A review

...of *almost* everything

1. Vectors

Pythagorus		$a^2 + b^2 = c^2$
Trig	$\sin$, $\cos$, $\tan$, $\sin^{-1}$, $\cos^{-1}$, $\tan^{-1}$	Needed to get the components or find resultants

2. Kinematics

The way things move.

Displacement	$\mathbf{x}$
Velocity	$\mathbf{v} = \frac{\Delta \mathbf{x}}{\Delta t}$
Acceleration	$\mathbf{a} = \frac{\Delta \mathbf{v}}{\Delta t}$

2.1 Kinematic Equations

Velocity	$\mathbf{v} = \mathbf{v}_0 + \mathbf{a}t$
Displacement	$\mathbf{x} = \bar{\mathbf{v}}t = \frac{\mathbf{v} + \mathbf{v}_0}{2}t$
Displacement	$\mathbf{x} = \mathbf{x}_0 + \mathbf{v}_0 t + \frac{1}{2}\mathbf{a}t^2$
Speed	$v^2 = v_0^2 + 2a\Delta x$

2.2 2-D kinematics

Motions happen in 2 dimensions. Treat these dimensions separately.

x-Displacement	$\mathbf{x} = \mathbf{x}_0 + \mathbf{v}_{x0} t + \frac{1}{2}\mathbf{a}_\mathbf{x} t^2$
y-Displacement	$\mathbf{y} = \mathbf{y}_0 + \mathbf{v}_{y0} t + \frac{1}{2}\mathbf{a}_\mathbf{y} t^2$

3. Forces

Newtons' Three Laws

$\sum \mathbf{F} = m\mathbf{a}$

3.3 Catalog of Forces

Pushing/pulling	General, non-descript interactions
Tension	Forces applied using ropes.
Gravity	Attractive force between *all* objects with mass
Normal	Interaction force - points perpendicular to plane of contact
Friction	A model to explain how surfaces interact
Drag	Velocity Dependent air resistance
Springs	Hooke's Law
Buoyancy Force	"The weight of the fluid displaced"

3.4 Gravity

Newton's Law of Gravitation $|\mathbf{F}_G| = \frac{Gm_1m_2}{r^2}$

little g $g = \frac{Gm_E}{R_E^2}$

weight (near surface of the earth) $\mathbf{F}_G = -mg$

3.5 Friction

static friction max $f_s^{\max} = \mu_s F_N$

kinetic friction $f_k = \mu_k F_N$

3.6 Springs

Hooke's Law / Restoring Force $\mathbf{F}_{spring} = -k\mathbf{x}$

4. Circular Motion

centripetal acceleration $a_c = \frac{v^2}{r}$

period / speed $v = \frac{2\pi r}{T}$

4.7 Work & Energy

work	$W = Fs\cos\theta$
kinetic energy	$KE = \frac{1}{2}mv^2$
potential energy	$PE = mgh$
conservation of energy	$W_{\mathrm{NC}} = E_f - E_i$

4.8 Power

Power: change in energy per time

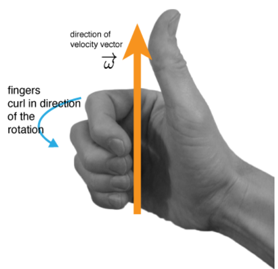
Find the rate of energy change	$P = \frac{\Delta E}{\Delta t}$

4.9 Impulse

Impulse	$\mathbf{J} = \mathbf{F}\Delta t$
momentum	$\mathbf{p} = m\mathbf{v}$
impulse-momentum	$\mathbf{J} = \Delta\mathbf{p}$

And, momentum is always conserved.

5. Rotational Kinematics

Arc length	$r\theta = s$
angular displacement	$\theta = \theta_0 + \omega_0 t + \frac{1}{2}\alpha t^2$
angular velocity	$\overline{\omega} = \frac{\Delta\theta}{\Delta t}$
angular velocity	$\omega^2 = \omega_0^2 + 2\alpha\theta$
$\boldsymbol{\omega}$ is a vector	R.H.R. 

5.10 Rotational

Arc length	$r\theta = s$
angular displacement	$\theta = \theta_0 + \omega_0 t + \frac{1}{2}\alpha t^2$
angular velocity	$\overline{\omega} = \frac{\Delta\theta}{\Delta t}$
angular velocity	$\omega^2 = \omega_0^2 + 2\alpha\theta$

5.11 Torque

Torque	$\tau = rF\sin\phi$
Moment of Inertia (point)	$I = mr^2$
Rotational 2nd law	$\tau = I\alpha$
Kinetic energy of rotation	$KE_{\text{Rot}} = \frac{1}{2}I\omega^2$
And, angular momentum is always conserved.	$L = I\omega$

6. Oscillations

General Restoring Force	$\mathbf{F} = m\mathbf{a} = -\mathcal{O}\mathbf{x}$	Solution: $x(t) = A\cos(\omega t + \phi)$
Mass on a spring		$\omega = 2\pi f = \frac{2\pi}{T} = \sqrt{\frac{k}{m}}$
Potential Energy		$U_{\text{sp}} = \frac{1}{2}kx^2$
Simple Pendulum		$T = 2\pi\sqrt{\frac{L}{g}}$

6.12 Simple Harmonic Motion

Position	$x(t) = A\cos(\omega t)$
Velocity	$v(t) = -A\omega\sin(\omega t)$
Acceleration	$a(t) = -A\omega^2\cos(\omega t)$
Damping	$x(t) = e^{-t/\tau}A\cos(\omega t + \phi)$

7. Fluids

density	$\rho = \frac{m}{V}$
Pressure	$P = \frac{F}{A}$
Change in pressure due to depth	$P_2 = P_1 + \rho g h$
Archimedes' Principle.	$F_B = W_{\text{fluid}}$

7.13 Moving Fluids

Continuity	$\rho_1 A_1 v_1 = \rho_2 A_2 v_2$
Bernoulli	$P_1 + \frac{1}{2}\rho v_1^2 + \rho g y_1 = P_2 + \frac{1}{2}\rho v_2^2 + \rho g y_2$

8. Temperature and Heat

Thermal Contraction	$\Delta L = \alpha L_0 \Delta T$
Specific Heat	$Q = cm\Delta T$
Phase changes	$Q = mL_F \text{ or } mL_V$
Thermal Conductivity	$Q = \frac{kA\Delta T\, t}{L}$

9. Kinetic Theory

Ideal gas $PV = nRT = Nk_BT$

rms speed $v_{rms} = \sqrt{\frac{3k_BT}{m}}$

mean free path $\lambda = \frac{1}{\sqrt{2}\pi d^2 N/V}$