Statics

Friction: $F_{S,\max} = \mu_S R$

$F_D = \mu_D R$

Hydrostatics: No shear forces

Isotropism

$P_B = P_T + \rho g h$

Upthrust: $F_U = m_F g$

Centre Of Mass: $\underline{R}_{CoM} = \frac{\sum_i m_i \underline{r}_i}{\sum_i m_i}$

Dynamics

Work Done: $W = \int_{\underline{x}_{start}}^{\underline{x}_{end}} \underline{F}.d\underline{x}$

Potential Energy: Work that would have to be done to put system into the state, starting from a common reference point

Power: $P = \frac{dU}{dt} = \underline{F}.\frac{d\underline{x}}{dt} = \underline{F}.\underline{v}$

Relativity

Fraction Of C: $\beta = \frac{v}{c}$

Gamma Factor: $\gamma = \frac{1}{\sqrt{1-\beta^2}}$

Lorentz Transform: $x' = \gamma(x - vt)$

$y' = y, z' = z$

$t' = \gamma(t - \frac{vx}{c^2})$

Doppler Effect (Towards Observer): $v = \sqrt{\frac{c+v}{c-v}} v_0$

Momentum: $\underline{p} = \gamma_u m \underline{u}$

Force (Straight Line): $F = \gamma^3 m a$

Energy: $E = \gamma_u m c^2$

E – p Invariant: $E^2 - p^2 c^2 = m^2 c^4$

E – p Transform: $p_x' = \gamma(p_x - \frac{vE}{c^2})$

$p_y' = p_y, p_z' = p_z$

$E' = \gamma(E - v p_x)$

Gravitation

Force: $\underline{F} = \frac{-GMm}{r^2}\hat{\underline{r}}$

Field: $g(\underline{r}) = \frac{\underline{F}}{m} = \underline{a}$

Potential Energy: $U(r) = \frac{-GMm}{r}$

Potential: $\phi(r) = \frac{U(r)}{m}$

Field-Potential Relationship: $\phi(\underline{r}) = -\int_{\infty}^{r} \underline{g}.d\underline{s}$

Gauss' Law: $\phi = \int \underline{g}.d\underline{A} = 4\Pi GM$

Rotational Dynamics

Velocity: $\underline{\omega} = \frac{d\theta}{dt} = \frac{v}{r}$

Moment Of Inertia: $I = \int r^2 dm$

Momentum: $\underline{L} = I\underline{\omega} = \underline{r} \wedge \underline{p}$

Torque: $\underline{G} = \frac{d\underline{L}}{dt} = \underline{r} \wedge \underline{F}$

Kinetic Energy: $E_{ROT} = \frac{I\omega^2}{2}$

Parallel Axis: $I = I_{CoM} + M|x|^2$

Perpendicular Axis: $I_Z = I_X + I_Y$

Keplers Laws

Orbits are ellipses with the sun at one focus

Radius vector from the sun to a planet sweeps out equal area in equal time

$$T^2 \propto R^3$$