# IGCSE Physics Equations

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## 1 Measurements and units

**Prefixes:**

| Prefix | Meaning |
|---|---|
| G (giga) | $10^9$ |
| M (mega) | $10^6$ |
| k (kilo) | $10^3$ |
| d (deci) | $10^{-1}$ |
| c (centi) | $10^{-2}$ |
| m (milli) | $10^{-3}$ |
| $\mu$ (micro) | $10^{-6}$ |
| n (nano) | $10^{-9}$ |

**Density:** $\rho = \dfrac{m}{v}$ / density $= \dfrac{\text{mass}}{\text{volume}}$

## 2 Forces and motion

**Speed / velocity:** $v = \dfrac{d}{t}$ / speed $= \dfrac{\text{distance}}{\text{time}}$, velocity $= \dfrac{\text{displacement}}{\text{time}}$

**Acceleration:** $a = \dfrac{v-u}{t}$ / acceleration $= \dfrac{\text{change in velocity}}{\text{time}}$

**Weight:** $W = mg$ / weight = mass $\times$ $g$

**Resultant force:** $F = ma$ / resultant force = mass $\times$ acceleration

**Resultant force by momentum:** $F = \dfrac{mv - mu}{t}$ / resultant force $= \dfrac{\text{change in momentum}}{\text{time}}$

**Elastic collision:** $m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$

**Stick together after collision:** $m_1u_1 + m_2u_2 = (m_1 + m_2)v_{1+2}$

**Centripetal force (do not need for exam):** $F = \dfrac{mv^2}{r}$

## 3 Forces and pressure

**Moment:** moment = force $\times$ perpendicular distance from pivot

**Spring constant:** $F = kx$ / load = spring constant $\times$ extension

**Pressure:** $P = \dfrac{F}{A}$ / pressure $= \dfrac{\text{force}}{\text{surface area in contact}}$

**Pressure at a depth in liquid:** $P = \rho gh$ / pressure at a depth = density of liquid $\times$ $g$ $\times$ depth

**Boyle's law:** $p_1V_1 = p_2V_2$

# 4 Forces and energy

**Work:** $W = fd$ / work done = force × distance

**GPE:** $GPE = mgh$ / gravitational potential energy = mass × $g$ × height

**KE:** $E_k = \frac{1}{2}mv^2$ / kinetic energy = $\frac{1}{2}$ × mass × speed$^2$

**Efficiency:** $\text{efficiency} = \frac{\text{useful work done}}{\text{total energy input}} = \frac{\text{useful energy output}}{\text{total energy input}} = \frac{\text{useful power output}}{\text{total power input}}$

**Power:** $P = \frac{E}{t}$ / $\text{speed} = \frac{\text{energy transferred}}{\text{time}} = \frac{\text{work done}}{\text{time}}$

# 5 Thermal effects

**Kelvin temperature:** Kelvin temperature = Celsius temperature + 273

**Absolute zero:** 0 K / $-273°$C

**Pressure law:** $\frac{P_1}{T_1} = \frac{P_2}{T_2}$

**Charles' law:** $\frac{V_1}{T_1} = \frac{V_2}{T_2}$

***** Temperatures should be in Kelvin (SI unit)

**Specific heat capacity:** $\triangle E = mc\triangle T$ / energy transferred = mass × specific heat capacity × temperature change

**Specific heat capacity of water:** 4200 J/kg°C

**Latent heat unit:** J/kg, KJ/kg, etc.

# 6 Waves and sounds

**Wave speed:** $v = f\lambda$ / wave speed = frequency × wavelength

**Speed of sound:** gas ≈ 340 m/s, liquid ≈ 1500 m/s, solid ≈ 5000 m/s

# 7 Rays and waves

**Refractive index:** $n_{\text{substance}} = \frac{c_{\text{vacuum}}}{c_{\text{substance}}}$ / $\text{refractive index} = \frac{\text{speed of light in sound}}{\text{speed of light in substance}}$

**Snell's law:** $n_1 \sin\theta_1 = n_2 \sin\theta_2$

**To faster medium:** $\frac{\sin i}{\sin r} = \frac{1}{n}$

**To slower medium:** $\frac{\sin i}{\sin r} = n$

**Critical angle:** $\sin c = \frac{1}{n}$

**Speed of light:** $3 \times 10^8$ m/s

# 8 Electricity

**Charge of 1 electron:** $1.6 \times 10^{-19}$ C (one Coulomb is about the charge of $6 \times 10^{18}$ electrons)

**Current:** $I = \frac{Q}{t}$ / $\text{current} = \frac{\text{charge}}{\text{time}}$

**Voltage:** $V = \frac{W}{Q}$ / $\text{voltage} = \frac{\text{energy transferred}}{\text{charge}}$

**Ohm's law:** $V = IR$ / voltage = current × resistance

**Resistance of a wire:** $R = \dfrac{\rho L}{A}$ / $\text{resistance} = \dfrac{\text{resistivity} \times \text{length}}{\text{cross sectional area}}$

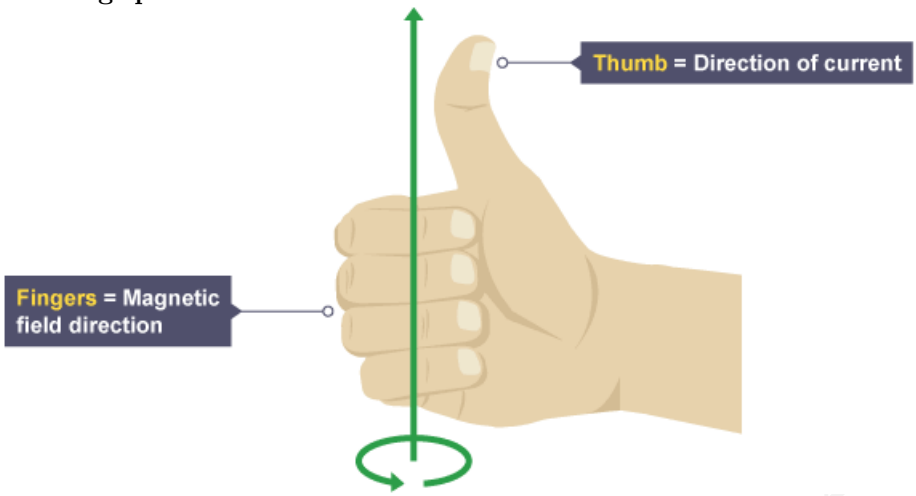
**Combined resistances of resistors in series:** $R = R_1 + R_2$ / $R = R_1 + R_2 + R_3$

**Combined resistances of resistors in parallel:** $\dfrac{1}{R} = \dfrac{1}{R_1} + \dfrac{1}{R_2}$ / $\dfrac{1}{R} = \dfrac{1}{R_1} + \dfrac{1}{R_2} + \dfrac{1}{R_3}$

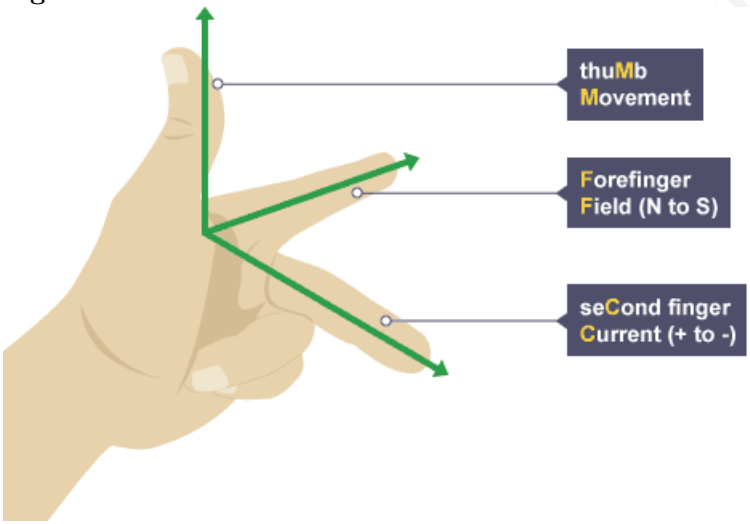
**Power:** $P = VI = I^2R = \dfrac{V^2}{R}$

# 9 Magnets and currents

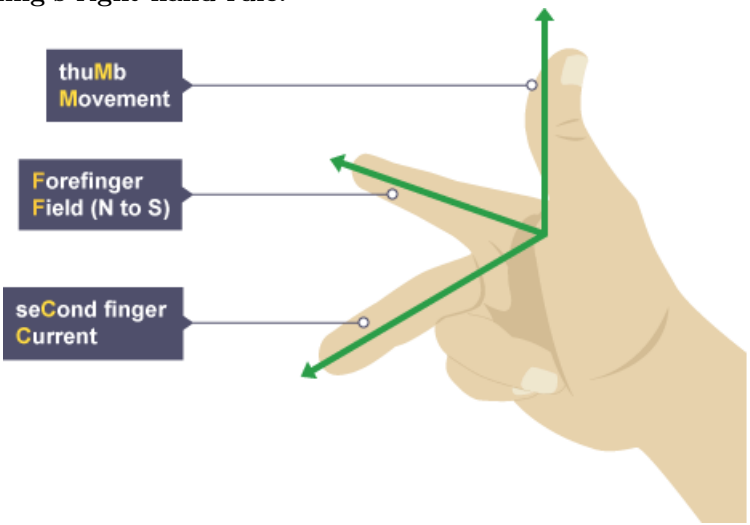
**Right hand grip rule:**




**Fleming's left hand rule:**




**Fleming's right hand rule:**



**Transformer voltage:** $\dfrac{V_p}{V_s} = \dfrac{N_p}{N_s} \;/\; \dfrac{\text{input voltage}}{\text{output voltage}} = \dfrac{\text{number of turns on primary coil}}{\text{number of turns on secondary coil}}$

**Transformer current:** $V_p \times I_p = V_s \times I_s$

**Power lost in cable:** $P = I^2R$

# 10 Atoms and radioactivity

**Alpha decay:** ${}^{A}_{Z}X \rightarrow {}^{A-2}_{Z-4}Y + {}^{4}_{2}\alpha$

**Beta decay:** ${}^{A}_{Z}Y \rightarrow {}^{A}_{Z+1}Y + {}^{0}_{-1}\beta$

**Gamma decay:** ${}^{A}_{Z}X \rightarrow {}^{A}_{Z}Y + {}^{0}_{0}\gamma$

# 11 The Earth in space

**Gravitational force from sun:** $F \propto \dfrac{1}{r^2}$

**Distance of 1 light year:** $9.5 \times 10^{1}5$ m / $9.5 \times 10^{1}2$ km

**Hubble constant:** $H_0 = \dfrac{v}{d} \approx 2.2 \times 10^{-18}$ s$^{-1}$

**Age of universe:** $t = \dfrac{d}{v} = \dfrac{1}{H_0} \approx 4.55 \times 10^{17}$ s $\approx 14.4$ billion years