IX. Gravity

(A) $\boxed{F_g = \frac{G m_1 m_2}{r^2}}$

(B) $F_g = m a_g \Rightarrow \frac{G m_1 m_2}{r^2} = m_1 a_g$

$\boxed{a_g = \frac{G M_2}{r^2}}$

(C) Orbits

1. $E_1 = E_2$ $\left(U = -\frac{G m_1 m_2}{r}\right)$
2. $L_1 = L_2 = r \times p$ b/c $\Sigma \tau = 0$
3. Circular orbits
   (a) $F_g = F_c \Rightarrow \frac{G m_1 m_2}{r^2} = \frac{m_1 v^2}{r}$
   (b) $2\pi r = vT$

(D) Bound Systems & Escape Velocity

1. Bound $\Rightarrow$ $K + U < 0$
2. Vesc $\Rightarrow$ $K + U > 0$

$\frac{1}{2} m_1 v_{esc}^2 - \frac{G m_1 m_2}{r} > 0$

$v_{esc} = \sqrt{\frac{2 G M_2}{r}}$

3. sphere with $\rho(r) = 6r$
   (a) find mass: $m' = \int \rho dV = \int_0^R \rho(r) \underbrace{4\pi r^2 dr}_{dV}$
   (b) $F_g = \frac{GM_1M'}{r^2}$

(F) Kepler's Laws
1. elliptical orbits with sun at a focal pt.
2. sweeps out equal areas in equal time.
3. $T^2 \propto R^3$