# Physics 213 Constants and Equations (Ver 2)

| Constant | Symbol | Value | Constant | Symbol | Value |
|---|---|---|---|---|---|
| Acceleration due to gravity | $g$ | 9.8 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 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 |
| Universal gas constant | $R$ | 8.31 J/K mol | Mean distance from Sun | *1 AU* | 1.5 x 10$^{11}$ m |
| Electron-volt | *eV* | 1.60 x 10$^{-19}$ J | Radius of Earth | $R_{earth}$ | 6.37 x 10$^6$ m |
| Unified mass unit | $u$ | 931.5 MeV/c$^2$ | Unified mass unit | $u$ | 1.66 x 10$^{-27}$ kg |

### Dynamics

$$\vec{v} = \frac{d\vec{r}}{dt}$$

$$\vec{a} = \frac{d\vec{v}}{dt}$$

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

$$F_k = \mu_k N$$

$$F_s \le \mu_s N$$

### Kinematics
*(constant acceleration)*

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

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

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

### Circular Motion

$$v_t = \omega r$$

$$a_r = \frac{v^2}{r} = \omega^2 r$$

$$a_t = r\alpha$$

### Work and Energy

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

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

$$K = \tfrac{1}{2}mv^2$$

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

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

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

### Linear Momentum

$$\vec{p} = m\vec{v}$$

### Drag

$$F_D = \tfrac{1}{2}\rho A C_D v^2$$

### Conservation Laws

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

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

### Vector Identities

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

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

### Torque

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

### Angular Momentum

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

### Rotational Inertia

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

### Rotational Dynamics

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

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

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

### Rot. Kinematics
*(constant $\alpha$)*

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

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

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

### Nuclear Physics

$$E = mc^2$$

$$N = N_o e^{-\lambda t}$$

$$t_{\frac{1}{2}} = \frac{\ln 2}{\lambda}$$

$$R = \left|\tfrac{dN}{dt}\right| = \lambda N$$

### Gravitation

$$F = \frac{Gm_1 m_2}{r^2}$$

$$U = -\frac{Gm_1 m_2}{r}$$

### Gravity Near Earth

$$\vec{W} = m\vec{g}$$

$$U = mgh$$

### Circular Orbits

$$E = \tfrac{1}{2}U$$

### Law of Atmospheres

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

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

### Kinetic Theory of Gases

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

$$PV = NkT$$

$$PV = nRT$$

$$\tfrac{1}{2}m\overline{v^2} = \tfrac{3}{2}kT$$

### Springs

$$F = -kx$$

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

### Rockets

$$T = -v_{ex}\frac{dM}{dt}$$

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