The Law of Gravitation

Pre-Lecture Questions

Problem Set #38 (due next time)

Lecture Outline

1. Explaining Kepler's Third Rule
2. Explaining Tides
3. Explaining GPS

Pre-Class Summary:

The Law of Universal Gravitation $\vec{F}_g = G\frac{m_1 m_2}{r^2}\hat{r}$.

where the gravitation constant is, $G = 6.67x10^{-11}\ \frac{N \cdot m^2}{kg^2}$.

Example 1: Show that for any planet, the area swept out per unit time is constant.

Example 2: Show that for any planet, find the ratio of the square of the period to the cube of the radius. Show it is the same for all planets.

Below is a table of the largest moons of Jupiter. Can you explain why the mass of the planet is quoted to five decimal places while the mass of the moons is known to less accuracy?

Planet	Moons	Mass (kg)
Jupiter		1.8985×10^{27}
	Io	8.93×10^{22}
	Europa	4.80×10^{22}
	Ganymede	1.48×10^{23}
	Callisto	1.08×10^{23}

Our Ocean Tides

1. Consider two equal-mass blobs of water, A and B, initially at rest in the moon's gravitational field. The vector shows the gravitational force of the moon on A.

   a. Draw a force vector on B due to the moon's gravity.

   b. Is the force on B more or less than the force on A? _____

   c. Why? _____

   d. The blobs accelerate toward the moon. Which has the greater acceleration? (A) (B)

   e. Because of the different accelerations, with time

      (A gets farther ahead of B) (A and B gain identical speeds) and the distance between A and B

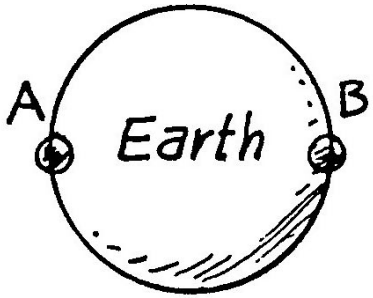
      (increases) (stays the same) (decreases).

   f. If A and B were connected by a rubber band, with time the rubber band would

      (stretch) (not stretch).

   g. This (stretching) (non-stretching) is due to the (difference) (non-difference) in the moon's gravitational pulls.

2. Now consider the same two blobs located on opposite sides of the earth.



a. Because of differences in the moon's pull on the blobs, they tend to

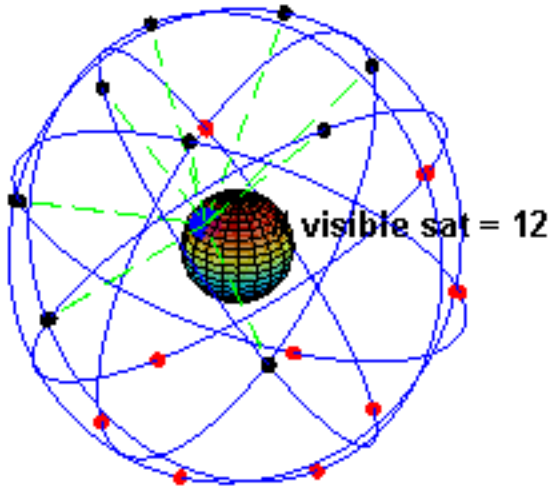
(spread away from each other) (approach each other).

b. Does this spreading produce ocean tides? (Yes) (No)

c. If earth and moon were closer, gravitational force between them would be (more) (the same) (less), and the difference in gravitational forces on the near and far parts of the ocean would be (more) (the same) (less).

Example 3: (a)Compare the force exerted on 1.00kg of seawater by the sun and by the moon. (b)Find the difference between the force exerted on 1.00kg of seawater by the moon on each side of Earth. (c)Find the difference between the force exerted on 1.00kg of seawater by the sun on each side of Earth. (d)Explain why the tides are more strongly associated with the moon than the sun even though the sun exerts more force on seawater than the moon.

Global Positioning System Satellites



Example 4: GPS satellites each complete two orbits in a day. Find (a)the radius of orbit and (b)their altitude.

Lecture 38 - Summary

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