Exercise 13.5

**Description:** Two uniform spheres, each of mass 0.260 kg, are fixed at points A and B (the figure). (a) Find the magnitude of the initial acceleration of a uniform sphere with mass 0.010 kg if released from rest at point P and acted on only by forces of...

Two uniform spheres, each of mass 0.260 kg, are fixed at points A and B (the figure).

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**Part A**

Find the magnitude of the initial acceleration of a uniform sphere with mass 0.010 kg if released from rest at point P and acted on only by forces of gravitational attraction of the spheres at A and B.

**Express your answer using two significant figures.**

**ANSWER:**

\[ a = 2.1 \times 10^{-9} \text{ m/s}^2 \]

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**Part B**

Find the direction of the initial acceleration of a uniform sphere with mass 0.010 kg.

**ANSWER:**
Exercise 13.16

Description: Jupiter’s moon Io has active volcanoes (in fact, it is the most volcanically active body in the solar system) that eject material as high as 500 km (or even higher) above the surface. Io has a mass of $8.93 \times 10^{22}$ kg and a radius of 1821 km.

Jupiter’s moon Io has active volcanoes (in fact, it is the most volcanically active body in the solar system) that eject material as high as 500 km (or even higher) above the surface. Io has a mass of $8.93 \times 10^{22}$ kg and a radius of 1821 km. For this calculation, ignore any variation in gravity over the 500-km range of the debris.

Part A

How high would this material go on earth if it were ejected with the same speed as on Io?

Express your answer to three significant figures and include the appropriate units.

ANSWER:

$h = 91.6 \text{ km}$

Also accepted: $91.7 \text{ km}$, $91.6 \text{ km}$

Problem 13.48

Description: At a certain instant, the earth, the moon, and a stationary spacecraft lie at the vertices of an equilateral triangle whose sides are $3.84 \times 10^5$ km in length. (a) Find the magnitude of the net gravitational force exerted on the spacecraft by the earth and moon.

At a certain instant, the earth, the moon, and a stationary $1140 \text{ kg}$ spacecraft lie at the vertices of an equilateral triangle whose sides are $3.84 \times 10^5$ km in length.

Part A

Find the magnitude of the net gravitational force exerted on the spacecraft by the earth and moon.

Express your answer to three significant figures.

ANSWER:

$$F = \frac{6.673 \times 10^{-11} \cdot 5.97 \times 10^{24}}{(3.84 \times 10^8)^2} \sqrt{1 + \left(\frac{7.35}{597}\right)^2 + \left(\frac{7.35}{597}\right)^2} = 3.10 \text{ N}$$
Find the direction of the net gravitational force exerted on the spacecraft by the earth and moon. State the direction as an angle measured from a line connecting the earth and the spacecraft.

Express your answer to three significant figures.

ANSWER: 0.607°

Part C

What is the minimum amount of work that you would have to do to move the spacecraft to a point far from the earth and moon? You can ignore any gravitational effects due to the other planets or the sun.

Express your answer to three significant figures.

ANSWER:

\[
W = \frac{6.673 \times 10^{-11} \times (5.97 \times 10^2 + 7.35 \times 10^3) \times (10^9)}{3.84} = 1.20 \times 10^9 \text{ J}
\]

Problem 13.49

Description: Many satellites are moving in a circle in the earth's equatorial plane. They are at such a height above the earth's surface that they always remain above the same point. (a) Find the altitude of these satellites above the earth's surface. (Such an..."

Many satellites are moving in a circle in the earth's equatorial plane. They are at such a height above the earth's surface that they always remain above the same point.

Part A

Find the altitude of these satellites above the earth's surface. (Such an orbit is said to be geosynchronous.)

ANSWER:

\[
h = 3.58 \times 10^7 \text{ m}
\]

Problem 13.54

Description: (a) Suppose you are at the earth's equator and observe a satellite passing directly overhead and moving from west to east in the sky. Exactly t hours later, you again observe this satellite to be directly overhead. Assume a circular orbit. How far...

Part A

Suppose you are at the earth's equator and observe a satellite passing directly overhead and moving from west to east in the sky. Exactly 10.0 hours later, you again observe this satellite to be directly overhead. Assume a circular orbit. How far above the earth's surface is the satellite's orbit?

ANSWER:
Part B

You observe another satellite directly overhead and traveling east to west. This satellite is again overhead in 10.0 hours. How far is this satellite's orbit above the surface of the earth?

ANSWER:

\[
h = \sqrt[3]{\left(6.67 \times 10^{-11} \cdot 5.98 \times 10^{24} \left(\frac{\frac{5.24 - 3900}{\pi}}{2}\right)^2\right)} - 6380 \times 10^3 = 1.23 \times 10^7 \text{ m}
\]