Physics Formulas: Electricity and Waves

coddy.tech/physics/formulas/electricity

CURRENT AND RESISTANCE

Current and charge

CURRENT

$$I = \frac{\Delta Q}{\Delta t}$$

CHARGE

$$Q = ne$$

I current Q charge n number of charges
e elementary charge

Ohm's law

$$V = IR$$

RESISTIVITY

$$R = \frac{\rho L}{A}$$

V voltage R resistance ρ resistivity L length
A cross-sectional area

Electrical power and energy

ELECTRICAL POWER

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

ENERGY TRANSFERRED

$$E = Pt = IVt$$

P power t time

Emf and internal resistance

$$\varepsilon = I(R + r)$$

TERMINAL VOLTAGE

$$V = \varepsilon - Ir$$

ε emf r internal resistance

CIRCUITS

Resistors in series

TOTAL RESISTANCE

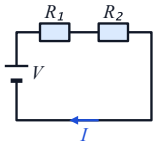
$$R_T = R_1 + R_2 + \cdots$$

CURRENT

$$I_T = I_1 = I_2 = \cdots$$

VOLTAGE

$$V_T = V_1 + V_2 + \cdots$$



Resistors in parallel

TOTAL RESISTANCE

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \cdots$$

TWO RESISTORS

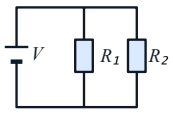
$$R_T = \frac{R_1 R_2}{R_1 + R_2}$$

CURRENT

$$I_T = I_1 + I_2 + \cdots$$

VOLTAGE

$$V_T = V_1 = V_2 = \cdots$$



Kirchhoff's laws

JUNCTION RULE

$$\Sigma I_{\text{in}} = \Sigma I_{\text{out}}$$

LOOP RULE

$$\Sigma \Delta V = 0$$

Capacitors

CAPACITANCE

$$C = \frac{Q}{V}$$

ENERGY STORED

$$U = \tfrac{1}{2}QV = \tfrac{1}{2}CV^2$$

IN PARALLEL

$$C_T = C_1 + C_2 + \cdots$$

IN SERIES

$$\frac{1}{C_T} = \frac{1}{C_1} + \frac{1}{C_2} + \cdots$$

TIME CONSTANT

$$\tau = RC$$

C capacitance Q charge

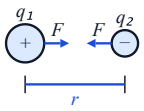
ELECTRIC FIELDS

Coulomb's law

$$F = k\frac{|q_1 q_2|}{r^2}$$

COULOMB CONSTANT

$$k = \frac{1}{4\pi\varepsilon_0}$$



q_1, q_2 charges r distance

Electric field

$$E = \frac{F}{q}$$

POINT CHARGE

$$E = k\frac{|q|}{r^2}$$

BETWEEN PARALLEL PLATES

$$E = \frac{V}{d}$$

E electric field strength q charge
d distance between the plates

Electric potential

POINT CHARGE

$$V = k\frac{q}{r}$$

ELECTRIC POTENTIAL ENERGY

$$U = qV$$

CHANGE IN POTENTIAL ENERGY

$$\Delta U = q\Delta V$$

V electric potential q charge U potential energy

MAGNETISM

Magnetic force

ON A MOVING CHARGE

$$F = |q|vB\sin\theta$$

ON A WIRE CARRYING CURRENT

$$F = BIL\sin\theta$$

B magnetic field θ angle to the field

Magnetic field of a long wire

$$B = \frac{\mu_0 I}{2\pi r}$$

μ_0 permeability of free space
r distance from the wire

Electromagnetic induction

MAGNETIC FLUX

$$\Phi = BA\cos\theta$$

FARADAY'S LAW

$$\varepsilon = -N\frac{\Delta\Phi}{\Delta t}$$

ROD MOVING ACROSS A FIELD

$$\varepsilon = BLv$$

Φ magnetic flux
θ angle between the field and the normal to the area
N number of turns L length v speed

WAVES AND OPTICS

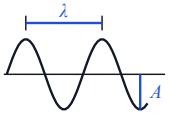
Wave equation

WAVE SPEED

$$v = f\lambda$$

PERIOD

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



f frequency λ wavelength
A amplitude

Light and photons

SPEED OF LIGHT

$$c = f\lambda$$

PHOTON ENERGY

$$E = hf = \frac{hc}{\lambda}$$

In a vacuum: λ is the wavelength in a vacuum.

h Planck constant

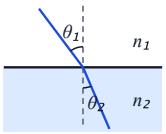
Refraction

REFRACTIVE INDEX

$$n = \frac{c}{v}$$

SNELL'S LAW

$$n_1 \sin\theta_1 = n_2 \sin\theta_2$$



CRITICAL ANGLE

$$\sin\theta_c = \frac{n_2}{n_1}$$

Angles are measured from the normal. A critical angle exists only when $n_1 > n_2$.

n refractive index θ_1, θ_2 angles from the normal

Lenses and mirrors

THIN LENS

$$\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$$

MAGNIFICATION

$$M = \frac{h_i}{h_o} = -\frac{d_i}{d_o}$$

f focal length d_o object distance
d_i image distance h_o, h_i object and image heights

Double slit interference

BRIGHT FRINGES

$$d \sin\theta = m\lambda$$

FRINGE SPACING

$$\Delta y = \frac{\lambda L}{d}$$

Fringe spacing: for small angles, with the screen far from the slits.

d distance between the slits m order of the fringe
L distance to the screen

CONSTANTS

Constants

ELEMENTARY CHARGE

$$e = 1.60 \times 10^{-19}\ \mathrm{C}$$

COULOMB CONSTANT

$$k = 8.99 \times 10^{9}\ \mathrm{N\,m^2/C^2}$$

PERMITTIVITY OF FREE SPACE

$$\varepsilon_0 = 8.85 \times 10^{-12}\ \mathrm{C^2/(N\,m^2)}$$

SPEED OF LIGHT

$$c = 3.00 \times 10^{8}\ \mathrm{m/s}$$

PLANCK CONSTANT

$$h = 6.63 \times 10^{-34}\ \mathrm{J\,s}$$

PERMEABILITY OF FREE SPACE

$$\mu_0 = 4\pi \times 10^{-7}\ \mathrm{T\,m/A}$$