

Formula sheet

$$g = 9.81 \text{ m/s}^2$$

$$0 = ax^2 + bx^2 + c \implies x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Vectors:

$$\vec{a} = a_x \hat{i} + a_y \hat{j} + a_z \hat{k}$$

$$\vec{b} = b_x \hat{i} + b_y \hat{j} + b_z \hat{k}$$

$$|\vec{a}| = \sqrt{a_x^2 + a_y^2}$$

$$\tan \theta = \frac{a_y}{a_x}$$

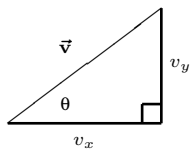
$$\vec{a} + \vec{b} = (a_x + b_x) \hat{i} + (a_y + b_y) \hat{j} + (a_z + b_z) \hat{k}$$

$$\vec{a} \cdot \vec{b} = a_x b_x + a_y b_y + a_z b_z$$

$$|\vec{a} \cdot \vec{b}| = |\vec{a}| |\vec{b}| \cos \varphi$$

$$|\vec{a} \times \vec{b}| = |\vec{a}| |\vec{b}| \sin \varphi$$

$$\vec{c} = (a_y b_z - a_z b_y) \hat{i} + (a_z b_x - a_x b_z) \hat{j} + (a_x b_y - a_y b_x) \hat{k}$$



$$v_y = |\vec{v}| \sin \theta$$

$$v_x = |\vec{v}| \cos \theta$$

$$\tan \theta = \frac{v_y}{v_x}$$

1-D motion:

$$v(t) = \frac{d}{dt} x(t)$$

$$a(t) = \frac{d}{dt} v(t) = \frac{d^2}{dt^2} x(t)$$

const. acc.

$$x_f = x_i + v_{xi} t + \frac{1}{2} a_x t^2$$

$$v_{xf}^2 = v_{xi}^2 + 2a_x \Delta x$$

$$v_f = v_i + at$$

Projectile motion:

$$v_x(t) = v_i \cos \theta$$

$$v_y(t) = v_i \sin \theta - gt$$

$$x(t) = x_i - v_x t$$

$$y(t) = y_i + v_{yi} t + \frac{1}{2} a_y t^2$$

over level ground:

$$\text{max height} = H = \frac{v_i^2 \sin^2 \theta_i}{2g}$$

$$\text{Range} = R = \frac{v_i^2 \sin 2\theta_i}{g}$$

2-D motion:

$$\vec{r} = x(t) \hat{i} + y(t) \hat{j}$$

$$x(t) = x_i + v_{ix} t + \frac{1}{2} a_x t^2$$

$$y(t) = y_i + v_{iy} t + \frac{1}{2} a_y t^2$$

$$\vec{v} = v_x(t) \hat{i} + v_y(t) \hat{j}$$

$$v_x(t) = \frac{dx}{dt} = v_{xi} + a_x t$$

$$v_y(t) = \frac{dy}{dt} = v_{yi} + a_y t$$

$$\vec{a} = a_x(t) \hat{i} + a_y(t) \hat{j}$$

$$a_x(t) = \frac{dv_x}{dt}$$

$$\vec{a}(t) = \frac{d^2 s}{dt^2} \hat{T} + \kappa |\vec{v}|^2 \hat{N} = \frac{d^2 s}{dt^2} \hat{T} + \frac{|\vec{v}|^2}{R} \hat{N} \equiv a_N \hat{T} + a_T \hat{N}$$

$$a_c = \frac{v^2}{r} \text{ circ.}$$

$$T = \frac{2\pi r}{v} \text{ circ.}$$

Force:

$$\Sigma \vec{F} = \vec{F}_{\text{net}} = m\vec{a}$$

$$\Sigma F_x = ma_x$$

$$\Sigma F_y = ma_y$$

$$F_{\text{grav}} = mg = \text{weight}$$

$$\vec{F}_{12} = -\vec{F}_{21}$$

$$f_s \leq \mu_s n$$

$$f_{s, \text{max}} = \mu_s n$$

$$f_k = \mu_k n$$

$$\vec{F}_{\text{drag}} = -\frac{1}{2} C \rho A |\vec{v}| \vec{v}$$

$$\vec{F}_c = -\frac{mv^2}{r} \hat{r}$$

Power	Prefix	Abbreviation
10^{-12}	pico	p
10^{-9}	nano	n
10^{-6}	micro	μ
10^{-3}	milli	m
10^{-2}	centi	c
10^3	kilo	k
10^6	mega	M
10^9	giga	G
10^{12}	tera	T

Right-hand rule for $x \times y = z$

1. Point the fingers of your right hand along the direction of x .
2. Point your thumb in the direction of y .
3. The direction of z is pointing out of the back of your hand.