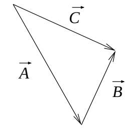
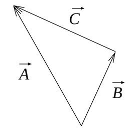
$\Delta x = x_f - x_i$	for any scalar/vector in place of x
$\vec{d}_{\text{net}} = \vec{d_1} + \vec{d_2}$	Knight's version for vector displacement
$\Delta\vec{x} = \vec{x}_f - \vec{x}_i$	Carl's version for vector displacement
$v_x = \frac{\Delta x}{\Delta t}$	definition of 1-D (instantaneous) velocity, take a slope of $x(t)$
$a_x = \frac{\Delta v_x}{\Delta t}$	definition of acceleration, take a slope of $v_x(t)$
$\Delta x = v_x \Delta t \leftrightarrow A = hw$	displacement as area under $v_x(t)$ curve
$\Delta v = a_x \Delta t \leftrightarrow A = hw$	change in v_x as area under $a_x(t)$ curve
$\Delta x = (v_x)_i \Delta t + \frac{1}{2}\Delta v_x \Delta t$	displacement as area under a linear $v_x(t)$ curve
$x_f = x_i + v_x \Delta t$	kinematic formula for constant velocity
$y = mx + b$	high school formula for a straight line
$x_f = x_i + (v_x)_i \Delta t + \frac{1}{2} a_x (\Delta t)^2$	kinematic formula for displacement with constant acceleration
$(v_x)_f = (v_x)_i + a_x \Delta t$	kinematic formula for velocity with constant acceleration
$(v_x)_f^2 = (v_x)_i^2 + 2a_x \Delta x$	the "no-time" formula for constant acceleration
$a_y = -g = -9.80\,\text{m/s}^2$	free-fall acceleration due to gravity
$\sin\theta = \frac{\text{opps}}{\text{hyp}}$, $\cos\theta = \frac{\text{adj}}{\text{hyp}}$ $\tan\theta = \frac{\text{opps}}{\text{adj}}$	high school trig formulas
$(\text{hyp})^2 = (\text{adj})^2 + (\text{opps})^2$	Pythagoras' theorem (right angle triangles)
$c^2 = a^2 + b^2 - 2ab\cos(\angle C)$	law of cosines for side c opposite $\angle C$
$\vec{v} = \frac{\vec{d}}{\Delta t} = \frac{\Delta\vec{x}}{\Delta t}$	definition of velocity in 2 or more dimensions in terms of displacement vector $\vec{d}$ or $\Delta\vec{x}$
$\vec{a} = \frac{\Delta\vec{v}}{\Delta t}$	definition of acceleration in 2 or more dimensions

	$\vec{C} = \vec{A} + \vec{B}$
	$\vec{C} = \vec{A} - \vec{B}$
$\vec{A} = \vec{A}_x + \vec{A}_y$	decomposing a vector into components
$\lvert\vec{A}\rvert \equiv$ mag. or length of $\vec{A}$	quantity is always positive, sometimes just called A
$\vec{A} = \vec{A}_{xR} + \vec{A}_{yR}$	decomposing a vector into ramp components
$a_{xR} = \pm g\cos\theta$	acceleration of free object on a ramp
$\Delta y_R = v_{yR} = a_{yR} = 0$	no motion in y_R direction
$\vec{v}_{AC} = \vec{v}_{AB} + \vec{v}_{BC}$	subscript rule for relative velocities (Galilean transformation)
$(v_x)_i = \lvert\vec{v}_i\rvert\cos\theta$ $(v_y)_i = \lvert\vec{v}_i\rvert\sin\theta$	initial velocity components for a launched projectile
$x_f = x_i + (v_x)_i \Delta t$	projectile, uniform x-motion
$(v_x)_f = (v_x)_i$	projectile, constant v_x, $a_x = 0$
$y_f = y_i + (v_y)_i \Delta t - \frac{1}{2} g (\Delta t)^2$	projectile, y-displacement, $a_y = -g$
$(v_y)_f = (v_y)_i - g\Delta t$	projectile, decreasing v_y
$f = \frac{1}{T}$	relationship between frequency and period
$v = \frac{2\pi r}{T} = 2\pi r f$	orbital *speed* (velocity changes)
$\vec{a} = \left(\frac{v^2}{r}, \text{toward centre}\right)$	centripetal acceleration
$\vec{F}_{\text{net}} = \vec{0} \Rightarrow \vec{v}$ is constant	Newton's 1st law, constant may or may not be 0
$\vec{v}$ is constant $\Rightarrow \vec{F}_{\text{net}} = \vec{0}$	Newton's 1st law stated in *converse* form
$\vec{a} = \frac{\vec{F}_{\text{net}}}{m}$ or $\vec{F}_{\text{net}} = m\vec{a}$	Newton's 2nd law, definition of mass
$\vec{F}(\text{B on A}) = -\vec{F}(\text{A on B})$	Newton's 3rd law
$\vec{F}_{\text{net}} = \vec{F}_1 + \vec{F}_2 + \ldots = \Sigma\vec{F}_i$	forces sum to produce net force

$w_{\text{apparent}} = m(g + a_y)$	apparent weight
$n = w_{yR} = mg\cos\theta$	magnitude of normal force for a ramp
$f_{\text{s,max}} = \mu_s n$	magnitude of maximum static friction
$f_k = \mu_k n$	magnitude of kinetic friction $\vec{f}_k$ is opposite to direction of $\vec{v}$
$f_r = \mu_r n$	rolling friction
$D = \frac{1}{2} C_D \rho A v^2$	empircal law for drag force in air
$F = T$	tension in a massless string or rope provides a force
$\lvert\vec{T}_1\rvert = \lvert\vec{T}_2\rvert$	magnitude of tension constant for massless pulley
$F_{\text{centripetal}} = \frac{mv^2}{r}$	a net force directed toward the centre
$F_{\text{grav}} = \frac{Gm_1m_2}{r^2}$	Newton's inverse square law for gravitation; $G = 6.67 \times 10^{-11}$ N$\cdot$m^2/kg^2
$(F_{\text{sp}})_x = -k\,\Delta x$	Hooke's Law for a spring
$s = r\,\theta$	arc length s, only true if θ is in radians
2π radians=360$^{\text{o}}$=1 rev	relations between angular units
$\omega = \frac{\Delta\theta}{\Delta t}$	positive if motion is CCW
$v = \omega r$	this is tangential or orbital motion, $\vec{v}$ changes
$a_{\text{centri}} = \frac{v^2}{r} = \omega^2 r$	$\vec{a}_{\text{centri}}$ is always directed towards the centre of the circle
$v_{\text{orbit}} = \sqrt{gr}$	a freefalling object in circular orbit; g is not 9.80 if not at earth's surface
$g = \frac{GM}{r^2}$	a generalized gravitational acceleration near a "planet" with mass M
$T^2 = \left(\frac{4\pi^2}{GM}\right) r^3 = kr^3$	Kepler's 3rd law. Use k form when comparing orbiting objects.
$\alpha = \frac{\Delta\omega}{\Delta t}$	angular acceleration

$\theta_f = \theta_i + \omega_i \Delta t + \frac{1}{2}\alpha(\Delta t)^2$	an example of an "angular" kinematic equation
$a_{\tan} = \alpha r$	tangential component of acceleration
$\tau = rF_\perp = r_\perp F = rF\sin\phi$	torque about a pivot
$\tau_{\text{net}} = \tau_1 + \tau_2 + \ldots = \Sigma\tau_i$	summing torques
$x_{cg} = \frac{m_1x_1+m_2x_2+m_3x_3+\ldots}{m_1+m_2+m_3+\ldots}$	centre of gravity in x, similar expression for y_{cg}
$I = \Sigma m_i r_i^2$	moment of intertia, depends on choice of centre
$\alpha = \frac{\tau_{\text{net}}}{I}$	Newton's 2nd law for rotation
$I = MR^2$	moment of intertia for a hoop
$I = \frac{1}{2}MR^2$	moment of intertia for a disc or cylinder
$I = \frac{2}{5}MR^2$	moment of intertia for a solid sphere
$a_{\text{obj}} = \alpha R$	example of a constraint equation for a pulley of radius R
$v = \omega R$	rolling constraint, rolling object as a whole moves at v
$v_{\text{top}} = 2v,\ \ v_{\text{bottom}} = 0$	speeds at top and bottom of a rolling object
$F_{x,\text{net}} = F_{y,\text{net}} = \tau_{\text{net}} = 0$	conditions for static equilibrium of extended object, choose any pivot point
$\theta_c = \tan^{-1}\left(\frac{t}{2h}\right)$	critical tipping angle if c.o.g. is height h above and centred over a base of width t
$\frac{F}{A} = Y\,\frac{\Delta L}{L}$	relationship between stress, strain, and Young's modulus
tensile strength=$\frac{F_{\max}}{A}$	tensile strength is related to maximum stress before breaking
$\vec{J} = (\vec{F}_{\text{net}})_{\text{avg}}\Delta t = \vec{p}_f - \vec{p}_i$	impulse defined and impulse-momentum theorem
$\vec{p} = m\vec{v}$	momentum defined
$\vec{P} = \Sigma_i m_i \vec{v}_i$	system momentum

$\vec{P}_i = \vec{P}_f$	conservation of momentum for no external forces
$L = I\omega$	angular momentum
$L_{\text{system}} = \sum I_i \omega_i$	system angular momentum
$(L_{\text{system}})_i = (L_{\text{system}})_f$	conservation of angular momentum for no external torques
$\Delta L = (\tau_{\text{net}})_{\text{avg}} \Delta t$	angular impulse-momentum theorem
$E = K + U_{\text{g}} + U_{\text{s}} + E_{\text{th}} + E_{\text{chem}} + \ldots$	total energy of a system
$\Delta E = \Delta K + \Delta U_{\text{g}} + \Delta U_{\text{s}} + \Delta E_{\text{th}} + \Delta E_{\text{chem}} + \ldots$	total energy *change* of a system
$W = \Delta E$	work-energy theorem; work done “on” the system represents only energy input
$W = F_{\text{env}} d \cos\theta$	work done on the system by the environment, not F_{net}
$K = \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2$	kinetic energy from translation and rotation
$U_{\text{g}} = mgy$	gravitational potential energy for constant g, you have choosen a potential =0 point
$U_{\text{s}} = \frac{1}{2}kx^2$	x is the extension of the spring
$\Delta E_{\text{th}} = f_k \lvert \Delta x \rvert$	thermal energy for a dragged object