

Standard force and motion

$v^2 - u^2 = 2as$	$v = u + at$
$s = \frac{1}{2}at^2 + ut$	$s = \frac{(u+v)t}{2}$
$F = \frac{dp}{dt} = m \frac{dv}{dt}$ $= ma$	$f_{max} = \mu F_N$
$F_{drag} = \frac{1}{2}C\rho Av^2$	$\vec{J} = \Delta\vec{p} = m \cdot \Delta\vec{v}$ $= \int \vec{F} dt$
$W = \vec{F} \cdot \vec{s} = \vec{F} \vec{s} \cos \theta = \int F ds$	
$\vec{r}_{CoM} = \frac{1}{M} \sum \vec{r}m = \frac{1}{M} \int \vec{r} dm$	

Rotation stuff

$\omega^2 - \omega_0^2 = 2\alpha\theta$	$\omega = \omega_0 + \alpha t$
$\theta = \frac{1}{2}\alpha t^2 + \omega_0 t$	$\theta = \frac{(\omega_0 + \omega)t}{2}$
<i>Linear quantity = Angular quantity \times Radius</i>	
$\vec{v} = \vec{\omega} \times \vec{r}$	
$a_{radial} = \vec{\alpha} \times \vec{r}$	$a_{centripetal} = \vec{\omega} \times \vec{v}$
$\vec{a} = \vec{\alpha} \times \vec{r} + \vec{\omega} \times \vec{v} = a_{radial} + a_{centripetal}$	
$F_{centripetal} = m \frac{v^2}{r} = mr\omega^2$	
$I = \sum mr^2 = \int r^2 dm$	
$KE = \frac{1}{2}I\omega^2 = \frac{1}{2}\omega^2 \int r^2 dm$	
Shifting centre of rotation: $I = I_0 + Mh^2$	
Angular momentum: $\vec{L} = I\omega = \vec{r} \times \vec{p} = \vec{r} \times m\vec{v}$	
$\vec{\tau} = \vec{r} \times \vec{F} = rF \sin \theta = I\alpha = \frac{dL}{dt}$	
$P = \tau\omega$	$W = \frac{1}{2}I(\omega^2 - \omega_0^2)$
Pure rolling:	
$v = R\omega$	$KE = \frac{1}{2}I\omega^2$
Rolling + Sliding:	
$KE = \frac{1}{2}I\omega^2 + \frac{1}{2}Mv^2 = \frac{1}{2}(I + MR^2)\omega^2$	

Spring stuff

$F = kx$
$W = \int F dx = \int kx dx = \frac{1}{2}k(x_f^2 - x_i^2)$

Power and energy

$W = \Delta KE = -\Delta U$	$F = -\frac{d}{dx}U$
$P = \frac{d}{dt}W$ $= \frac{d}{dt}(Fx \cos \theta) = Fv \cos \theta = \vec{F} \cdot \vec{v}$	

FluidicsDensity - ρ

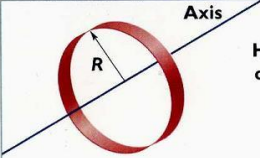
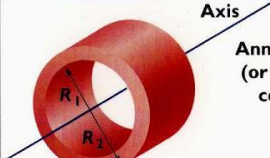
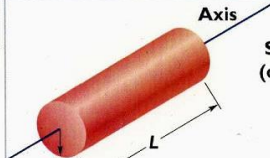
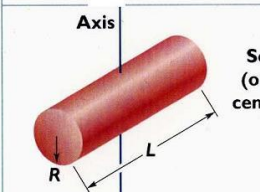
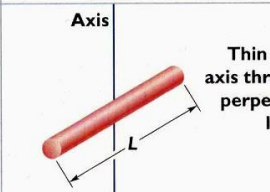
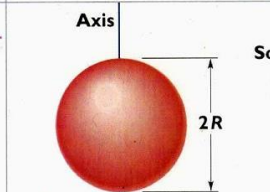
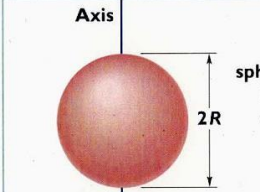
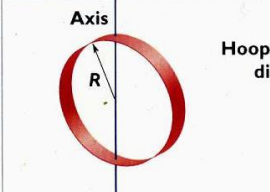
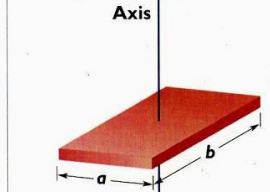
$\rho = \frac{m}{V}$	$p = \frac{F}{A}$
$p = p_{atmosphere/external} + \rho gh$	
$F_{buoyant} = Weight_{displaced} = \rho Vg$	
Bernoulli's: $p + \frac{1}{2}\rho v^2 + \rho gh = \text{const.}$	
Pipe continuity: $Av = \text{const.}$	

Harmonic motionTorsion - κ

$x(t) = A \cos(\omega t + \phi)$	$a(t) = -\omega^2 x(t)$
$\omega = 2\pi f$	$T = 2\pi \sqrt{\frac{m}{k}}$
$U(t) = \frac{1}{2}kA^2 \cos^2(\omega t + \phi)$	
$KE(t) = \frac{1}{2}kA^2 \sin^2(\omega t + \phi)$	
$E_{total} = U(t) + KE(t) = \frac{1}{2}kA^2$	
Angular oscillator (Rotating stuff):	
$\tau = I\alpha = -\kappa\theta$	$T = 2\pi \sqrt{I/\kappa}$
Simple pendulum:	
Linear density - μ	
$\tau = Lmg \sin \theta$	$\alpha = -\frac{mgL}{I}\theta$
$\omega = \sqrt{\frac{mgL}{I}}$	$T = 2\pi \sqrt{\frac{I}{mgL}}$
$v_{wave} = f\lambda = \frac{\omega}{k} = \sqrt{\frac{T}{\mu}}$	Small A: $T = 2\pi \sqrt{\frac{L}{g}}$

Mathematics fundamentals

Dot product	$\vec{a} \cdot \vec{b} = \vec{a} \vec{b} \cos \theta = i_a i_b + j_a j_b + k_a k_b$
Cross product	$\vec{a} \times \vec{b} = \hat{n} \vec{a} \vec{b} \sin \theta = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ i_a & j_a & k_a \\ i_b & j_b & k_b \end{vmatrix}$
Vector projection	$\vec{a} \xrightarrow{\text{proj.}} \vec{b} = (\vec{a} \cdot \hat{b}) \hat{b}$

 <p>Axis</p> <p>Hoop about central axis</p> <p>$I = MR^2$</p> <p>(a)</p>	 <p>Axis</p> <p>Annular cylinder (or ring) about central axis</p> <p>$I = \frac{1}{2} M (R_1^2 + R_2^2)$</p> <p>(b)</p>	 <p>Axis</p> <p>Solid cylinder (or disk) about central axis</p> <p>$I = \frac{1}{2} MR^2$</p> <p>(c)</p>
 <p>Axis</p> <p>Solid cylinder (or disk) about central diameter</p> <p>$I = \frac{1}{4} MR^2 + \frac{1}{12} ML^2$</p> <p>(d)</p>	 <p>Axis</p> <p>Thin rod about axis through center perpendicular to length</p> <p>$I = \frac{1}{12} ML^2$</p> <p>(e)</p>	 <p>Axis</p> <p>Solid sphere about any diameter</p> <p>$I = \frac{2}{5} MR^2$</p> <p>(f)</p>
 <p>Axis</p> <p>Thin spherical shell about any diameter</p> <p>$I = \frac{2}{3} MR^2$</p> <p>(g)</p>	 <p>Axis</p> <p>Hoop about any diameter</p> <p>$I = \frac{1}{2} MR^2$</p> <p>(h)</p>	 <p>Axis</p> <p>Slab about perpendicular axis through center</p> <p>$I = \frac{1}{12} M (a^2 + b^2)$</p> <p>(i)</p>