

29. (a) The density of a uniform sphere is given by $\rho = 3M/4\pi R^3$, where M is its mass and R is its radius. The ratio of the density of Mars to the density of Earth is

$$\frac{\rho_M}{\rho_E} = \frac{M_M}{M_E} \frac{R_E^3}{R_M^3} = 0.11 \left(\frac{0.65 \times 10^4 \text{ km}}{3.45 \times 10^3 \text{ km}} \right)^3 = 0.74 .$$

- (b) The value of a_g at the surface of a planet is given by $a_g = GM/R^2$, so the value for Mars is

$$a_{gM} = \frac{M_M}{M_E} \frac{R_E^2}{R_M^2} a_{gE} = 0.11 \left(\frac{0.65 \times 10^4 \text{ km}}{3.45 \times 10^3 \text{ km}} \right)^2 (9.8 \text{ m/s}^2) = 3.8 \text{ m/s}^2 .$$

- (c) If v is the escape speed, then, for a particle of mass m

$$\frac{1}{2}mv^2 = G\frac{mM}{R}$$

and

$$v = \sqrt{\frac{2GM}{R}} .$$

For Mars

$$v = \sqrt{\frac{2(6.67 \times 10^{-11} \text{ m}^3/\text{s}^2 \cdot \text{kg})(0.11)(5.98 \times 10^{24} \text{ kg})}{3.45 \times 10^6 \text{ m}}} = 5.0 \times 10^3 \text{ m/s} .$$