Physics 12 Formulas

Fundamental Constants and Equations

1 Physics Formulas

1.1 CH1,2,3: Kinematics

$$\vec{v} = \vec{v}_0 + \vec{a}t \qquad \bar{v} = \frac{\vec{v}+\vec{v}_0}{2} \qquad v^2 = v_0^2 + 2\vec{a}\cdot\vec{d}$$

$$\vec{d} = \vec{v}_0 t + \tfrac{1}{2}\vec{a}t^2 \qquad d = \left(\frac{v_f+v_i}{2}\right)t \qquad v_x = v\cos\theta$$

$$v_y = v\sin\theta \qquad v = \sqrt{v_x^2+v_y^2} \qquad \theta = \tan^{-1}\left(v_y/v_x\right)$$

$$h = \frac{v_{0y}^2}{2g} \qquad R = \frac{v_0^2\sin 2\theta_0}{g} \qquad (\text{max when } \theta_0 = 45^\circ)$$

1.2 CH4,5,9: Dynamics

$$\vec{F}_{\text{net}} = m\vec{a} \qquad \vec{F}_{\text{net}} = \vec{F}_{\text{applied}} - \vec{F}_{\text{against}} \qquad \vec{F}_g = m\vec{g}$$

$$\vec{F}_{\text{fr}} = \mu\vec{F}_N \qquad T = \frac{F_\perp}{2\sin(\theta)} \qquad \Delta L = \frac{1}{Y}\frac{F}{A}L_0$$

$$w_\parallel = w\sin(\theta) = mg\sin(\theta) \qquad w_\perp = w\cos(\theta) = mg\cos(\theta) \qquad F_{\text{D}} = \tfrac{1}{2}\text{C}\rho A v^2$$

$$\text{MA} = \frac{F_{\text{o}}}{F_{\text{i}}} = \frac{l_{\text{i}}}{l_{\text{o}}} \qquad \tau = rF\sin\theta$$

1.3 CH6: Circular Motion and Gravity

$$\Delta\theta = \frac{\Delta s}{r} \qquad v = r\omega \text{ or } \omega = \frac{v}{r}$$

$$a_{\text{c}} = \frac{v^2}{r} = r\omega^2 \qquad F_{\text{c}} = ma_{\text{c}} = m\frac{v^2}{r} = mr\omega^2$$

$$F = G\frac{mM}{r^2} \qquad \frac{T_1^2}{T_2^2} = \frac{r_1^3}{r_2^3},\ T^2 = \frac{4\pi^2}{GM}r^3$$

1.4 CH7: Work, Energy, and Power

$$W = \vec{F}\cdot\vec{d} \qquad E_p = mgh \qquad E_k = \tfrac{1}{2}mv^2$$

$$P = \frac{W}{t} \qquad \Delta E = E_f - E_i$$

1.5 CH8: Momentum

$$\vec{p} = m\vec{v} \qquad \Delta\vec{p} = \vec{F}\Delta t \qquad m_T\vec{V}_T = m_1\vec{v}_1 + m_2\vec{v}_2$$

$$a = \frac{v_{\text{e}}}{m}\frac{\Delta m}{\Delta t} - g \qquad v = v_{\text{e}}\ln\frac{m_0}{m_{\text{r}}}$$

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

$E_p = \frac{kq_1q_2}{r}, \quad \Delta PE = q\Delta V$

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

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

$C = \frac{Q}{V} \quad = \varepsilon_0\frac{A}{d}$ (parallel) $\quad = \kappa\varepsilon_0\frac{A}{d}$ (dielectric)

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

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

1.8 CH20: Current and Resistance

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

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

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

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

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

Series: $R_s = R_1 + R_2 + \cdots, \quad I_1 = I_2 = \cdots$

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

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

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

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

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

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

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

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

$\text{emf} = Bl\nu$

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

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

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

2 Mathematical Formulas

2.1 Right-angled Triangles

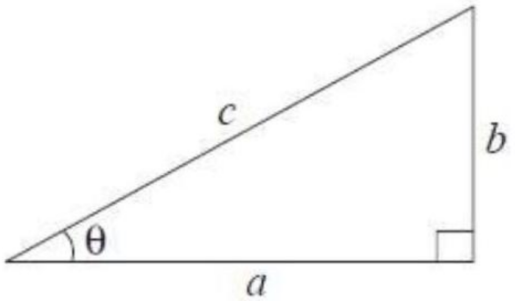

Figure 1: Right-angled triangle

$a^2 + b^2 = c^2$ $\quad \sin\theta = \frac{b}{c}$ $\quad \cos\theta = \frac{a}{c}$

$\tan\theta = \frac{b}{a}$ $\quad$ area $= \frac{1}{2}ab$

2.2 All Triangles

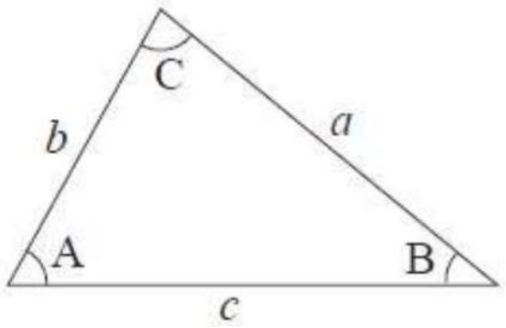

Figure 2: Non-Right-angled triangle

area $= \frac{1}{2}$base $\times$ height $\quad$ Sine Law: $\frac{\sin A}{a} = \frac{\sin B}{b} = \frac{\sin C}{c}$

Cosine Law: $c^2 = a^2 + b^2 - 2ab\cos C$

2.3 Circle and Sphere

Circle circumference: $2\pi r$ $\quad$ Circle area: πr^2 $\quad$ Sphere surface area: $4\pi r^2$

Sphere volume: $\frac{4}{3}\pi r^3$

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

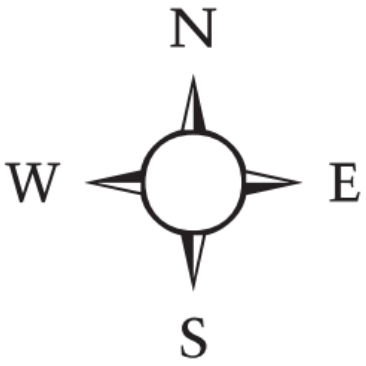

Figure 3: Cardinal directions: North, South, East, and West

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