Problem

Mars' moon Phobos has a mass of approximately 2×10^{-9} the mass of Earth and orbits around Mars at a distance of 1.5 times Earth radius **from the center of the planet**. Knowing that Mars has 0.1 times the mass of Earth, find:

The potential energy of Phobos.

$$U = \frac{G(2\times10^{-9}M_E)(0.1\,M_E)}{1.5\,R_E} = \frac{(6.67\times10^{-11})(2\times10^{-10})(5.98\times10^{24})^2}{(1.5)(6.37\times10^6)}$$

$$= 4.99\times10^{22}\ \text{J}$$

The orbital speed of Phobos assuming that the orbit is a perfect circle.

$$v = \sqrt{\frac{GM_{MARS}}{R_{ORBIT}}} = \sqrt{\frac{G(0.1M_E)}{1.5\,R_E}} = \sqrt{\left(\frac{0.1}{3}\right)\frac{2GM_E}{R_E}}$$

$$= \sqrt{\frac{0.1}{3}}\,v_e^{EARTH} = \sqrt{\frac{0.1}{3}}\,11.2\ \text{km/s} = 2.04\ \text{km/s}$$

The orbital period of Phobos.

$$T = \frac{2\pi(1.5\,R_E)}{2.04\ \text{km/s}} = \frac{2\pi(1.5)(6370\,\text{km})}{2.04\ \text{km/s}} = 2.9\times10^4\,\text{s}$$

If Phobos has a radius of just 11 km (i.e. 0.0017 times Earth radius), find the escape speed from Phobos' surface.

$$v_e^{PHOBOS} = \sqrt{\frac{2G(2\times10^{-9}M_E)}{0.0017\,R_E}} = \sqrt{\frac{2\times10^{-9}}{0.0017}}\,v_e^{EARTH}$$

$$= 0.012\ \text{km/s} = 12\ \text{m/s}$$