Prefixes

z=10^{-21},	a=10^{-18},	f=10^{-15},	p=10^{-12},	n=10^{-9},	$\mu = 10^{-6}$,	m=10^{-3},	c=10^{-2},	k=10^{3},	M=10^{6},	G=10^{9},	T=10^{12},	P=10^{15},	E=10^{18},	Z=10^{21}
zepto,	atto,	femto,	pico,	nano,	micro,	milli,	centi,	kilo,	mega,	giga,	tera,	peta,	exa,	zeta.

Physical Constants

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

Algebra

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

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

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

Chapter 2 - Vectors - Magnitude & Direction

2D Vectors:	$\vec{\mathbf{a}} = a_x\hat{\mathbf{i}} + a_y\hat{\mathbf{j}}$	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:	$\vec{\mathbf{a}} + \vec{\mathbf{b}}$, head to tail.	Subtraction: $\vec{\mathbf{a}} - \vec{\mathbf{b}}$ is $\vec{\mathbf{a}} + (-\vec{\mathbf{b}})$	$-\vec{\mathbf{b}}$ is $\vec{\mathbf{b}}$ reversed.
Scalar product:	$\vec{\mathbf{a}} \cdot \vec{\mathbf{b}} = ab\cos\phi$	$\vec{\mathbf{a}} \cdot \vec{\mathbf{b}} = a_x b_x + a_y b_y + a_z b_z$	$\hat{\mathbf{i}} \cdot \hat{\mathbf{i}} = 1$, $\hat{\mathbf{i}} \cdot \hat{\mathbf{j}} = 0$, etc.
Cross product:	$\lvert\vec{\mathbf{a}} \times \vec{\mathbf{b}}\rvert = ab\sin\phi$	$\hat{\mathbf{i}} \times \hat{\mathbf{j}} = \hat{\mathbf{k}}$, etc.	$\hat{\mathbf{i}} \times \hat{\mathbf{i}} = \hat{\mathbf{j}} \times \hat{\mathbf{j}} = \hat{\mathbf{k}} \times \hat{\mathbf{k}} = 0$

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:	$v = v_0 + at$,	$v_{\text{avg}} = \frac{1}{2}(v_0 + v)$,	$\Delta x = v_{\text{avg}}\Delta t$.
	$x = x_0 + v_0 t + \frac{1}{2}at^2$,	$x = x_0 + v_{\text{avg}}t$,	$v^2 = v_0^2 + 2a\Delta x$.
	(position from acceleration)	(using average velocity)	(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 5 - Newton's laws and forces

Newton's 1$^{\text{st}}$ 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$^{\text{nd}}$ 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$^{\text{rd}}$ 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:	$F_{g,\parallel} = mg\sin\theta,\ F_{g,\perp} = mg\cos\theta$	$\leftarrow$ 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):	$f_s \le \mu_s N$	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.

Chapter 7 - Work and kinetic energy

Work done by a force:	$dW = \vec{\mathbf{F}} \cdot d\vec{\mathbf{r}} = F\ dr\ \cos\theta$	$W_{AB} = \int_A^B \vec{\mathbf{F}} \cdot d\vec{\mathbf{r}}$ (along the path $A \to B$)
Work of a constant force:	$W = \vec{\mathbf{F}} \cdot \Delta\vec{\mathbf{r}}$	$\Delta\mathbf{r} = \vec{\mathbf{r}}_B - \vec{\mathbf{r}}_A$ = displacement.
Work done by gravity:	$W_g = -mg\Delta y$	$\Delta y = y_B - y_A$ (final minus initial height)
Work done by a spring:	$W_s = -\frac{1}{2}k(x_B^2 - x_A^2)$	B=final stretch, A =initial stretch.
Work done by friction:	Use formula for constant force.	Friction's work can be positive or negative!!
Work-KE theorem:	$\Delta\mathrm{KE} = W_{\mathrm{net}}$ = all works on m.	$\mathrm{KE} = \frac{1}{2}mv^2$, $P = \frac{dW}{dt}$, $P_{\mathrm{ave}} = \frac{\Delta W}{\Delta t}$.
Instantaneous power:	$P = dW/dt$	$\leftarrow$ the rate of doing work by some force.
When $\vec{\mathbf{F}}$ acts on m:	$P = \vec{\mathbf{F}} \cdot \vec{\mathbf{v}}$	$\leftarrow$ instantaneous power only due to $\vec{\mathbf{F}}$
Average power:	$P_{\mathrm{ave}} = \Delta W/\Delta t$	$\leftarrow$ average over time interval Δt.

Chapter 8 - Potential energy and Conservation of energy

PE for gravity:	$\Delta U = mg\Delta y$,	$U(y) = mgy+$ constant.
PE for springs:	$\Delta U = \frac{1}{2}k(x_B^2 - x_A^2)$,	$U(x) = \frac{1}{2}kx^2$ + constant.
Arbitrary system:	$\Delta E_{\mathrm{total}} = 0$,	$E_{\mathrm{total}} = E_{\mathrm{mec}} + E_{\mathrm{thermal}} + E_{\mathrm{other}}$. (nothing is left out of energy accounting).

Chapter 9 - Linear momentum and collisions

Linear Momentum:	$\vec{\mathbf{p}} = m\vec{\mathbf{v}}$,	Impulse Theorem:	$\Delta\vec{\mathbf{p}} = \vec{\mathbf{J}} = \int \vec{\mathbf{F}}(t)\,dt = \vec{\mathbf{F}}_{\mathrm{ave}}\Delta t$.
Instantaneous force:	$\vec{\mathbf{F}} = \frac{d\vec{\mathbf{p}}}{dt}$,	Average force:	$\vec{\mathbf{F}}_{\mathrm{ave}} = \frac{\Delta\vec{\mathbf{p}}}{\Delta t}$.
Conservation (@ $\vec{\mathbf{F}}_{\mathrm{net}} = 0$):	$\Delta\vec{\mathbf{p}}_{\mathrm{total}} = 0$,	$\vec{\mathbf{p}}_{1\mathrm{i}} + \vec{\mathbf{p}}_{2\mathrm{i}} = \vec{\mathbf{p}}_{1\mathrm{f}} + \vec{\mathbf{p}}_{2\mathrm{f}}$,	i=initial, f=final.

Center of mass:	$\vec{\mathbf{r}}_{\mathrm{com}} = \frac{m_1\vec{\mathbf{r}}_1 + m_2\vec{\mathbf{r}}_2 + \ldots}{m_1 + m_2 + \ldots}$,	$\vec{\mathbf{v}}_{\mathrm{com}} = \frac{m_1\vec{\mathbf{v}}_1 + m_2\vec{\mathbf{v}}_2 + \ldots}{m_1 + m_2 + \ldots}$	
1D elastic collisions:	$v_{1\mathrm{f}} = 2v_{\mathrm{com}} - v_{1\mathrm{i}}$	$v_{2\mathrm{f}} = 2v_{\mathrm{com}} - v_{2\mathrm{i}}$,	Equal masses swap velocities.
Other collisions:	$\vec{P}_{\mathrm{total}} = M\vec{\mathbf{v}}_{\mathrm{com}}$ = const.	$\vec{P}_{\mathrm{total}} = m_1\vec{\mathbf{v}}_1 + m_2\vec{\mathbf{v}}_2$ = const.	

Extended objects: The point $\vec{\mathbf{r}}_{\mathrm{com}}$ moves as a point mass $M = \sum_i m_i$ subjected to net force $\vec{F}_{\mathrm{net}}$.

Chapter 12 - Static equilibrium

Statics requirements:	$\sum F_x = \sum F_y = \sum F_z = 0$,	$\sum \tau = 0$,	$\tau = rF\sin\theta$.
Stress & strain:	stress = $F_\perp/A$,	strain = $\Delta L/L_0$,	stress = $Y\times$ strain.
Shear forces:	stress = $F_\parallel/A$,	strain = $\Delta x/L_0$,	stress = $S\times$ strain.
Bulk modulus B:	b-stress = Δp,	b-strain = $\Delta V/V_0$,	b-stress = $B\times$ b-strain.
Units:	stress in Pa=N/m^2,	strain = % or no units,	Y, S, B in Pa=N/m^2.

Chapter 13 - Gravitation

Gravitational force:	$F = Gm_1m_2/r^2$,	$F = mg$,	$g = GM/r^2$,	$v_{\mathrm{escape}} = \sqrt{2GM/r}$.
Gravitational PE:	$U = -Gm_1m_2/r$,	$\Delta U + \Delta K = 0$,	$\Delta K = -\Delta U$,	$\Delta K = \frac{1}{2}m(v_{\mathrm{f}}^2 - v_{\mathrm{i}}^2)$.
Orbits:	$F = mv^2/r$,	$v = 2\pi r/T$,	$v_{\mathrm{orb}} = \sqrt{GM/r}$,	Kepler: $T^2 = \frac{4\pi^2}{GM}\bar{r}^3$.

Chapter 14 - Fluids

1 atmosphere = 1 atm = 101.3 kPa = 1.013 bar = 760 torr = 760 mm Hg = 14.7 lb/in^2.

Units:	1 Pa = 1 N/m^2,	1 bar = 10^5 Pa,	1 mm Hg = 1 torr = 133.3 Pa.
Density:	$\rho = m/V$,	$\rho_{H_2O} = 10^3$ kg/m^3 (4°C),	10^3 kg/m^3 = 1 g/cm^3.
Pressure:	$p = F/A$,	$p_2 = p_1 + \rho g d$,	$p_{\mathrm{abs}} = p_{\mathrm{atm}} + p_{\mathrm{gauge}}$.
Archimedes:	$F_B = \rho_{\mathrm{fluid}} g V_s$,	Bernoulli energy conserv.$\to$	$p + \rho g y + \frac{1}{2}\rho v^2$ = const.
Flow rates:	$Q = Av$,	$Q_m = \rho A v$,	$Q = (p_2 - p_1)\pi r^4/(8\eta L)$.
Viscosity:	$F = \eta v A/L$,	$N_R = 2\rho v r/\eta$,	$N_R < 2000$ laminar, $N_R > 3000$ turbulent.