For another body (e.g. planet or moon)

$$\frac{g_P}{g_{Earth}} = \left(\frac{R_{Earth}}{R_P}\right)^2 \left(\frac{M_P}{M_{Earth}}\right)$$

e.g. for Mars, $g_{Mars} = 0.377\, g_{Earth} = 3.69\ ms^{-2}$

Exercise: Use the table of planetary data from lecture 1 to calculate g for all planets

We can also express g in terms of the average density, $\bar{\rho}$, of a body.

$$\bar{\rho} = \frac{\text{Mass}}{\text{volume}} = \frac{M}{\frac{4}{3}\pi R^3}$$

$$\Rightarrow \quad M = \frac{4}{3}\pi R^3 \bar{\rho}$$

$$\Rightarrow \quad g = \frac{G \times \frac{4}{3}\pi R^3 \bar{\rho}}{R^2} = \frac{4}{3} G \pi R \bar{\rho}$$

For constant $\bar{\rho}$, larger planets have larger surface gravity