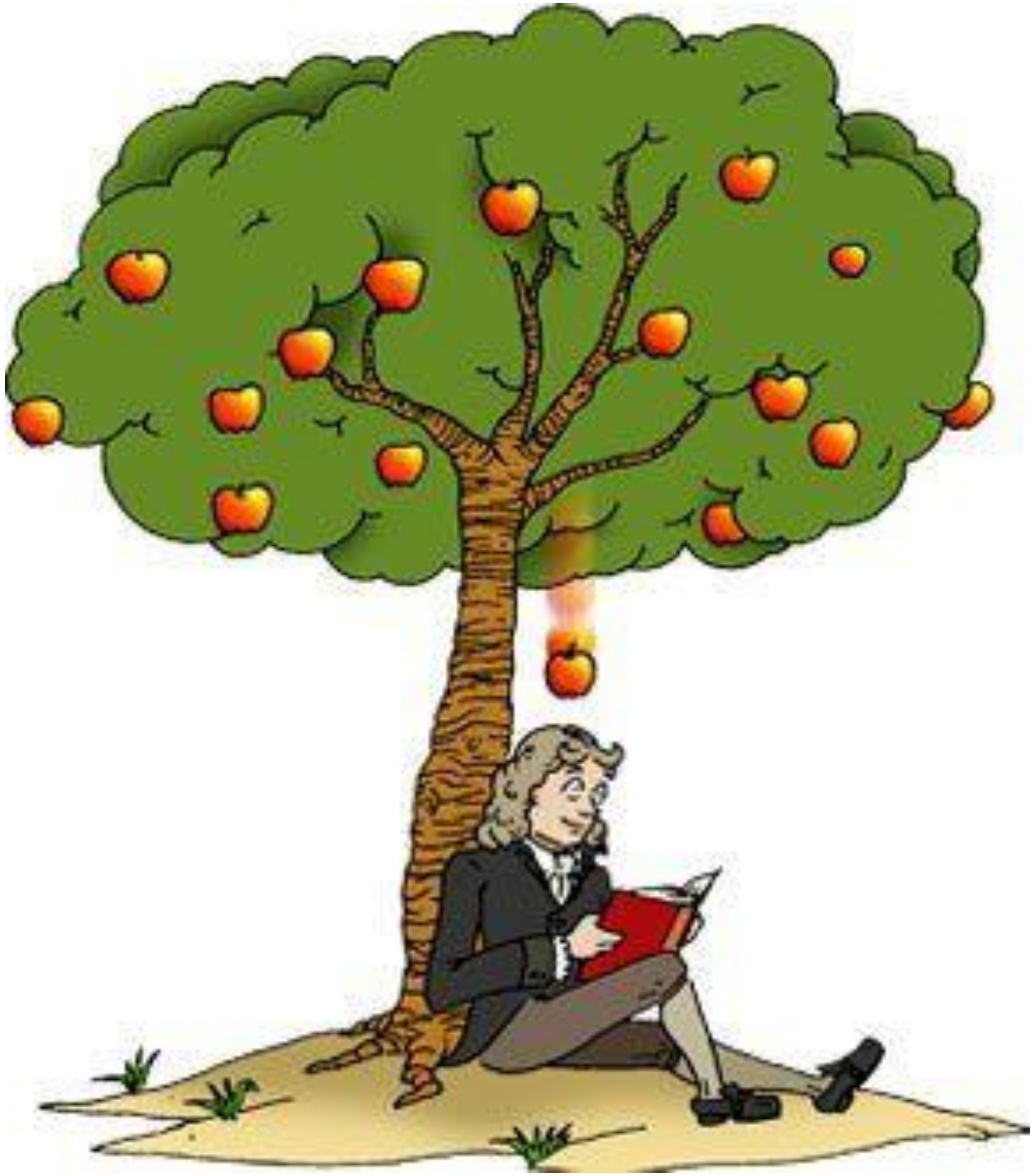
SQUARECAP

Do you have a favorite story of how a scientific discovery was made?



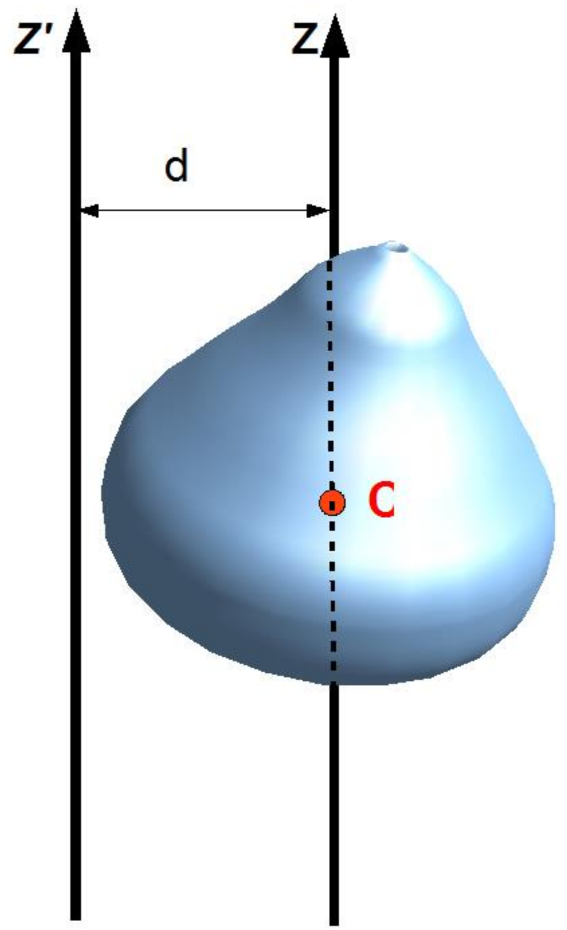
Notes

- Midsemester Survey (today!):

- Homework on Rotational Dynamics due Friday

- Exam II will be Nov 20 (Momentum, Rotational Motion - Dynamics, and Gravity)

Recap: Moment of Inertia - *Parallel Axis Theorem*



$$I = I_{cm} + Md^2$$

Example: Rod

$$I_{cm} = \frac{1}{12}ML^2$$

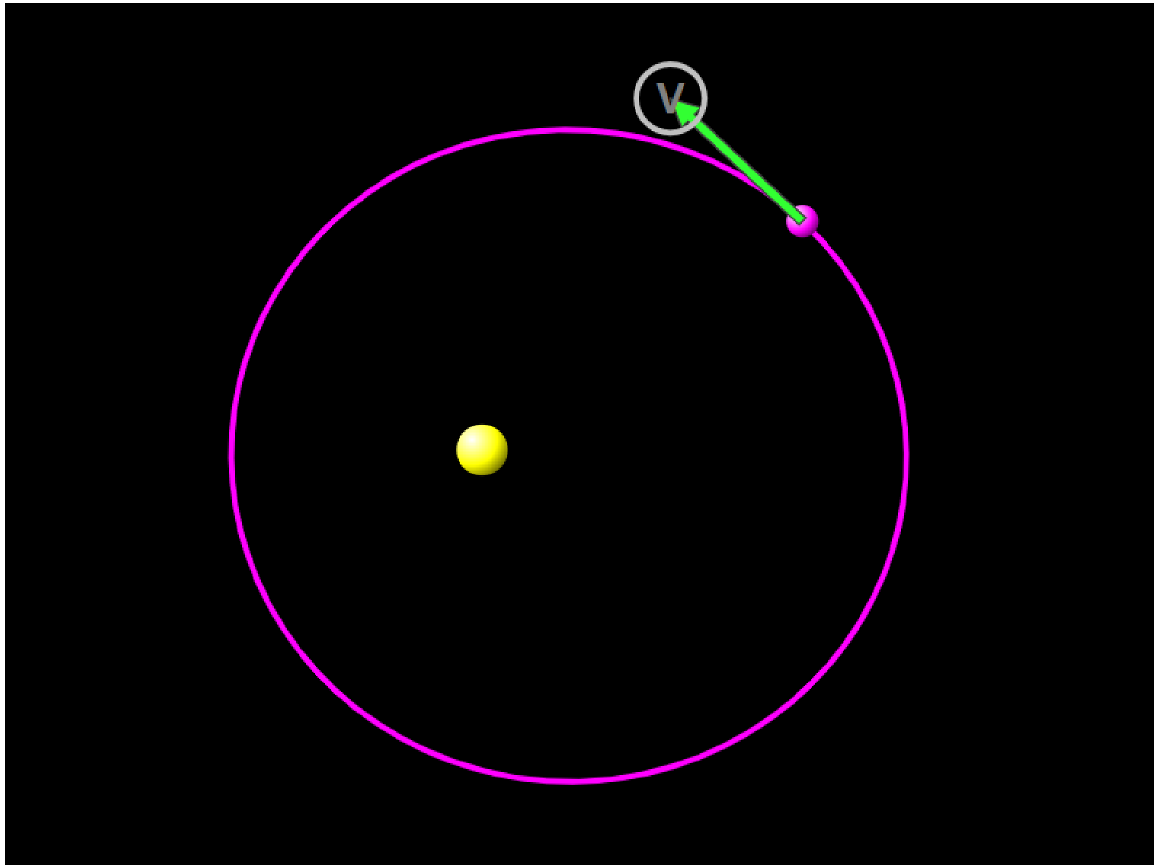
$$d = \frac{1}{2}L$$

$$I_{end} = \frac{1}{12}ML^2 + M\left(\frac{1}{2}L\right)^2$$

$$= \left(\frac{1}{12} + \frac{1}{4}\right)ML^2 = \frac{1}{3}ML^2$$

As we found before!

Prelecture Review: Kepler's Laws



1. Kepler's First Law says that objects move not in circles but ellipses. Check this out in the simulation under "First Law". How can you understand this in terms of mechanics?

2. Kepler's Second Law says that equal areas are swept out in equal times. Check this out in the simulation under "Second Law". Can you think of how mechanics might explain this?

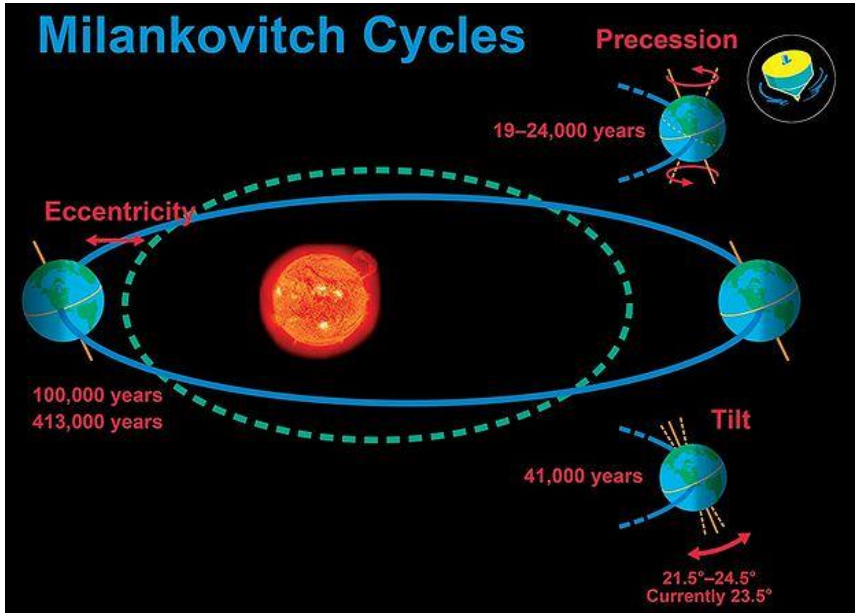
3. Kepler's Third Law states that the square of orbital period is proportional to the cube of the distance. Check this out under "Third Law". What might this tell us about forces underlying orbital motion?

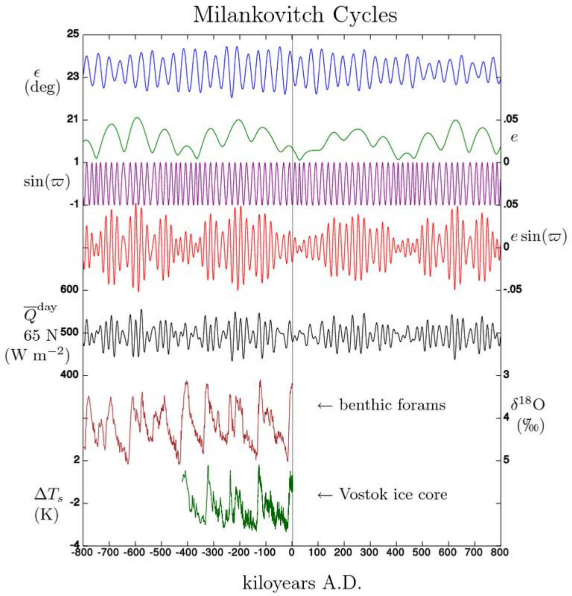
Let's brainstorm – open to speculation!

What are our comments and questions?

Comments and Questions

- If the areas are swept out in equal times according to Kepler's Second Law, doesn't that mean the tangential velocity of the terrestrial body orbiting around the sun have a higher velocity at some point compared to others? Also, the circumference distance that the terrestrial body has to cover as it rotates around the sun changes per equal allotted area based on its location in relation to the sun.
- Another question I have is if it's true that the tangential velocity of Earth changes as it rotates around the sun based on the Earth's location along its orbit, how does this affect life on Earth?





My Comments and Questions

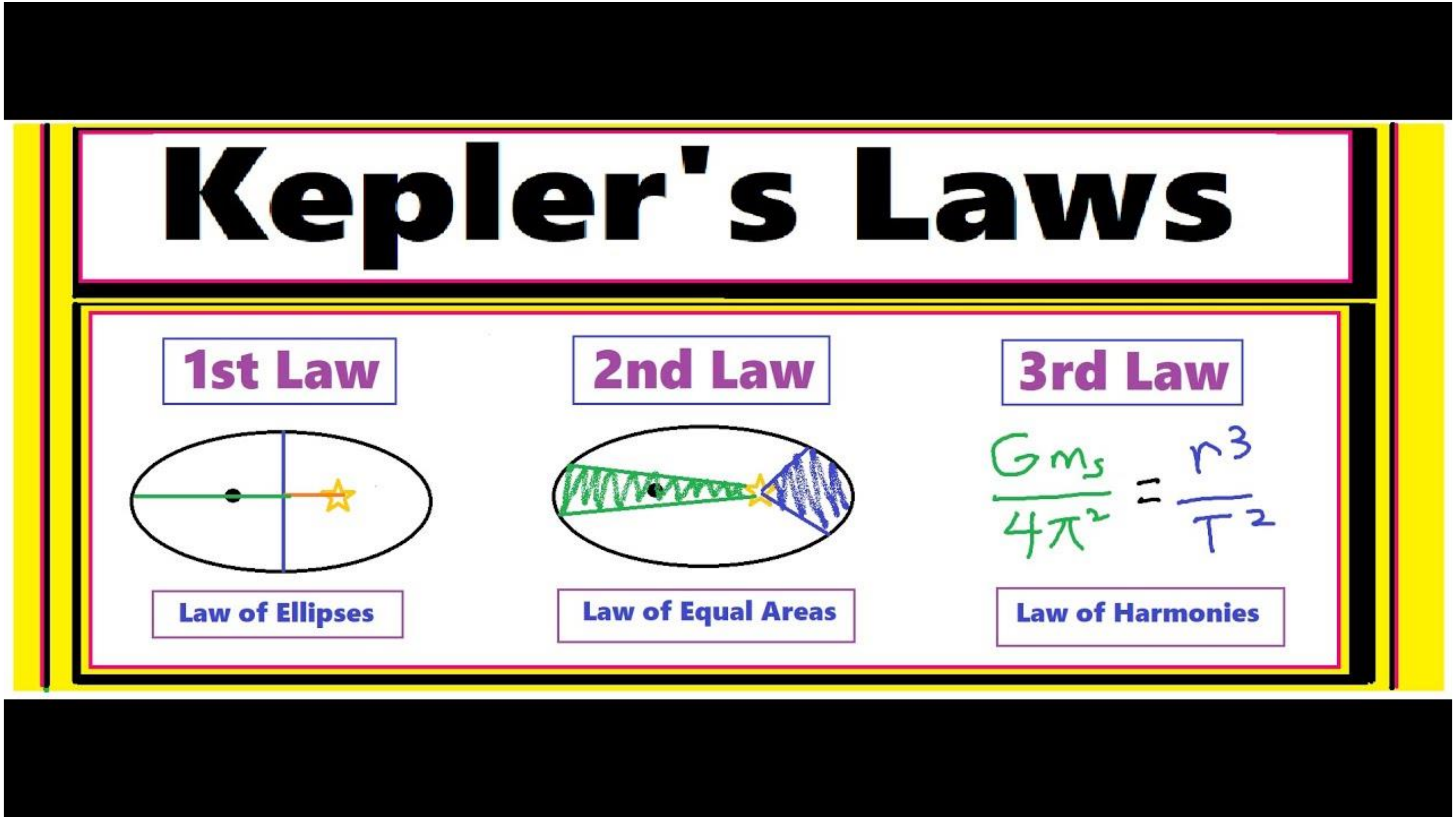
- In ancient times it was thought that there was a division between motion on Earth, and motion in “the heavens”.

→On Earth, motion was naturally translational, with the radial component special in the sense that things fell towards the center of the Earth.

→In space, motion appeared naturally rotational, with objects rotating around the center of the Earth (or later, the sun).

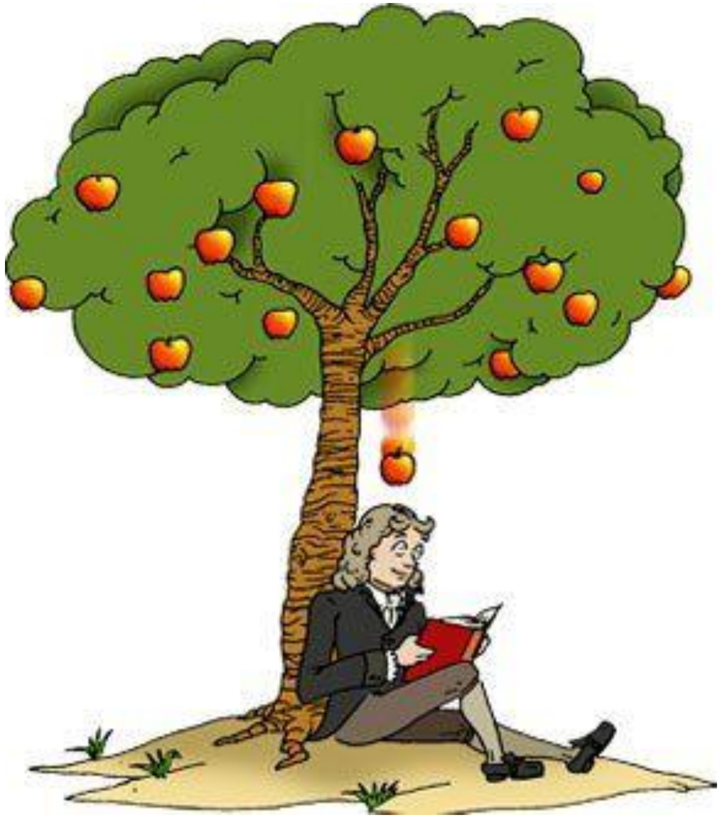
- What Newton and others accomplished was the break this down and replace it with a framework where *universal laws apply the same way everywhere* – no such division exists!

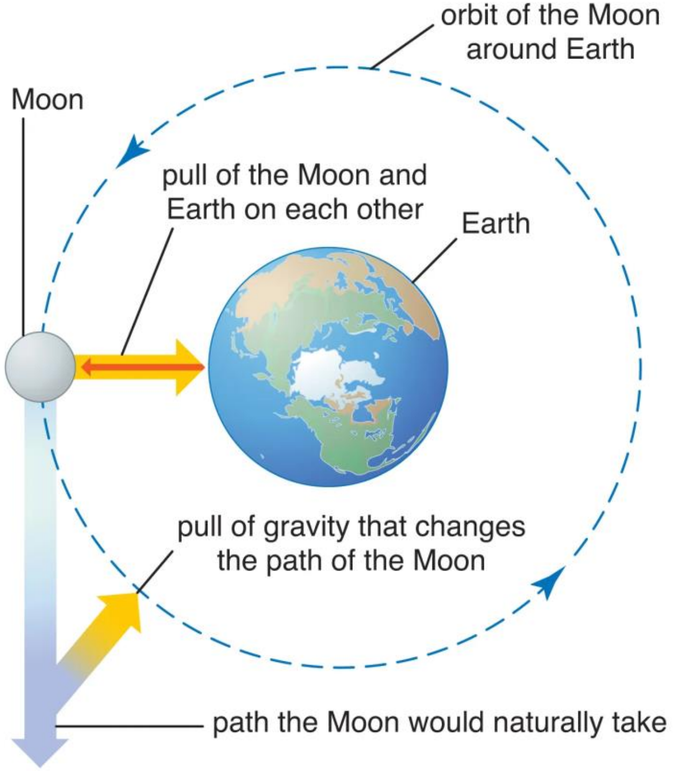
Kepler’s Laws and a Newtonian Analysis



Universal Gravitation

- The stipulation is that $F = -\frac{GMm}{r^2}$ accounts for the falling apples and the orbit of the moon?
- We can measure $g \approx 9.81\frac{m}{s}$, we have $R_{earth} = 6{,}378km$, $d_{moon} = 384{,}400\ km$
- If the same force is responsible, we should be able to predict the orbital period!





New Idea: Universal Gravitation

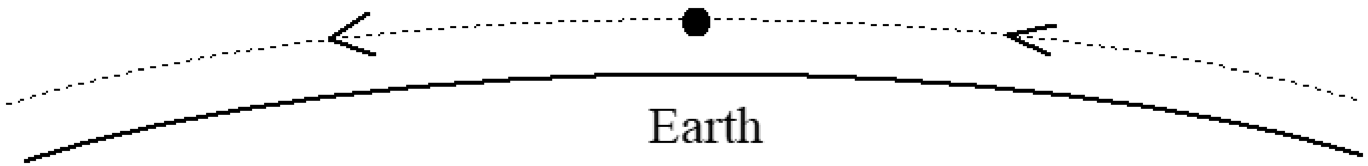
- All matter exerts a force on all other matter in the universe:

$$F = -\frac{GMm}{r^2}\,\hat{r}$$

- How does this happen, mechanically? Newton did not know. You may learn: there is an entity called the gravitational field, and this field represents the geometry of space itself.

Discuss and Answer:

A satellite is in circular orbit at an altitude of 100 miles above the surface of the Earth.



The satellite's pre-launch weight is its weight measured on the ground. The magnitude of the force of gravity on the satellite while it is in orbit is..

A) slightly greater than its pre-launch weight.
B) the same as its pre-launch weight.
C) slightly less than its pre-launch weight.
D) much less than its pre-launch weight, but not zero.
E) zero.