Displacement, Speed, Velocity, and Acceleration

$\Delta x = x_2 - x_1$ (similarly for Δy, etc.)

$\bar{v}_x = \dfrac{\Delta x}{\Delta t} = \dfrac{x_2 - x_1}{t_2 - t_1}$ (similarly for $\bar{v}_y$, etc.)

$\bar{s} = \dfrac{\text{total distance}}{\Delta t}$

$s = \sqrt{v_x^2 + v_y^2}$

v_x = slope of x vs t plot

$\bar{a} = \dfrac{\Delta v}{\Delta t}$

a = slope of v vs t plot

Constant Acceleration

$x_f = x_i + v_{ix}\Delta t + \dfrac{1}{2}a_x \Delta t^2$

$v_{fx} = v_{ix} + a_x \Delta t$

$v_{fx}^2 = v_{ix}^2 + 2a_x\left(x_f - x_i\right)$

$x_f = x_i + \dfrac{1}{2}\left(v_{ix} + v_{fx}\right)\Delta t$

Projectile Motion

(assumes $+y$ is upwards)

$a_x = 0$

$a_y = -g$

$g = +9.8 \dfrac{\text{m}}{\text{s}^2}$

$\tan\theta_0 = \dfrac{v_{0y}}{v_{0x}}$

$v_{0x} = |v_0|\cos\theta_0$

$v_{0y} = |v_0|\sin\theta_0$

$y = y_0 + (x - x_0)\left(\dfrac{v_{0y}}{v_{0x}}\right) - \dfrac{g(x - x_0)^2}{2v_{0x}^2}$

or

$y = y_0 + (x - x_0)\tan\theta_0 - \dfrac{g(x - x_0)^2}{2(v_0\cos\theta_0)^2}$

$R = \dfrac{v_0^2}{g}\sin(2\theta_0)$

(destination and source at same height)

Work, Energy, Power

$W_F = F \cdot \Delta x \cdot \cos\theta$ (note $\cos 180^\circ = -1$)

$\Sigma W = KE_f - KE_i$

$KE = \dfrac{1}{2}mv^2$

$\bar{P} = \dfrac{W}{\Delta t} = F \cdot v$

$PE_{2g} = mgy_2$ if $+y$ is upwards

$E = KE + PE_g$

$E_2 = E_1 + W_{1\to 2,\text{all but gravity}}$, so:

$KE_2 + PE_2 = KE_1 + PE_1 + W_{1\to 2,\text{all but gravity}}$

Momentum & Impulse

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

$\Sigma\vec{F} \cdot \Delta t = \Delta\vec{p}$

$\Sigma\vec{F}_x \cdot \Delta t = m\left(v_{fx} - v_{ix}\right)$

$\vec{p}_f = \vec{p}_i$ if $\Sigma\vec{F} = 0$

$\vec{J} = \Sigma\vec{F} \cdot \Delta t$

1D Elastic Collisions

$v_{1f} = \dfrac{m_1 - m_2}{m_1 + m_2}v_{1i} + \dfrac{2m_2}{m_1 + m_2}v_{2i}$

$v_{2f} = \dfrac{2m_1}{m_1 + m_2}v_{1i} + \dfrac{m_2 - m_1}{m_1 + m_2}v_{2i}$

Vectors

$\vec{A} = A_x\hat{x} + A_y\hat{y} + A_z\hat{z}$

$A = \left|\vec{A}\right| = \sqrt{A_x^2 + A_y^2 + A_z^2}$

$\theta = \arctan\left(\dfrac{A_y}{A_x}\right)$

$A_x = A\cos\theta$

$A_y = A\sin\theta$

Forces

Name an object or group of objects !!!!

$\Sigma F_x = ma_x, \quad \Sigma F_y = ma_y$

$W = mg$ (down)

$f_{s,\max} = \mu_s N$

$f_k = \mu_k N$

Gravity

$F = G\dfrac{m_1 m_2}{r^2}$

$G = 6.67\times 10^{-11}\dfrac{\text{Nm}^2}{\text{kg}^2}$

$T = 2\pi\sqrt{\dfrac{R^3}{GM}}$

Circular Motion

$|a_c| = \dfrac{v^2}{r}$ towards the center of the circle

$T = \dfrac{2\pi r}{v} = \dfrac{1}{f}$ (constant speed)

L or $s = r\Delta\theta$ (distance traveled, $\Delta\theta$ in radians)

$T = 2\pi\sqrt{\dfrac{R^3}{GM}}$ (orbits)