity" → use attraction
- Don't use "wind resistance" or "air pressure" → correct = air resistance (drag)

FORCES AS VECTORS

- Forces are vector quantities → have both magnitude (N) and direction

FORCE PAIRS (INTERACTIONS)

- When two objects interact, they exert equal & opposite forces (Newton's 3rd Law).

Examples:

  - Pushing rock → person pushes rock ⬅️, rock pushes back ➡️
  - Standing on ground → foot pushes down ⬇️, ground pushes back up ⬆️
- All force pairs shown as arrows in diagrams.

GRAVITY, WEIGHT & MASS

MASS - Amount of matter in an object| Scalar (direction) | Measured in kg | Stays everywhere (e.g. Earth vs M

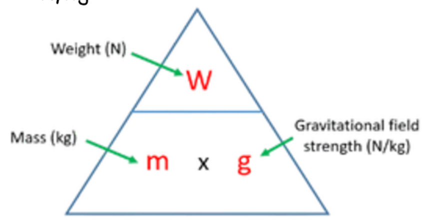
Force du vity acting Vector (nwards) | New ewtonmeter (s hanges with locatio

GRAVITATIONAL FIELD STRENGTH

- Force | Measured in N/kg
- Eart N/kg | Moon ≈ 1.6 N/k ↑ weight

ASS–GRAVITY SHIP

- weight in N | m = mass in kg | g = gravitational field strength in N/kg



EXAMPLES

1. Calculate weight
   - Mass = 70 kg | g = 9.8 N/kg → W = 70 × 9.8 = 686 N
2. Calculate mass from weight
   - Weight = 98 N | g = 9.8 → m = 98 ÷ 9.8 = 10 kg

MEASURING MASS VS WEIGHT

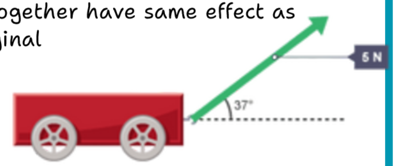
- Mass → measured with balance (compares mass to known mass)
- Weight → measured with spring balance/newtonmeter (measures force)

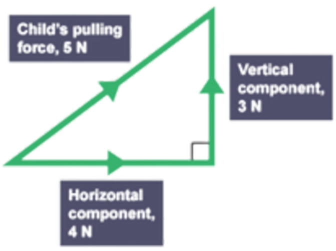
RESOLVING FORCES

Breaking a single force into components at right angles (horizontal and vertical) -> Makes it easier to analyse forces acting at angles

- e.g. 5 N force at 37°
- → Horizontal = 4 N
- → Vertical = 3 N

→ Together have same effect as original





PRESSURE IN A FLUID

Fluids → liquids or gases that can flow.

- Pressure = concentration of force or force per unit area → formula: P = F ÷ A.
- Units → Pascals (Pa) | 1 Pa = 1 N/m².
- Pressure acts at 90° (normal) to the surface.

EXAMPLES

- Tractors → large tyres → spread force over large area → ↓ pressure → no sinking.
- Nails/Drawing pins → sharp tip → small area → ↑ pressure → easier to penetrate.
- High heels vs Flat shoes → smaller area = higher pressure | larger area = lower pressure.

EQUATION

- P = F ÷ A →
- rearrange: F = P × A,
- A = F ÷ P.

→ Large area = small pressure | Small area = large pressure.

- Always use cross-sectional area where force acts at right angles.

In liquids:

- Immersed objects experience pressure from all directions → fluid exerts forces normal to surfaces.
- Pressure in fluids can be used to lift or move objects (e.g. hydraulic systems).

WORKED EXAMPLE

- Given: area = 2.73×10^{-2} m², pressure = 5.28×10^{5} Pa
- F = P × A → (5.28×10^{5}) × (2.73×10^{-2}) = 1.44×10^{4} N = 14.4 kN (3 s.f.)

ATMOSPHERIC PRESSURE

- The Earth's atmosphere is a thin layer of air around the planet → extends over 100 km into space.

At sea level:

- Air exerts a pressure of ... 100 kPa.
- Atmospheric pressure ... air molecules collidin... → force per unit area.

ATMOSPHERIC PRESSURE

Variation with Altitude:

- Altitude ↑ → Pressure ↓
- → Higher altitude = fewer air molecules abo... → less weight of ai... pressing do...
- → Air be... dense, so fewer collisio... with surfaces.

Graph sh...

- Decre... pidly at fir... off wi... asing ...

Key idea:

- Pressur... ds on the weight of ...
- The higher you go, the smaller th... air column and lower the pres...
- Everyday links:
- Weather: high pressure = ca... skies | low pressure = cloudy, unsettled.

PRESSURE IN A LIQUID (HT)

- Pressure in a liquid is caused by the weight of the liquid above a point → increases with depth and density.

KEY EQUATION:

- p = h × ρ × g

P = h ρ ...

Pressure = height of the column x density of ... gravitational field strength

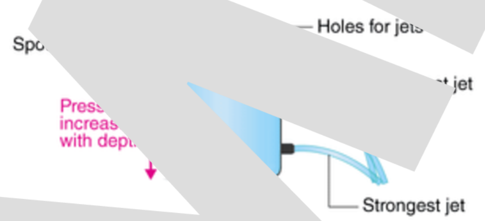
- → p = pressure (Pa) | h = height/depth (m) | ρ = density (kg/m³) | g = gravitational field strength (N/kg).
- On Earth, g ≈ 9.8 N/kg

FACTORS AFFECTING PR...

- Depth (h): ↑ depth → ... above → ↑ pressure.
- Density (ρ): denser liquid → gre... per volume → ↑ pres...
- Gravitational st... ...nger gravity → ↑ p...
- Direction of ... n all directions ... ight ang...) to surfaces.

EXAMPLE...

- Pressure ... rface (greater dept...
- Jet from bottom ... st... | top = weakes...



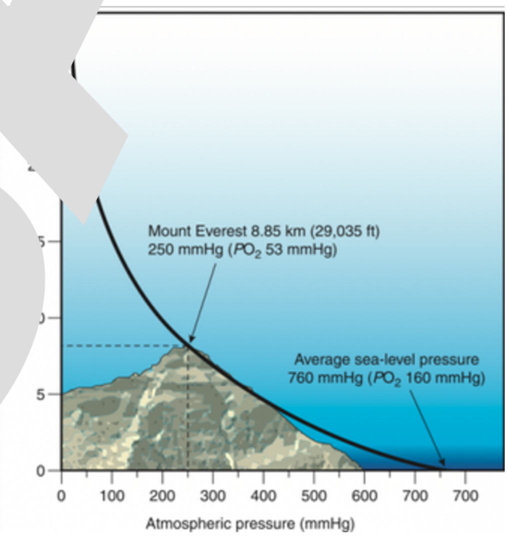
...rines and ...alls.

...MPLE:

- ... ressure at 15 m depth in wat... ...m³, g = 9.8 N/kg).
- p = hρg ... 9.8 = 147,000 Pa = 147 kPa.

... = p ÷ (ρg).

... kPa, ρ = 1000 kg/m³ → ...000 ÷ (1000 × 9.8) = 3.06 m.



UPTHRUST (HT)

Upthrust = upward force on an object ...bmerged in a fluid (liquid or gas) → ...cts opposite to weight.

- Caus... difference in pressure bet... and bottom of object → bo... periences ... igher pressure (... ssure ↑ ... th).

...t = Weig... splaced fluid

De...

- → ... enser fluid → greater u...
- → Volume of flu... displaced (larger volume ... reater upthrust)

Effects:

- Objec... less when immersed (par... ced by upthrust).
- ... use tanks: fill with ... ink | fill with air → rise ... weight vs upthrust).

FLOAT... G & SINKING

Balance condition:

- Float → Upthrust = Weight
- Sink → Weight > Upthrust
- Hover/submerged → Upthrust = Weight (neutral buoyancy)

Density link:

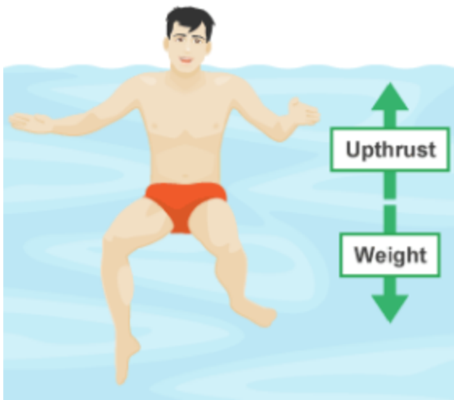
- Object less dense than fluid → floats.
- Object more dense than fluid → sinks.

Why:

- If object's density < fluid's, it displaces enough fluid before being fully submerged to make upthrust = its weight.
- If denser, it can't displace enough fluid → upthrust < weight → sinks.

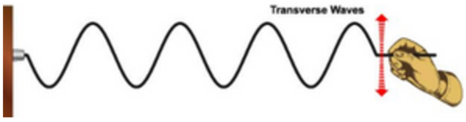
Examples:

- Polystyrene (ρ = 0.05 g/cm³) → floats (much less dense than water, 1.0 g/cm³).
- Wood (ρ = 0.9 g/cm³) → partly submerged but floats (slightly less dense).
- Iron (ρ = 7.9 g/cm³) → sinks (denser than water).

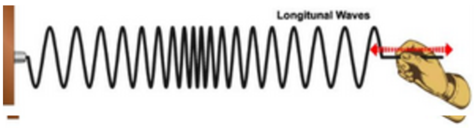


TRANSVERSE & LONGITUDINAL WAVES

Waves transfer energy, not matter → 2 types:
🔹 Transverse → vibrations perpendicular to energy transfer
🔹 Longitudinal → vibrations parallel to direction of energy transfer



📈 **TRANSVERSE WAVES**
Definition: Vibrate at right angles (90°) to direction of energy transfer → e.g. EM waves, ripples, S-waves, guitar strings
🔸 Crest = highest point | Trough = lowest
🔸 Can move through solids, liquid surfaces, and vacuum (EM only)
🥏 Seen on a rope → move hand up/down → wave travels across



🌀 **LONGITUDINAL WAVES**
Definition: Vibrate parallel to energy transfer → e.g. sound, P-waves, pressure waves
🔸 Compression = close particles | Rarefaction = spread out
🔸 Travel through solids, liquids, gases → not vacuum
🔴 Seen in a slinky → push/pull coil → wave travels forward

🖊 **REPRESENTING WAVES**
📘 Transverse: drawn as continuous c
🪗 Longitudinal: drawn as lines → compressions close, rarefactions spr

🌐 **WAVEFRONTS**
🔹 Wavefront = top view of wave
🔹 Transverse: 1 line = crest or trough | Longitudinal: 1 line = compression or rarefaction
🔹 Close lines = short wav … → Far apart = long wavelength

TIP✅ Know the differen…
→ wavefront diagram (line … ve)
→ wave shape diagram (side

TRANSMISSION OF SO… WAVES

Speed deper… close particles are. Fastest in … rticles tightly packed).

- When … oves from o…
  anoth… e speed c…
- This … chan…
  while … me.
- If spee…
- If speed … gth ↓

REFRACTION OF SOUND FROM DENSER → LESS DENSE

- Velocity decreases
- Wavelength decreases
- Frequency stays the same

WAVE MOTION

- Waves transfer energy, not matter, through a medium → particles oscill… but remain in the same place.

AMPLITUDE (A)

- Maximum displacement from r… position to peak/trough.
- Measured in metres (m) → bi… amplitude = more energy.

WAVELENGTH (λ)

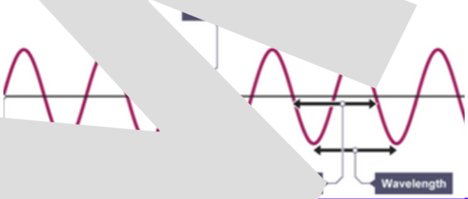
- Distance between same points on two adjacent waves (e.g. peak to peak or trough to trough).
- Measured in metre…
- Transverse: crest … ough to trough
- Longitudinal: centre o… next compression

FREQUENCY (f)

- Number o… int each second.
- Unit = … z) → 1 H… e per secon…
- Hig… ncy → mo… gy

TIME PE…

- Time for o… a point or one full cycle.
- … seconds (s)
- … T → T = 1 ÷ …
- … in Hz, T = …



…RING WAVE SPEED

🔊 … WEEN TWO POINTS

- Tw… 00 m apart → distance … with trundle wheel → one bangs … en blocks above head … pwatch to time delay … hearing 🔔
- … erage time
- … peed of sound = distance ÷ time

…ETHOD 2: USING AN OSCILLOSCOPE

- Place 2 microphones ~5 m apart (measured with tape measure) → connect to oscilloscope → loud sound near 1st mic (e.g. clap) → oscilloscope … ws time delay between microphones
- Speed of sound = distance between … ics ÷ time between peaks

🎤 **ALT OSCILLOSCOPE METHOD – USING SIGNAL GENERATOR**

- Attach signal generator to speaker → connect to 2 microphones + oscilloscope → move one mic until waves align (1 wavelength apart)
- → Measure distance (λ), use known frequency (f)
- → Speed = f × λ

WAVE EQUATION

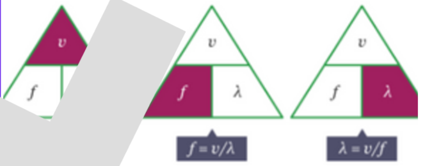
- Wave Speed = Frequency × Wavelength

v = f × λ

- v = … speed (m/s) → how fast e… transferred
- f… ency (Hz) → number of … passing p… d
- … avelength … istance … en corr… g points on …

… ypes (trans… dinal)

🔄 **REARRANGI… THE EQUATION**



…ED EXAMPLE
A wa… has speed 0.12 m/s, and a time period of 4 s

- a) Find frequency
- b) Find wavelength

Part (a):

- T = 4 s → f = 1 ÷ T = 1 ÷ 4 = 0.25 Hz

Part (b):

- v = 0.12 m/s f = 0.25 Hz
- λ = v ÷ f = 0.12 ÷ 0.25 = 0.48 m

🎯 **TIPS**
✅ Use correct symbols: v, f, λ (not L or W)
✅ Watch for kHz → 1 kHz = 1000 Hz
✅ If units are in cm, convert speed to cm/s

MEASURING CONT.

💧 **MEASURING SPEED OF WATER WAVES**

- In calm water → measure distance between 2 people with tape measure → one creates ripple → second times ripple travel using stopwatch
- → Repeat 10× for average
- → Wave speed = distance ÷ time

🧠 **TIP – ACCURACY**

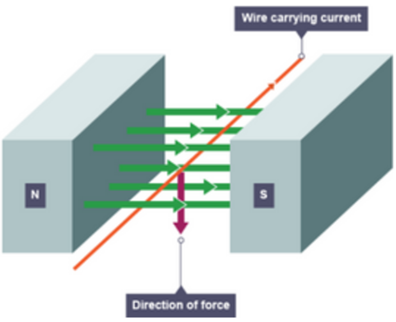
- Most accurate → oscilloscope (automatic timing)
- Least accurate → direct timing (short interval + human reaction error)

WAVES

MAGNESTISM & ELECTROMAGNETISM

THE MOTOR EFFECT (HT)

- When a current-carrying conductor is placed in a magnetic field, it experiences a force.
- The conductor's magnetic field interacts with the external magnetic field.
- The direction of the force is perpendicular to both the magnetic field and the current.
- No force if current is parallel to magnetic field lines.



FORCE SIZE FACTORS

- Magnetic flux density (B) — stronger field → larger force.
- Current (I) — higher current → larger force.
- Length of conductor in field (l) — longer conductor → larger force.

FORCE EQUATION

- F = B × I × l
- F = force (N)
- B = magnetic flux density (tesla, T)
- I = current (A)
- l = length of conductor in field (m)

REVERSING FORCE DIRECTION

- Reversing the current reverses the force direction.
- Reversing the magnet… direction also revers… direction.

WORKED EXAMPLE

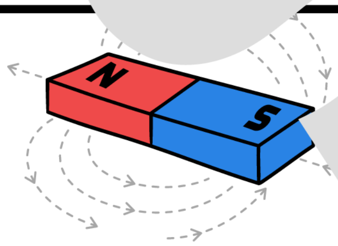
A wire of length 0.40 m carrie… current of 2.5 A at right angles … magnetic field of flux density 0.60 … Calculate the force on the wire.

- Working:
- Formula: … × I × l

Substitute:

- F = 0… × 0.40
- F = 0…

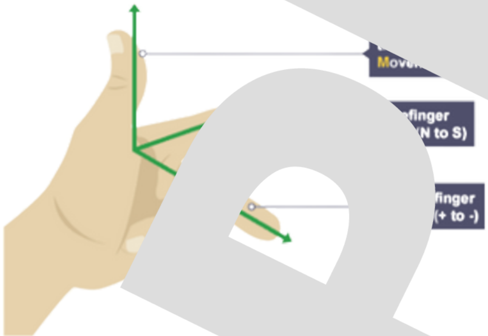
Answer: …e on th… N.



FLEMING'S LEFT-HAND RU… (HT)

Used to find direction of force on a cu… carrying conductor in a magnetic field.

- Three directions are all at right angles t… each other:
- Thumb 👍 = Force / Thrust / Motion
- First finger ☝ = Magnetic Field (N → S)
- Second finger ✌ = Current (Positive → Negative)
- Works only if conductor … field, and current are perpen…



USING T… RULE 🔄

- Poi… …er in direction m… …h to South).
- P… …ion of curre… (pos…
- Thumb … the force…

TIPS 💡

- …agnetic field is … …om North to
- … …to
- …ve c…
- …m, you can physically use your …ck — just do it subtly!

LOUDSPEA… …T)

- Loudspeakers & he… …ones convert … …und via the MOTOR
- … in coil changes d… → magnetic field around coil … → interaction with permanent … → force on coil (Fleming's LH rule) … vibrates → cone vibrates → air …ates → sound waves.

…E OF A LOUDSPEAKER

- … …re wrapped around one pole of a p… …ent magnet → attached to a spe… …r cone.
- Frequency of sound = frequency of AC (changing AC frequency changes pitch).

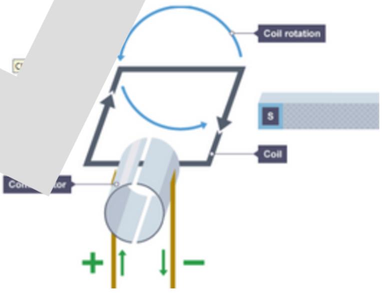
…OPHONES

- Work identically to loudspeakers but in mini form → small coil + small permanent magnet + small cone/diaphragm.
- • Always mention alternating current + changing magnetic field + force on coil.
- • Do not confuse with microphones (they detect sound, not produce it).

ELEC… …C MOTORS (HT)

HOW T… …S

- B… …the moto… … – …carrying … magnetic …eriences … …o r… … a uniform
- Con… …ring commuta… …bon brushes → allows curren… …ection in coil to reverse every half-turn, keeping rotatio… same direction.



FORCES ON THE COIL

Horizontal position:

- Current flows in opposite directions on each side of the coil → forces act in opposite directions (one up, one down) → coil rotates.
- Use Fleming's Left-Hand Rule to find force directions.

Vertical position:

- Split ring not in contact with brushes → no current → no force.
- Coil keeps moving due to momentum.

After vertical:

- Split ring reconnects; current flows again but coil sides swapped.
- Forces act in same rotational direction → continuous spin.

FACTORS AFFECTING THE MOTOR

Speed ↑ by:

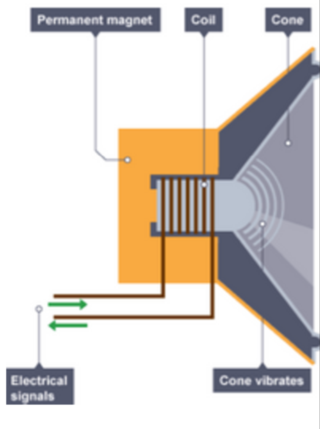
- Increasing current
- Using a stronger magnet

Direction of rotation changed by:

- Reversing current supply
- Reversing magnetic field (swap magnet poles)

Force output ↑ by:

- Increasing current
- Increasing magnetic field strength
- Adding more turns to coil



--Always state that forces on opposite sides of coil are in opposite directions due to opposite current
--Fleming's Left-Hand to check direction.

SPACE PHYSICS

THE SOLAR SYSTEM

- Sun at centre → a star → >99% of Solar System's mass.
- 8 planets orbit the Sun.
- Dwarf planets also orbit the Sun → gravity not strong enough to clear neighbourhood.
- Rocky planets → Mercury, Venus, Earth, Mars.
- Gas planets → Jupiter, Saturn, Uranus, Neptune.

MOONS / SATELLITES

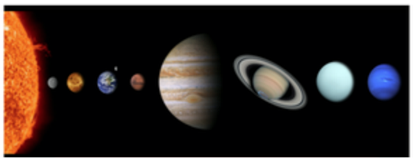
- Moons = natural satellites (orbit planets).
- Artificial satellites = man-made (e.g. ISS).

ASTEROIDS & COMETS

- Asteroid = small rocky object orbiting Sun → asteroid belt between Mars & Jupiter.
- Comet = ice + dust → long elliptical orbit → forms a tail when close to Sun.

MNEMONIC FOR PLANETS

- My Very Excellent Mother Just Served Us Noodles.



OUR PLACE IN SPACE

- Solar System = part of Milky Way galaxy.
- Milky Way = billions of stars → some have planets.
- Universe = billions of galaxies.

DISTANCES IN THE SOLAR SYSTEM

- We see planets because they reflect sunlight.
- Outer Solar System [illegible] from Sun → even lig[illegible] to reach.
- Light from Sun to Ear[illegible]
- Nearest star light trave[illegible] years.

SPEED OF LIGHT

- c = 3 × 10^8 [illegible]

LIFE C[illegible] OF LAR[illegible] STAR[illegible]

LIFE CY[illegible] SUN)

- nebula → [illegible] massive main sequence star → red supergiant → supernova → neutron star / black hole

STAR FORMATION

NEBULA

- Giant cloud of hydrogen gas + dust

FORMATION PROCESS

- Gravity pulls particles closer toget[illegible] → cloud collapses → heats up
- Core becomes dense + hot → be[illegible] rotate
- Hot, dense ball forms → protostar

PROTOSTAR

- Gravity pulls particles inward → density ↑, temperature ↑
- More collisions betwe[illegible]ticles
- When hot enough, nu[illegible] starts (H nuclei → He [illegible]

MAIN SEQUENCE STAR

- Fusion releases heat + light ene[illegible] outward force
- Star becomes s[illegible] main sequence for[illegible]

EQUILIBRIU[illegible]ARS

BALANCE OF [illegible]

- Gravity [illegible]lls o[illegible]yers inward
- Fusion pressur[illegible] hot expanding gases
- Ba[illegible]rces → star is [illegible] e[illegible]

IF T[illegible]

- Te[illegible]ward press[illegible]
- Temp ↓ [illegible]nergy [illegible] pressure ↓ [illegible]ntracts

[illegible]ER

[illegible]ANT

- [illegible] years, hydrogen runs out [illegible]
- Core beg[illegible]m → carbon → nitrogen/oxyg[illegible]ments up to iron
- [illegible] + cool → star [illegible]ergiant.

SUP[illegible]

- [illegible]tops in the core → core [illegible]es suddenly.
- [illegible] layers explode outward → [illegible]ernova.
- [illegible]on creates: Neutron star (dense [illegible]nant)
- [illegible] gas/dust → new nebulae
- [illegible]e may form new stars + pla[illegible]tary systems.
- Heaviest elements (heavier than iron) are formed and scattered into space.

[illegible]TRON STAR / BLACK HOLE

- Neutron star forms from the collapsed dense core.
- If the star is very massive, core collapses further:
- Forms a black hole (extremely dense; gravity so strong not even light escapes).

[illegible]E O[illegible]AR

MAS[illegible]

- All stars s[illegible]ame: nebula → protostar → ma[illegible]equence star.
- Final stag[illegible] depend on star size:
- Stars ab[illegible] same size as the Sun
- Stars m[illegible]ger than the Sun

[illegible]N-LIKE STARS

- [illegible]uence star → Red giant → W[illegible]warf → Black dwarf

RED GIANT

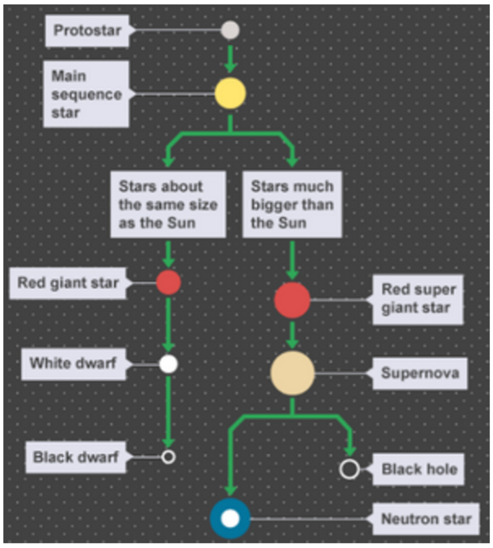
- After billions of years, hydrogen fuel starts to run out.
- Fusion decreases → core shrinks + heats (gravity > pressure).
- Core becomes hot enough for helium to fuse into heavier elements.
- Outer layers expand + cool → star becomes a red giant.

WHITE DWARF

- Helium eventually runs out → fusion stops.
- Star becomes unstable → core collapses under gravity.
- Hot, dense remnant = white dwarf, which gradually cools.
- As it cools, the energy it emits decreases.

BLACK DWARF

- When the white dwarf loses almost all remaining energy → black dwarf.
- It continues cooling until it eventually becomes invisible.



Z

MR. ZEE’S RESOURCES