8.01L Summary of Equations

Note: Quantities shown in **bold** are vectors.

$\mathbf{v} = d\mathbf{r}/dt \quad \mathbf{a} = d\mathbf{v}/dt$

For *constant* acceleration **a**, if at $t = 0$ $\mathbf{r} = \mathbf{r}_0$ and $\mathbf{v} = \mathbf{v}_0$:

$$\mathbf{v} = \mathbf{v}_0 + \mathbf{a}t$$
$$\mathbf{r} = \mathbf{r}_0 + \mathbf{v}_0 t + \tfrac{1}{2}\mathbf{a}t^2$$

Circular motion at constant speed $a = v^2/r = \omega^2 r$ (Centripetal acceleration, points towards center of circle, ω is angular speed in radians per second)

Adding relative velocities ("wrt" is short for "with respect to"): $\mathbf{v}_{\substack{A\\ wrt\\ B}} + \mathbf{v}_{\substack{B\\ wrt\\ C}} = \mathbf{v}_{\substack{A\\ wrt\\ C}}$

$\sum \mathbf{F} = 0 \Leftrightarrow \mathbf{a} = 0$ (Newton's first law)

$\mathbf{F} = m\mathbf{a}$ or $\mathbf{F} = d\mathbf{p}/dt$ (Newton's second law) $\mathbf{F}_{AB} = -\mathbf{F}_{BA}$ (Newton's third law)

$\mathbf{p} = m\mathbf{v}$ (momentum)

$\mathbf{J} = \int_{t_1}^{t_2} \mathbf{F}\, dt = \int_{t_1}^{t_2} \frac{d\mathbf{p}}{dt} dt = \mathbf{p}_2 - \mathbf{p}_1$ (impulse)

$\mathbf{r}_{cm} = \frac{\Sigma m_i \mathbf{r}_i}{\Sigma m_i}$ (position of center of mass)

$\mathbf{F} = -k\mathbf{x}$ (spring force) $f \le \mu N$ (Friction force relative to Normal force)

$\mathbf{F} = -\frac{GMm}{r^2}\hat{\mathbf{r}}$ (gravitational force between two particles)

$W = \int \mathbf{F} \cdot d\mathbf{r}$ (work done by force **F**)

$W_{other} = \Delta E = E_F - E_I \quad E = KE + PE$ (work-energy theorem)

$F_x = -\frac{dU}{dx}$ (force derived from potential energy)

Potential Energies: $U = \frac{1}{2}kx^2$ (spring force)

$U = -\frac{GMm}{r}$ (gravitational, general) $U = mgh$ (gravitational, near Earth)

$\omega = \sqrt{k/m} \quad x = A\cos(\omega t + \phi)$

$v = -A\omega\sin(\omega t + \phi) \quad T = 2\pi/\omega$

(Equations for Simple Harmonic Motion)

<u>Physical Constants:</u>

$g = 9.8\ m/s^2$ Use the approximate value $g = 10\ m/s^2$ where told to do so.

$G = 6.67\times10^{-11}\ N\ m^2/kg^2$

<u>Conversion reminder:</u>

π radians = 180^o

<u>Lazy Physicist 's Favorite Angle:</u> (to be used when calculators are not allowed):

36.9^o and 53.1^o are the angles of a 3-4-5 right triangle so:

$\sin(36.9°) = \cos(53.1°) = 0.60 \quad \cos(36.9°) = \sin(53.1°) = 0.80$

$\tan(36.9°) = 0.75 \quad \tan(53.1°) = 1.33$

<u>Solution to a Quadratic Equation:</u> If $ax^2 + bx + c = 0$ then $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$