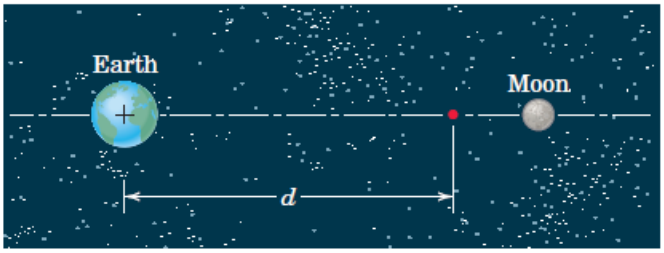
Istanbul Technical University – Faculty of Aeronautics and Astronautics **11.10.2019**
2019-2020 Fall Term
15549 STA201E Statics

Quiz – 2 - SOLUTION

Problem: Calculate the distance *d* from the center of the earth at which a particle experiences equal attractions from the earth and from the moon. The particle is restricted to the line through the centers of the earth and the moon.



Not to scale

Universal gravitational constant $G = 6.673(10^{-11})\ \text{m}^3/(\text{kg}\cdot\text{s}^2)$
Mass of Earth $m_e = 5.976(10^{24})\ \text{kg}$
Mass of moon relative to earth: 0.0123
Mean distance from moon to earth (center to center) : 384 398 km

Solution:

Attraction force between earth and particle: $F_1 = G\frac{m_e m_P}{d^2}$

Attraction force between moon and particle: $F_2 = G\frac{m_m m_P}{(384398\cdot 10^3 - d)^2} = G\frac{0.0123 m_e m_P}{(384398\cdot 10^3 - d)^2}$

Since the forces must be equal,

$$F_1 = G\frac{m_e m_P}{d^2} = G\frac{0.0123 m_e m_P}{(384398\cdot 10^3 - d)^2} = F_2 \rightarrow \frac{384398\cdot 10^3 - d}{d} = \sqrt{0.0123} = 0.1109$$

$$\rightarrow d = 346022.7\cdot 10^3\ m = 346022.7\ km$$

This *d* value corresponds to a position that is between the earth and the moon. However there is also a second position at which the attraction forces of the earth and the moon are equal and it is found as given below:

$$\frac{384398\cdot 10^3 - d}{d} = -\sqrt{0.0123} = -0.1109$$
$$\rightarrow d = 432347\cdot 10^3\ m = 432347\ km$$