Possibly Useful Formulae

- Friction:
  $F_S \leq \mu_S N, F_K = \mu_K N$
- Air/fluid resistance:
  $\vec{F} = -\lambda v^{n-1}\vec{v}$
  Terminal velocity
  $v = (mg/\lambda)^{1/n}$
- Thrust $= -\dot{m}u$
  $u =$exhaust speed
- 1D harmonic oscillator
  $F_{restore} = -kx \equiv -m\omega_0^2 x$
  $V = kx^2/2$
  $F_{damping} = -2m\gamma\dot{x}$
- 3D isotropic oscillator
  $\vec{F} = -k\vec{r}, V = kr^2/2$
- Cylindrical coordinates
  $x = \rho\cos\varphi, y = \rho\sin\varphi, z = z$
  $ds^2 = d\rho^2 + \rho^2 d\varphi^2 + dz^2$
  $\vec{v} = \dot{\rho}\hat{\rho} + \rho\dot{\varphi}\hat{\varphi} + \dot{z}\hat{z}$
- Spherical polar coordinates
  $x = r\sin\theta\cos\phi,$
  $y = r\sin\theta\sin\phi, z = r\cos\theta$
  $ds^2 = dr^2 + r^2 d\theta^2 + r^2\sin^2\theta d\phi^2$
  $\vec{v} = \dot{r}\hat{r} + r\dot{\theta}\hat{\theta} + r\sin\theta\dot{\phi}\hat{\phi}$
- Angular momentum $\vec{J} = \vec{r} \times \vec{p}$
  Torque $\vec{\tau} = \vec{r} \times \vec{F}$
- Kepler's second law
  $dA/dt = J/2m$ constant
- Effective Potential
  $U(r) = V(r) + J^2/2mr^2$