

Prefixes

z=10⁻²¹, a=10⁻¹⁸, f=10⁻¹⁵, p=10⁻¹², n=10⁻⁹, μ =10⁻⁶, m=10⁻³, c=10⁻², k=10³, M=10⁶, G=10⁹, T=10¹², P=10¹⁵, E=10¹⁸, Z=10²¹
zepto, atto, femto, pico, nano, micro, milli, centi, kilo, mega, giga, tera, peta, exa, zeta.

Physical Constants

$g = 9.80 \text{ m/s}^2$ (gravitational acceleration)	$G = 6.67 \times 10^{-11} \text{ N}\cdot\text{m}^2/\text{kg}^2$ (gravitational constant)
$M_E = 5.98 \times 10^{24} \text{ kg}$ (mass of Earth)	$R_E = 6380 \text{ km}$ (mean radius of Earth)
$m_e = 9.11 \times 10^{-31} \text{ kg}$ (electron mass)	$m_p = 1.67 \times 10^{-27} \text{ kg}$ (proton mass)
$c = 299,792,458 \text{ m/s}$ (speed of light)	$1 \text{ amu} = 1 \text{ u} = 1.6605402 \times 10^{-27} \text{ kg}$ (atomic mass unit)

Units & Conversions

1 inch = 1 in = 2.54 cm	1 foot = 1 ft = 12 in = 0.3048 m
1 mile = 5280 ft = 1760 yards	1 mile = 1609.344 m = 1.609344 km
1 m/s = 3.6 km/hour	88 ft/s = 60 mile/hour
1 acre = (1 mile) ² /640 = 43 560 ft ²	1 hectare = (100 m) ² = 10 ⁴ m ²
1 lb = 4.45 N	1 N = 0.225 lb

Algebra

Quadratic equations: $ax^2 + bx + c = 0$, solved by $x = (-b \pm \sqrt{b^2 - 4ac}) / (2a)$.

Geometry

Triangles: $A = \frac{1}{2}bh$, Circles: $C = 2\pi r$, $A = \pi r^2$, arc = $s = r\theta$. Spheres: $A = 4\pi r^2$, $V = \frac{4\pi}{3}r^3$

Trigonometry

$\sin \theta = (\text{opp})/(\text{hyp})$, $\cos \theta = (\text{adj})/(\text{hyp})$, $\tan \theta = (\text{opp})/(\text{adj})$, $(\text{opp})^2 + (\text{adj})^2 = (\text{hyp})^2$.
 $\sin^2 \theta + \cos^2 \theta = 1$, $a^2 + b^2 - 2ab \cos \gamma = c^2$, $\frac{\sin \alpha}{a} = \frac{\sin \beta}{b} = \frac{\sin \gamma}{c}$, $\alpha + \beta + \gamma = 180^\circ = \pi \text{ rad}$.

Chapter 1 - Units, measurements, errors or uncertainties

Unit conversions:	value = # (old units),	(old units) \times ($\frac{\text{new units}}{\text{old units}}$) = (new units).
Significant figures:	\div or \times , use the least no. of sig. figs.,	+ or -, drop the insignificant <i>digits</i> .
Sig. figs. "1" rule:	if 1st digit=1, keep 1 extra digit,	\leftarrow for division or multiplication only.
Measurements:	measurement = $x \pm \delta x$,	x = observed value, δx = error or uncertainty.
Percent error:	measurement = value \pm error,	percent error = (error / value) \times 100%.
Combining errors:	\div or \times , add the % errors,	+ or -, $\delta x = \sqrt{(\delta x_1)^2 + (\delta x_2)^2 + \dots}$.

Chapter 2 - Vectors - Magnitude & Direction

2D Vectors:	$\vec{a} = a_x \hat{i} + a_y \hat{j}$	magnitude = $a = \sqrt{a_x^2 + a_y^2}$	direction $\rightarrow \tan \theta = a_y/a_x$
Components:	$a_x = a \cos \theta$	$a_y = a \sin \theta$	θ = angle to +x-axis.
Addition:	$\vec{a} + \vec{b}$, head to tail.	Subtraction: $\vec{a} - \vec{b}$ is $\vec{a} + (-\vec{b})$	$-\vec{b}$ is \vec{b} reversed.
Scalar product:	$\vec{a} \cdot \vec{b} = ab \cos \phi$	$\vec{a} \cdot \vec{b} = a_x b_x + a_y b_y + a_z b_z$	$\hat{i} \cdot \hat{i} = 1$, $\hat{i} \cdot \hat{j} = 0$, etc.
Cross product:	$ \vec{a} \times \vec{b} = ab \sin \phi$	$\hat{i} \times \hat{j} = \hat{k}$, etc.	$\hat{i} \times \hat{i} = \hat{j} \times \hat{j} = \hat{k} \times \hat{k} = 0$

Chapter 3 - 1D Kinematics - Straight-line motion

Velocity:	$v_{\text{avg}} = \Delta x / \Delta t$	$\Delta x = x - x_0$	$v(t) = \frac{dx}{dt}$ = slope of $x(t)$
Acceleration:	$a_{\text{avg}} = \Delta v / \Delta t$	$\Delta v = v - v_0$	$a(t) = \frac{dv}{dt}$ = slope of $v(t)$
Integrals = areas:	$x(t) = x_0 + \int_0^t v(t') dt'$,	$v(t) = v_0 + \int_0^t a(t') dt'$.	
Constant acceleration:	$v = v_0 + at$, $x = x_0 + v_0 t + \frac{1}{2} at^2$, (position from acceleration)	$v_{\text{avg}} = \frac{1}{2}(v_0 + v)$, $x = x_0 + v_{\text{avg}} t$, (using average velocity)	$\Delta x = v_{\text{avg}} \Delta t$. $v^2 = v_0^2 + 2a\Delta x$. (timeless equation)
Free fall (+y-axis is up):	$y = y_0 + v_{0y} t - \frac{1}{2} gt^2$,	$v_y = v_{0y} - gt$,	$v_y^2 = v_{0y}^2 - 2g\Delta y$.

Chapter 4 - 2D and 3D Motion - Vector displacement, velocity, acceleration

Position:	$\vec{r} = x\hat{i} + y\hat{j} + z\hat{k}$	$\vec{r} = (x, y, z)$	$\Delta\vec{r} = (\Delta x, \Delta y, \Delta z)$
Velocity:	$\vec{v}_{\text{avg}} = \Delta\vec{r}/\Delta t$	$\vec{v} = d\vec{r}/dt$	$\Delta\vec{r} = \vec{r} - \vec{r}_0$
Acceleration:	$\vec{a}_{\text{avg}} = \Delta\vec{v}/\Delta t$	$\vec{a} = d\vec{v}/dt$	$\Delta\vec{v} = \vec{v} - \vec{v}_0$
Projectiles:	$a_x = 0$	$v_x = v_{0x}$	$x = x_0 + v_{0x}t$
(+y-axis is up)	$a_y = -g$	$v_y = v_{0y} - gt$	$y = y_0 + v_{0y}t - \frac{1}{2}gt^2$
Range:	$R = (v_0^2/g) \sin(2\theta_0)$	\leftarrow (range on level ground only)	
Relative Motion:	$\vec{v}_{\text{BS}} = \vec{v}_{\text{BW}} + \vec{v}_{\text{WS}}$	B=Boat, S=Shore, W=Water.	BS is “boat relative to shore”, etc.
Circular motion:	$a_c = v^2/r = \omega^2 r$	$v = 2\pi r/T = \omega r$	$\omega = 2\pi/T$, T =period of 1 rev.

Chapter 5 - Newton's laws and forces

Newton's 1 st Law:	$\vec{a} = d\vec{v}/dt = 0$ unless $\vec{F}_{\text{net}} \neq 0$	$\vec{F}_{\text{net}} = \sum \vec{F}_i$ = sum of all forces on a mass.
Newton's 2 nd Law:	$\vec{F}_{\text{net}} = m\vec{a}$	$F_{\text{net},x} = ma_x$, $F_{\text{net},y} = ma_y$, $F_{\text{net},z} = ma_z$
Newton's 3 rd Law:	$\vec{F}_{AB} = -\vec{F}_{BA}$	Forces exist in action-reaction pairs.
Gravitational force near Earth:	$F_G = mg$, downward.	Apparent weight is force measured by a scales.
Gravity components on inclines:	$F_{\parallel} = mg \sin \theta$, $F_{\perp} = mg \cos \theta$	\leftarrow for incline at angle θ to horizontal.
Spring force:	$F_s = -kx$	x is the displacement from equilibrium.

Chapter 6 - Friction, circular motion

Static friction (object is stuck):	$f_s \leq \mu_s N$	Can balance other forces in any direction.
Kinetic friction (object sliding):	$f_k = \mu_k N$	Acts against the relative motion of surfaces.
Centripetal acceleration:	$a_c = v^2/r$	Points towards the center of the circle.
Centripetal force:	$F_{\text{net,inward}} = ma_c$	“Centripetal force” is the sum of forces inward.
Rates of circular motion:	$v = 2\pi r/T = 2\pi r f$	frequency $f = 1/T$, T =period of one revolution.