

Physics 12 Formulas

Fundamental Constants and Equations

1 Physics Formulas

1.1 CH1,2,3: Kinematics

$$\begin{array}{lll} \vec{v} = \vec{v}_0 + \vec{a}t & \bar{v} = \frac{\vec{v} + \vec{v}_0}{2} & v^2 = v_0^2 + 2\vec{a} \cdot \vec{d} \\ \vec{d} = \vec{v}_0t + \frac{1}{2}\vec{a}t^2 & d = \left(\frac{v_f + v_i}{2}\right)t & v_x = v \cos \theta \\ v_y = v \sin \theta & v = \sqrt{v_x^2 + v_y^2} & \theta = \tan^{-1}(v_y/v_x) \\ h = \frac{v_{0y}^2}{2g} & R = \frac{v_0^2 \sin 2\theta_0}{g} & (\text{max when } \theta_0 = 45^\circ) \end{array}$$

1.2 CH4,5,9: Dynamics

$$\begin{array}{lll} \vec{F}_{\text{net}} = m\vec{a} & \vec{F}_{\text{net}} = \vec{F}_{\text{applied}} - \vec{F}_{\text{against}} & \vec{F}_g = m\vec{g} \\ \vec{F}_{\text{fr}} = \mu\vec{F}_N & T = \frac{F_{\perp}}{2\sin(\theta)} & \Delta L = \frac{1}{Y} \frac{F}{A} L_0 \\ w_{\parallel} = w \sin(\theta) = mg \sin(\theta) & w_{\perp} = w \cos(\theta) = mg \cos(\theta) & F_D = \frac{1}{2} C \rho A v^2 \\ MA = \frac{F_o}{F_i} = \frac{l_i}{l_o} & \tau = rF \sin \theta & \end{array}$$

1.3 CH6: Circular Motion and Gravity

$$\begin{array}{ll} \Delta\theta = \frac{\Delta s}{r} & v = r\omega \text{ or } \omega = \frac{v}{r} \\ a_c = \frac{v^2}{r} = r\omega^2 & F_c = ma_c = m\frac{v^2}{r} = mr\omega^2 \\ F = G\frac{mM}{r^2} & \frac{T_1^2}{T_2^2} = \frac{r_1^3}{r_2^3}, T^2 = \frac{4\pi^2}{GM}r^3 \end{array}$$

1.4 CH7: Work, Energy, and Power

$$\begin{array}{lll} W = \vec{F} \cdot \vec{d} & E_p = mgh & E_k = \frac{1}{2}mv^2 \\ P = \frac{W}{t} & \Delta E = E_f - E_i & \end{array}$$

1.5 CH8: Momentum

$$\begin{array}{lll} \vec{p} = m\vec{v} & \Delta\vec{p} = \vec{F}\Delta t & m_T\vec{V}_T = m_1\vec{v}_1 + m_2\vec{v}_2 \\ a = \frac{v_e}{m} \frac{\Delta m}{\Delta t} - g & v = v_e \ln \frac{m_0}{m_r} & \end{array}$$

1.6 CH18: Electrostatics - Electric Forces and Fields

$$\vec{F}_E = k \frac{|q_1 q_2|}{r^2} \hat{r} \qquad \vec{E} = \frac{\vec{F}}{q} = k \frac{|Q|}{r^2} \hat{r}$$

1.7 CH19: Electric Potential and Capacitance

$$E_p = \frac{kq_1 q_2}{r}, \quad \Delta PE = q\Delta V$$

$$V = \frac{kQ}{r}, \quad V_{AB} = Ed \text{ (uniform field)}$$

$$\vec{E} = -\frac{\Delta V}{\Delta s} \hat{r}$$

$$C = \frac{Q}{V} = \epsilon_0 \frac{A}{d} \text{ (parallel)} = \kappa \epsilon_0 \frac{A}{d} \text{ (dielectric)}$$

$$\frac{1}{C_s} = \frac{1}{C_1} + \frac{1}{C_2} + \dots, \quad C_p = C_1 + C_2 + \dots$$

$$E_{cap} = \frac{QV}{2} = \frac{CV^2}{2} = \frac{Q^2}{2C}$$

1.8 CH20: Current and Resistance

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

$$\text{Ohm's Law: } I = \frac{V}{R}, \quad V = IR$$

$$R = \frac{\rho L}{A}, \quad \rho = \rho_0(1 + \alpha \Delta T), \quad R = R_0(1 + \alpha \Delta T)$$

$$P = IV = I^2 R = \frac{V^2}{R}, \quad E = Pt$$

$$\text{AC: } V = V_0 \sin 2\pi ft, \quad I = I_0 \sin 2\pi ft$$

$$V_{\text{rms}} = \frac{V_0}{\sqrt{2}}, \quad I_{\text{rms}} = \frac{I_0}{\sqrt{2}}, \quad P_{\text{ave}} = I_{\text{rms}} V_{\text{rms}}$$

1.9 CH21: Circuits

$$\text{Series: } R_s = R_1 + R_2 + \dots, \quad I_1 = I_2 = \dots$$

$$\text{Parallel: } \frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \dots, \quad V_1 = V_2 = \dots$$

$$\text{Terminal voltage: } V = \text{emf} - Ir$$

$$\text{Kirchhoff's Rules: } \sum I_{\text{in}} = \sum I_{\text{out}}, \quad \sum \Delta V = 0$$

$$V = \text{emf}(1 - e^{-t/\tau}) \text{ (chrg)}, = V_0 e^{-t/\tau} \text{ (dischrg)}$$

$$\text{RC Circuits: } \tau = RC$$

1.10 CH22: Magnetism

$$\vec{F} = Q\vec{v} \times \vec{B} = I\vec{L} \times \vec{B}$$

$$F = qvB \sin \theta$$

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

$$B_{\text{loop}} = \frac{\mu_0 I}{2r}$$

$$B_{\text{solenoid}} = \mu_0 nI$$

$$r = \frac{mv}{qB}$$

$$\tau = NIAB \sin \theta$$

$$\varepsilon_{\text{Hall}} = Blv$$

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

1.11 CH23: Electromagnetic Induction

$$\Phi = \vec{B} \cdot \vec{A} = BA \cos \theta$$

$$\mathcal{E} = -N \frac{d\Phi}{dt}$$

$$\vec{\mathcal{E}} = \vec{v} \times \vec{B}$$

$$\text{emf} = Blv$$

$$\text{emf}_0 = NAB\omega$$

$$V_{\text{back}} = \mathcal{E} - Ir$$

$$\frac{V_s}{V_p} = \frac{N_s}{N_p} = \frac{I_p}{I_s}$$

2 Mathematical Formulas

2.1 Right-angled Triangles

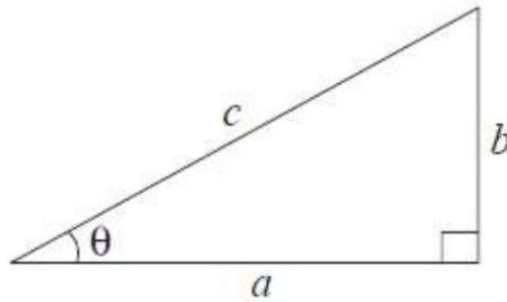


Figure 1: Right-angled triangle

$$\begin{array}{lll} a^2 + b^2 = c^2 & \sin \theta = \frac{b}{c} & \cos \theta = \frac{a}{c} \\ \tan \theta = \frac{b}{a} & \text{area} = \frac{1}{2}ab & \end{array}$$

2.2 All Triangles

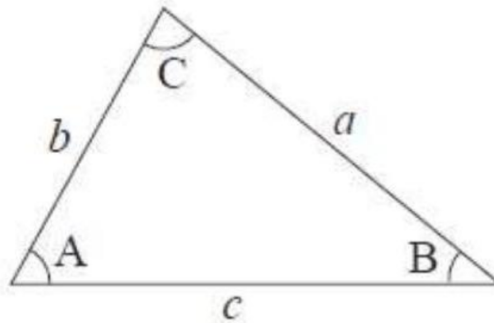


Figure 2: Non-Right-angled triangle

$$\begin{array}{ll} \text{area} = \frac{1}{2} \text{base} \times \text{height} & \text{Sine Law: } \frac{\sin A}{a} = \frac{\sin B}{b} = \frac{\sin C}{c} \\ \text{Cosine Law: } c^2 = a^2 + b^2 - 2ab \cos C & \end{array}$$

2.3 Circle and Sphere

$$\begin{array}{lll} \text{Circle circumference: } 2\pi r & \text{Circle area: } \pi r^2 & \text{Sphere surface area: } 4\pi r^2 \\ \text{Sphere volume: } \frac{4}{3}\pi r^3 & & \end{array}$$

2.4 Quadratic Equation

For $ax^2 + bx + c = 0$:

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

3 Metric Prefixes and Cardinal Directions

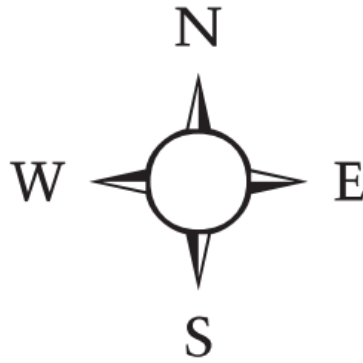


Figure 3: Cardinal directions: North, South, East, and West

Prefix	Symbol	Numerical	Exponential
mega	M	1000000	10^6
kilo	k	1000	10^3
hecto	h	100	10^2
deca	da	10	10^1
		1	10^0
deci	d	0.1	10^{-1}
centi	c	0.01	10^{-2}
milli	m	0.001	10^{-3}
micro	μ	0.000001	10^{-6}

4 Fundamental Constants and Physical Data

Gravitational constant:	$G = 6.67 \times 10^{-11} \text{Nm}^2/\text{kg}^2$
Coulomb's Law constant:	$k = 8.99 \times 10^9 \text{Nm}^2/\text{C}^2$
Elementary charge:	$e = 1.60 \times 10^{-19} \text{C}$
Electron mass:	$m_e = 9.11 \times 10^{-31} \text{kg}$
Proton mass:	$m_p = 1.67 \times 10^{-27} \text{kg}$
Avogadro's Number:	$N_A = 6.022 \times 10^{23} \text{kg}$
Permeability of free space:	$\mu_0 = 4\pi \times 10^{-7} \text{Tm/A}$
Permittivity of free space:	$\varepsilon_0 = 8.85 \times 10^{-12} \text{F/m}$
Speed of light:	$c = 3.00 \times 10^8 \text{m/s}$
Density of air:	$\rho = 1.21 \text{ kg/m}^3$
Boltzmann constant:	$k_B = 1.38 \times 10^{-23} \text{J/K}$

4.1 Earth

Radius:	$6.38 \times 10^6 \text{m}$	Mass:	$5.98 \times 10^{24} \text{kg}$
Surface gravity:	$g = 9.81 \text{m/s}^2$	Rotation period:	$8.61 \times 10^4 \text{s}$
Orbit radius (Sun):	$1.50 \times 10^{11} \text{m}$	Orbit period (Sun):	$3.16 \times 10^7 \text{s}$

4.2 Moon

Radius:	$1.74 \times 10^6 \text{m}$	Mass:	$7.35 \times 10^{22} \text{kg}$
Rotation period:	$2.36 \times 10^6 \text{s}$	Orbit radius (Earth):	$3.84 \times 10^8 \text{m}$
Orbit period (Earth):	$2.36 \times 10^6 \text{s}$		

4.3 Sun

Mass: $1.98 \times 10^{30} \text{kg}$