PHYSICS 110 CONSTANTS AND EQUATIONS FALL 2003

Constant	Symbol	Value	Constant	Symbol	Value
Acceleration due to gravity	g	9.81 m/s^2	*Mass of a proton*	m_p	1.007 276 u
Gravitational constant	G	6.67 x 10^{-11} Nm^2/kg^2	*Mass of a neutron*	m_n	1.008 665 u
Speed of light	c	3.00 x 10^8 m/s	*Mass of an electron*	m_e	0.000 548 u
Boltzmann's constant	k	1.38 x 10^{-23} J/K	*Mass of Earth*	M_{earth}	5.97 x 10^{24} kg
Unified mass unit	u	1.66 x 10^{-27} kg	*Mean distance from Sun*	*1 AU*	1.50 x 10^{11} m
Avogadro's number	N_A	6.02 x 10^{23} mol^{-1}	*Radius of Earth*	R_{earth}	6.37 x 10^6 m

Definitions

$$v_x = \frac{dx}{dt} \qquad a_x = \frac{dv_x}{dt}$$

Kinematics
(constant acceleration)

$$x = x_o + v_{xo}t + \tfrac{1}{2}a_x t^2$$

$$v_x = v_{xo} + a_x t$$

$$v_x^2 = v_{xo}^2 + 2a_x(x - x_o)$$

Newton's Second Law and Forces

$$\vec{F}_{net} = \Sigma\vec{F}_{ext} = m\vec{a} = \frac{d\vec{p}}{dt}$$

$$\vec{W} = m\vec{g} \qquad F = -kx$$

$$F = \mu N \qquad F_D = Dv^2$$

$$F = \frac{Gm_1m_2}{r^2} = \frac{GMm}{r^2}$$

Centripetal Acceleration

$$a_r = \frac{v_t^{\,2}}{r}$$

Work and Energy

$$W = \int_{r_1}^{r_2} \vec{F}\cdot d\vec{r}$$

$$K = \tfrac{1}{2}mv^2 \qquad K = \tfrac{1}{2}I\omega^2$$

$$\Delta K = W_{net}$$

$$P = \frac{dW}{dt}$$

$$\Delta U_{A\to B} = -\int_A^B \vec{F}\cdot d\vec{r}$$

$$F_x = -\frac{dU}{dx}$$

$$\Delta E = \Delta K + \Delta U = W_{nc}$$

$$E = K + U$$

Potential Energy

$$U = mgh$$

$$U = -\frac{Gm_1m_2}{r} = -\frac{GMm}{r}$$

$$U = \tfrac{1}{2}kx^2$$

Rockets

$$\vec{T} = -\vec{v}_{ex}\left|\frac{dM}{dt}\right|$$

$$v_f = v_i + v_{ex}\ln\left(\frac{M_i}{M_f}\right)$$

Impulse and Linear Momentum

$$\vec{I} = \int_{t_1}^{t_2}\vec{F}dt = \Delta\vec{p}$$

$$\vec{p} = m\vec{v} \qquad \sum\vec{p}_i = \sum\vec{p}_f$$

Rotational Definitions

$$\vec{\omega} = \frac{d\vec{\theta}}{dt} \qquad \vec{\alpha} = \frac{d\vec{\omega}}{dt}$$

Rotational Kinematics
(constant angular acceleration)

$$\theta = \theta_o + \omega_o t + \tfrac{1}{2}\alpha t^2$$

$$\omega = \omega_o + \alpha t$$

$$\omega^2 = \omega_o^2 + 2\alpha(\theta - \theta_0)$$

Linear/Rotational Connection

$$a_r = \frac{v_t^{\,2}}{r} = \omega^2 r$$

$$v_t = \omega r$$

$$a_t = \alpha r$$

Torque

$$\vec{\tau} = \vec{r}\times\vec{F}$$

$$\vec{\tau}_{net} = \Sigma\vec{\tau}_{ext} = I\vec{\alpha} = \frac{d\vec{L}}{dt}$$

Rotational Inertia/Moment of Inertia

$$I = \sum_i m_i r_i^2$$

Angular Momentum

$$\vec{L} = \vec{r}\times\vec{p} = I\vec{\omega}$$

$$\sum\vec{L}_i = \sum\vec{L}_f$$

Kinetic Theory of Gases

$$P = \frac{F}{A}$$

$$PV = NkT$$

$$\frac{1}{2}mv^2 = \frac{3}{2}kT$$

Law of Atmospheres

$$n(y) = n_0 e^{-mgy/kT}$$

$$P(y) = P_0 e^{-mgy/kT}$$

Simple Harmonic Motion

$$\omega = \sqrt{k/m}$$

$$\omega = \sqrt{g/\ell}$$

$$\omega = \frac{2\pi}{T} = 2\pi f$$

$$x(t) = A\cos(\omega t + \varphi)$$

Wave Motion

$$v = \frac{\lambda}{T} = \lambda f = \frac{\omega}{k}$$

$$k = \frac{2\pi}{\lambda}$$

$$y(x,t) = A\cos(kx \pm \omega t)$$

$$v = \sqrt{\frac{F}{\mu}} \qquad L = \frac{m\lambda}{2}$$

Relativity

$$\gamma = \frac{1}{\sqrt{1 - v^2/c^2}}$$

$$\Delta t' = \frac{\Delta t}{\gamma}$$

$$\Delta x' = \frac{\Delta x}{\gamma}$$

Vector Identities

$$\vec{A}\cdot\vec{B} = |\vec{A}||\vec{B}|\cos\theta$$

$$|\vec{A}\times\vec{B}| = |\vec{A}||\vec{B}|\sin\theta$$