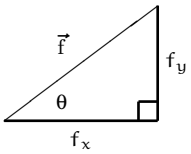
Formula sheet

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

$\downarrow$ quadratic formula:

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

Generic vector $\vec{f}$:



$$f_y = |\vec{v}| \sin\theta$$
$$f_x = |\vec{v}| \cos\theta$$
$$\tan\theta = \tfrac{f_y}{f_x}$$
$$|\vec{f}| = \sqrt{f_x^2 + f_y^2}$$

1-D motion, constant acceleration:

$$\overline{v} = \frac{x_2 - x_1}{t_2 - t_1} = \frac{\Delta x}{\Delta t}$$
$$\overline{a} = \frac{v_2 - v_1}{t_2 - t_1} = \frac{\Delta v}{\Delta t}$$
$$v(t) = \lim_{\Delta t \to 0} \frac{\Delta x}{\Delta t}$$
$$a(t) = \lim_{\Delta t \to 0} \frac{\Delta v}{\Delta t}$$
$$x_f = x_i + v_{xi} t + \frac{1}{2} a_x t^2$$
$$v_{xf}^2 = v_{xi}^2 + 2 a_x \Delta x$$
$$v_f = v_i + a t$$

2-D motion, constant acceleration:

$$\vec{r} = x(t)\,\hat{\imath} + y(t)\,\hat{\jmath}$$
$$x(t) = x_i + v_{ix} t + \frac{1}{2} a_x t^2$$
$$y(t) = y_i + v_{iy} t + \frac{1}{2} a_y t^2$$
$$v_x(t) = v_{xi} + a_x t$$
$$v_y(t) = v_{yi} + a_y t$$

Quantity	Unit	equivalent to
force	N	kg·m/s^2
acceleration	m/s^2	-
velocity	m/s	-
position	m	-

Projectile motion:

$$v_x(t) = v_i \cos\theta_o$$
$$x(t) = x_i + (v_i \cos\theta_o)\, t$$
$$v_y(t) = v_i \sin\theta_o - g t$$
$$y(t) = y_i + (v_i \sin\theta_o)\, t - \frac{1}{2} g t^2$$

$\downarrow$ over level ground:

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

$\downarrow$ launch at $y = 0$:

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

$\downarrow$ launched from origin

$$y(x) = (\tan\theta_o)\, x - \frac{g x^2}{2 v_o^2 \cos^2\theta_o}$$

Force in general:

$$\Sigma \vec{F} = \vec{F}_{\text{net}} = m\vec{a}$$
$$\Sigma F_x = m a_x$$
$$\Sigma F_y = m a_y$$
$$\vec{F}_{12} = -\vec{F}_{21}$$

Particular forces:

$$F_{\text{gravity}} = mg = \text{weight}$$
$$\text{friction} \begin{cases} f_s & \leqslant \mu_s n \\ f_{s,\max} & = \mu_s n \\ f_k & = \mu_k n \end{cases}$$
$$F_{\text{spring}} = -k\Delta x$$

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