Chapter 8 Problem 14 [†]

Given
$m_m = 3.30 \times 10^{23}\ kg$
$r_m = 2.44 \times 10^{6}\ m$
$m_t = 1.35 \times 10^{23}\ kg$
$r_t = 2.58 \times 10^{6}\ m$

Solution
a) Find the acceleration on the surface of Mercury.

The acceleration at the surface of Mercury is derived from Newton's 2^{nd} law. The only force acting on the object is gravity; therefore,

$$\vec{F}_g = m\vec{a}$$

where $F_g = G\frac{Mm}{r^2}$ and is directed toward the center of the moon. Then

$$G\frac{Mm}{r^2} = ma$$

The acceleration is then

$$a = \frac{GM}{r^2}$$

Substituting in the values for Mercury gives

$$a_m = \frac{(6.672 \times 10^{-11}\ Nm^2/kg^2)(3.30 \times 10^{23}\ kg)}{(2.44 \times 10^{6}\ m)^2}$$

$$a_m = 3.70\ m/s^2$$

b) Find the gravitational acceleration of Titan.

Substituting in the values for Titan gives

$$a_t = \frac{(6.672 \times 10^{-11}\ Nm^2/kg^2)(1.35 \times 10^{23}\ kg)}{(2.58 \times 10^{6}\ m)^2}$$

$$a_t = 1.35\ m/s^2$$

[†]Problem from Essential University Physics, Wolfson