

USEFUL FORMULÆ AND CONSTANTS

Electrical forces

$$\vec{F} = \sum \vec{F}_{All\ Sources} \qquad F = \frac{kQ_1Q_2}{r^2}$$

Electric Fields

$$\vec{E} = \sum \vec{E}_{All\ Sources} \qquad E = \frac{kQ}{r^2} \qquad dE = \frac{k dQ}{r^2} \qquad \vec{F} = q\vec{E}$$

$$\infty \text{ wire} : E = \frac{2k\lambda}{r} \qquad \infty \text{ sheet} : E = \frac{\lambda}{2\epsilon_0} \qquad \text{Sphere} : E = \frac{kQ}{r^2}$$

Gauss Law

$$\Phi = \int \vec{E} \cdot d\vec{A} \qquad \epsilon_0 \int \vec{E} \cdot d\vec{A} = Q$$

Electric Potentials

$$V = \sum V_{All\ Sources} \qquad V = \frac{kQ}{r} \qquad V = \int \frac{k dQ}{r}$$

$$U = qV \qquad U_{total} = \frac{1}{2} \sum_{i,j} q_i V_j \qquad -\Delta V = \int \vec{E} \cdot d\vec{s} \qquad E_s = -\frac{\partial V}{\partial s}$$

Energy

$$\Delta KE + \Delta PE = 0$$

$$W = \Delta KE = -\Delta PE$$

Integrals

$$\int \frac{dx}{(r^2 + x^2)^{3/2}} = \frac{1}{r^2} \frac{x}{\sqrt{r^2 + x^2}} \qquad \int \cos(x) dx = \sin(x) \qquad \int \sin(x) dx = -\cos(x)$$

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Volumes

$$\text{cube} = L^3 \qquad \text{sphere} = \frac{4\pi R^3}{3}$$

Areas

$$\text{circle} = \pi R^2 \qquad \text{sphere} = 4\pi R^2$$

Current

$$I = \lambda v A \qquad I = nevA \qquad I = \int ne\vec{v} \cdot d\vec{A}$$

Capacitors

$$Q = CV \qquad C = \kappa\epsilon_0 \frac{A}{d} \qquad C = 2\pi\kappa\epsilon_0 \frac{L}{\ln(b/a)} \qquad E = \frac{1}{2}QV = \frac{1}{2}CV^2 = \frac{1}{2}Q^2/C$$

Resistors

$$V = IR \qquad R = \rho \frac{l}{A} \qquad \text{Power} = IV = \frac{V^2}{R} = I^2R$$

Equivalent Circuits

$$C_{\text{parallel}} = C_1 + C_2 + \dots \qquad C_{\text{series}} = \left(\frac{1}{C_1} + \frac{1}{C_2} + \dots \right)^{-1}$$

$$R_{\text{parallel}} = \left(\frac{1}{R_1} + \frac{1}{R_2} + \dots \right)^{-1} \qquad R_{\text{series}} = R_1 + R_2 + \dots$$

Charging and discharging Capacitors

$$V_{\text{cap}} = V \times (1 - e^{-t/RC}) \qquad V_{\text{cap}} = V \times e^{-t/RC}$$

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Magnetism and Magnetic Forces

$$\vec{F} = q \vec{v} \times \vec{B} \quad F = I \vec{L} \times \vec{B} \quad F_{centripetal} = \frac{mv^2}{r}$$
$$\tau = NI\vec{A} \times \vec{B}$$

Biot Savart and Magnetic Fields

$$\vec{B} = \sum \vec{B}_{All \ Sources} \quad d\vec{B} = \frac{\mu_0}{4\pi} \frac{I d\vec{s} \times \hat{r}}{r^2}$$
$$B_{wire} = \frac{\mu_0 I}{2\pi R} \quad B_{loop} = \frac{N\mu_0 I}{2R} \quad B_{solenoid} = \mu_0 In$$

Amperes Law

$$\oint \vec{B} \cdot d\vec{s} = \mu_0 I$$

Magnetic Induction

$$\Phi = \int \vec{B} \cdot d\vec{A} \quad EMF = -\frac{d\Phi_{total}}{dt}$$

$$L = \frac{N\Phi}{I} \quad EMF = -\frac{LdI}{dt}$$

$$V_2/V_1 = N_2/N_1 \quad I_1 V_1 = I_2 V_2 \quad I_2/I_1 = N_1/N_2$$

Inductive circuit

$$I(t) = \frac{V_0}{R} (1 - e^{-t/\tau}) \quad I(t) = I_0 e^{-t/\tau} \quad \tau = L/R$$

Physical Constants

Acceleration due to gravity (g)	$9.80 \text{ m/s}^2 = 32 \text{ ft/s}^2$
Charge on Electron (e)	$1.602 \times 10^{-19} \text{ C}$
Mass of the electron	$9.11 \times 10^{-31} \text{ kg}$
Gravitational constant (G)	$6.672 \times 10^{-11} \text{ N}\cdot\text{m}^2/\text{kg}^2$
Electrical Constant (k)	$8.988 \times 10^9 \text{ N}\cdot\text{m}^2/\text{C}^2$
Permittivity of free space (ϵ_0)	$8.85 \times 10^{-12} \text{ C}^2/\text{Nm}^2$
Permeability of free space (μ_0)	$4\pi \times 10^{-7} \text{ T}\cdot\text{m/A}$

Conversion Constants

Length

1 in. = 2.54 cm
1 m = 39.37 in. = 3.281 ft
1 ft = 0.3048 m
12 in. = 1 ft
3 ft = 1 yd
1 yd = 0.9144 m
1 km = 0.621 mi
1 mi = 1.609 km
1 Å = 10^{-10} m
1 mm = 10^{-3} m
1 μm = $10^{-6} \text{ m} = 10^4 \text{ Å}$
1 lightyear = $9.461 \times 10^{15} \text{ m}$

Mass

1000 kg = 1 t (metric ton)
1000 g = 1 kg
1 slug = 14.59 kg
1 u = $1.66 \times 10^{-27} \text{ kg}$

Energy

1 J = 0.738 ft·lb = 10^7 erg
1 cal = 4.186 J
1 BTU = 252 cal = $1.054 \times 10^3 \text{ J}$
1 eV = $1.602 \times 10^{-19} \text{ J}$
931.5 MeV = 1 u
1 kW·h = $3.6 \times 10^6 \text{ J}$

Improper Conversions

1 lb (weight) = 0.454 kg (mass) at the surface of the earth

Force

1 N = $10^5 \text{ dyne} = 0.2248 \text{ lb}$
1 lb = 4.448 N
1 dyne = $10^{-5} \text{ N} = 2.248 \times 10^{-6} \text{ lb}$

Velocity

1 mi/h = 1.47 ft/s = 0.447 m/s
1 mi/h = 1.61 km/h
1 m/s = 100 cm/s = 3.281 ft/s
1 mi/min = 60 mi/h = 88 ft/s

Acceleration

1 $\text{m/s}^2 = 3.28 \text{ ft/s}^2 = 100 \text{ cm/s}^2$
1 $\text{ft/s}^2 = 0.3048 \text{ m/s}^2 = 30.48 \text{ cm/s}^2$

Power

1 hp = 550 ft·lb/s = 0.746kW
1 W = 1 J/s = 0.738 ft·lb/s
1 BTU/h = 0.293 W

Angle

1 radian = 57.29578°
1° = 0.01745 rad