$$P^2 = \frac{4\pi^2}{G(M_s + M_p)}(R_s + R_p)^3$$

$$P^2 \sim \frac{4\pi^2}{G(M_s)}(R_p)^3$$

$$a_c = \frac{v^2}{R_s}$$

$$a = \frac{GM_p}{(R_s + R_p)^2}$$

$$\frac{R_p}{R_s} = \frac{M_s}{M_p} \quad \rightarrow \quad M_p = \frac{M_s R_s}{R_p}$$

$$a = \frac{GM_s R_s}{R_p (R_s + R_p)^2}$$

$$(R_s + R_p) \simeq R_p$$

$$a \simeq \frac{GM_s R_s}{{R_p}^3}$$