Teach #	Target Audience/recommended course(s) Honors, AP and IB Physics Algebra 2/Trigonometry or higher
Teach Date: Length of lesson: Two—50 min periods	Title of Lesson: What if there were no moon?
Main Idea of the Lesson: Introduce students to one of the ways to use interdisciplinary studies to calculate the mass of the moon	
Florida Standards for Lesson: SC.8.E.5.7 SC.8.E.5.9 MA.912.T.2.1 MA.912.T.1.4	
Objective/s- Write objective/s in SWBAT form… The SWBAT:	Evaluation: In the space below, write at least one question to match the objective you listed or describe what you will look at to be sure that students can do this.
Students will be able to calculate the density of the moon using Physics and Trigonometry. Eratosthenes performed a similar calculation thousands of years ago to find the radius of the Earth. There is a pretty cool diagram at the following link: http://en.wikipedia.org/wiki/Eratosthenes#Measurement_of_the_Earth.27s_circumference	Given the formula : M1*D1 = M2*D2 Calculate the mass of the moon.

Engagement: **Estimated Time: 2.5 min_____** **Description of Activity:**		
What the teacher does:	**What the student does:**	**Possible questions to ask students—*think like a student and consider possible student responses***
Show: NASA – YouTube video of the moon formation http://www.youtube.com/watch?v=UIKmSQqp8wY	Watch video	Is the moon still changing? Has the moon completely cooled? How big is the moon? Compared to Earth?

Resources Needed:
Internet access, AV projector

Safety Considerations:
N/A

Exploration:

Estimated Time: 25 min_____

Overview of Activity:

What the teacher does:	What the student does:	Possible questions to ask students—*think like a student and consider possible student responses*
Hammer one stake vertically into the ground ½ meter. Have a friend (possible teacher in another school) hammer the other stake into the ground ½ meter at least 100 km to the east or west of the first stake. (There are ways around this step if you cannot find a friend *see notes below). *Stake and shadow length can be computed and given to the students if you cannot find a friend. **For Example:** At noon on July 21 in Melbourne Fla., a stick that is stuck in the ground and is completely vertical casts a shadow because of the sun. If you divide the length of the shadow by the height of the stick (above the ground), you find the ratio of 0.355. If you do the same experiment at exactly the same time in Tampa, 173 km away, you find a ratio of 0.386. This is because the sun is slightly lower in the sky in Tampa and casts a longer shadow. The Earth is not a perfect sphere, but it is close. Therefore, we can take the inverse tangent of these two ratios to find the relative altitude of the sun in Melbourne and Tampa at the same time. $\alpha = \theta_1 - \theta_2 = \tan^{-1}(0.386) - \tan^{-1}(0.355) = 1.56^{\circ}$	Have the students measure the length of the stakes above the ground. At an exact, coordinated time have the students measure the length of the shadow created by each of the stakes. Have students divide the length of the shadow by the length of the stake above the ground.	How accurate do our measurements need to be? How did you get the measurements from the other location?

Resources Needed:

2 stakes exactly the same height (2 meters), ruler, hammer, scientific calculator

Explanation: **Estimated Time: 20 min_____**
Overview of Activity:

What the teacher does:	**What the student does:**	**Possible questions to ask students – *think like a student and consider possible student responses***
To calculate the mass of the moon , we use the formula : **M_ Earth * D_ Earth = M – Moon * D_ Moon** Where: M_ = mass D_ = distance from the Barycenter Let's first calculate the volume of the Earth	Take the inverse tangent ($\tan^{-1}$) of the two ratios calculated in the Explore Activity to find the altitude of the Sun. $\propto = \theta_1 - \theta_2 = \tan^{-1}(1^{st}\ \text{stake}) - \tan^{-1}(2^{nd}\ \text{stake})$ *Calculator needs to be in deg mode when calculating $\tan^{-1}$ $\propto$ times Pi (3.14) divided by 180 will give us the angle of the sun in radians. Now take the arc length (distance between stakes – 100km) divided by the arc length in radians and you have calculated the radius of the Earth. We find the density of the Earth by measuring the mass of a known volume of rock. Since Earth is made of many minerals, we need to average the densities of the most abundant minerals found. The average density of the Earth is 5500kg/m^3.	

Resources Needed:

Elaboration: Estimated Time: 30 min_____
Overview of Activity:

What the teacher does:	What the student does:	Possible questions to ask students – *think like a student and consider possible student responses*
Place the students in groups of 3. Give each group the supplies listed below. Walk around the room and help students follow activity directions.	• Have the students tape the cups to each end of the yardstick. • Record the mass of the small marble (M1). • Record the mass of the large marble (M2) • Place one marble in each cup. • Place the yardstick on the triangular wedge between the 2 cups. • By trial and error move the wedge until the cups stay suspended the same distance off the table. • Measure from the center of the wedge to cup with the small marble (D1). • Measure from the center of the wedge to the cup with the large marble (D2). • Does the formula M1*D1 = M2*D2 hold true? • Replace one of the marbles with the mystery object. • Move the wedge until the yardstick balances. • Measure D1 and D2. • Using the same formula determine the missing M value.	What units do we use for mass? Distance?

Resources Needed:

Each group receives a yardstick, 2 identical plastic cups (approx. 8 – 12 oz), tape, triangular wedge, 1 large and 1 small marble, balance, ruler, mystery object (can be a superball, coin, pencil, etc.).

Evaluation: **Estimated Time: 15 min_____** **Description of Activity:**		
What the teacher does:	**What the student does:**	**Possible questions to ask students – *think like a student and consider possible student responses***
Share the following information with the students: PowerPoint slide #3	Calculate the mass of the moon	What formula should we use?

Resources Needed:

Safety Considerations: