

Physics summary: formulas and key points

Typed version of the handwritten O Level Physics revision summary. The original handwritten pages are on the same page of megalecture.com.

Measurements

Quantity	SI unit	Quantity	SI unit
Mass	kg	Current	A
Length	m	Temperature	K
Time	s	Amount of substance	mol

Prefix	Value	Prefix	Value
nano (n)	10 ⁻⁹	deci (d)	10 ⁻¹
micro (μ)	10 ⁻⁶	kilo (k)	10 ³
milli (m)	10 ⁻³	mega (M)	10 ⁶
centi (c)	10 ⁻²	giga (G)	10 ⁹

If the vectors to be added are drawn clockwise, the resultant vector must be anticlockwise, or vice versa.

Kinematics

- speed = distance / time
- acceleration = velocity / time, the slope of a velocity–time graph. Velocity is the slope of a displacement–time graph.
- Terminal velocity: air resistance = weight, acceleration = 0, so the object travels at constant velocity (the velocity–time graph rises steeply, then levels off).

Dynamics

- Newton's first law: an object will stay at rest or in constant motion until a force acts on it.
- Newton's second law: force = mass × acceleration.
- Newton's third law: every action has an equal and opposite reaction.
- Balanced forces allow an object to stay at rest or in constant motion; unbalanced forces will cause it to accelerate or decelerate.
- The resultant force is zero when an object is travelling at constant speed.

Mass, weight and density



- mass = force / acceleration = density $\times$ volume = weight / g.f.s.
- weight (N) = mass $\times$ gravitational field strength
- density (g/cm^3) = mass / volume

Turning effect of forces

- moment of force = force $\times$ distance
- Principle of moments: $F_1 \times d_1 = F_2 \times d_2$

Deformation

force = spring constant $\times$ extension (or compression)

Pressure

- pressure = force / area
- pressure in liquids = ρgh = density $\times$ g.f.s. $\times$ depth of liquid
- Pascal's principle: $F_x / A_x = F_y / A_y$
- Boyle's law: $P_1 V_1 = P_2 V_2$

Energy sources and transfer of thermal energy

- work done (J) = force $\times$ distance (energy is the ability to do work)
- power = work done / time (the rate of doing work)
- kinetic energy = $\frac{1}{2}mv^2$ (mass in kg, velocity in m/s)
- gravitational potential energy = mgh
- $E = mc^2$ (energy; c = speed of light = 3×10^8 m/s)
- efficiency = (energy or power output / energy or power input) $\times 100$
- elastic potential energy = $\frac{1}{2}ke^2$

Temperature

$\theta = (L_\theta - L_0) / (L_{100} - L_0) \times 100$, where L_0 is the length of mercury at the ice point, L_{100} the length at the steam point and L_θ the length at the unknown temperature.

sensitivity = increase in mercury level / increase in temperature ($\Delta l / \Delta \theta$)

Thermal properties of matter

- heat capacity (J/K or J/°C) = Q / θ , where Q is the energy supplied and θ the increase in temperature: the heat energy required to raise the temperature of a substance by 1 °C.
- specific heat capacity (J/(kg K) or J/(kg °C)) = $Q / (m\theta)$, where m is the mass of the substance: the heat energy required to raise the temperature of 1 kg of a substance by 1 °C.
- $Q = ml$, with l the latent heat (J/kg) and m the mass of substance that has changed state.

General wave properties

- velocity = frequency $\times$ wavelength: $v = f\lambda$ (λ is "lambda")
- frequency = $1 / T$

Light

- refractive index $n = \sin i / \sin r = c / v$ (speed of light in a vacuum / speed of light in the medium)
= real depth / apparent depth
- critical angle: $C = \sin^{-1}(1 / n)$

Electromagnetic spectrum

Wave	Typical frequency (Hz)	Uses
Radio waves	10^4	television, radio
Microwaves	10^{10}	satellites
Infra-red	10^{13}	remote-control devices, grills and toasters
Visible light	10^{14}	optic fibres for transmission of signals (and fluorescent tubes)
UV rays	10^{15}	sun-beds, sterilising medical equipment
X-rays	10^{17}	2-dimensional images in medicine, scanners
Gamma rays	10^{20}	killing cancerous cells and tumours, finding cracks in metals

Sound

- Higher pitch = higher frequency; larger amplitude = louder.
- Speed of sound: solid > liquid > gas. Speed of sound in air ≈ 330 m/s.

Electromagnetism

- Right-hand grip rule gives the direction of the field around a current.
- $\odot$ = current out of the page; $\otimes$ = current into the page.
- Two wires carrying current in the same direction attract each other; in opposite directions they repel.
- Fleming's left-hand rule: first finger = magnetic field, thumb = force, second finger = direction of current.
- Split-ring commutators are used in d.c. motors; slip rings in a.c. generators.

Current electricity

- current (amperes) = charge / time; $1 \text{ A} = 1 \text{ C} / 1 \text{ s}$
- voltage (volts) = energy / charge = work done / charge; $1 \text{ V} = 1 \text{ J} / 1 \text{ C}$

- $V = IR$; resistance (ohms) = voltage / current
- $V-I$ and $I-V$ graphs: filament lamp (curve bending over), thermistor (curve bending up), diode (no current until a forward voltage, then a straight rise).
- Series resistors: $I_1 = I_2 = I_3$; $V = V_1 + V_2 + V_3$; $R = R_1 + R_2 + R_3$
- Parallel resistors: $I = I_1 + I_2 + I_3$; $V_1 = V_2 = V_3$; $1/R = 1/R_1 + 1/R_2 + 1/R_3$
- $E = Pt = IVt = I^2Rt$ (joules); power = VI (watts)
- e.m.f. and p.d. are both voltages. Cells in series: $E = E_1 + E_2 + E_3$. Cells in parallel: $E_1 = E_2 = E_3$; if one fails the others keep working, they last longer, lower resistance, less energy loss.
- Energy = power $\times$ time: joules = watts $\times$ seconds; kilowatt-hours = kilowatts $\times$ hours.

Electronics

Potential divider: $V_1 = (R_1 / (R_1 + R_2)) \times V$, and $V_2 = (R_2 / (R_1 + R_2)) \times V$, where V is the supply across R_1 and R_2 in series and V_1 , V_2 are the voltages across each.

Radioactivity

Unstable nuclei emit:

- **α particles** (helium nuclei, ${}^4_2\alpha$): higher mass, so greatest ionisation power and least penetration; stopped by paper or 8–10 cm of air; speed about 10% of c ; deflected (less) in electric and magnetic fields.
- **β particles** (electrons, ${}^0_{-1}\beta$): ionisation power less than α , penetration greater than α ; stopped by a few mm of aluminium; speed about 90% of c ; deflected most in electric and magnetic fields.
- **γ rays** (electromagnetic waves): no charge, no mass; greatest penetration, stopped by a lead block; least ionisation; not deflected because they carry no charge; $c = 3 \times 10^8$ m/s.
- ${}_Z^AX \rightarrow {}^4_2\alpha + {}^{A-4}_{Z-2}Y$
- ${}_Z^AX \rightarrow {}^0_{-1}\beta + {}^A_{Z+1}Y$
- ${}_Z^AX \rightarrow \gamma + {}^A_ZX$

In every half-life, the number of atoms, the mass and the activity halve.

Still to add (from the last page's to-do list): the vertical-row / horizontal-line notation, melting point, boiling point, scale, periscope image properties, and a comparison of distance–time and speed–time graphs.

Checked by Mega Lecture

This typed version follows the handwritten summary. Corrections: typical frequencies for microwaves (written 10^6), infra-red (10^9) and visible light (10^{12}) replaced by 10^{10} , 10^{13} and 10^{14} Hz; speed of sound in air 300 m/s changed to about 330 m/s; "kilowatt-hour = kilowatt $\times$ seconds" changed to kilowatt $\times$ hours; "the potential divider formula" written with the supply voltage V (the notes swap V_1 and V_2). The $V-I$ graphs and the circuit diagram are described in words. Spotted a mistake? Tell us on WhatsApp: +92 336 780 1123.