Mass of Saturn Analysis

Teacher's Guide

Topic:

Circular Motion and Satellite Motion

The following information is provided to the student:

Question:
What is the mass of Saturn?

Purpose:
To use period-radius data for the moons of Saturn in order to determine the mass of Saturn.

A complete lab write-up includes a Title, a Purpose, a Data section, and a Conclusion/Discussion of Results. The Data section should include the provided sheet. At least one sample calculation should be shown; treatment of the units and conversions to kg should be clear. The Conclusion/Discussion should answer the *question* posed in the Purpose and describe the manner in which the evidence supports the conclusion which is made.

Materials Required:

Calculator; the provided table of data for Jupiter's moons.

Description of Procedure:

Students receive data for the period of the moons orbiting Saturn and their mean distance from the Saturn. The data is analyzed in order to determine the average value of T^2/R^3 for all the moons. *Kepler's third law equation* ($T^2/R^3 = 4 \bullet \prod^2/G/M_{saturn}$) is then used to determine the mass of Saturn.

Alternative Materials and Procedure:

Many alternative (or additional) data analysis exercises can be done. Data for the moons of other planets are readily available on the internet. Those who are looking for a more authentic exercise which not only involves the analysis of data but also the collection of data might investigate Project CLEA (http://www3.gettysburg.edu/~marschal/clea/CLEAhome.html).

Safety Concern:

There is always a higher than usual level of risk associated with working in a science lab. Teachers should be aware of this and take the necessary precautions to insure that the working environment is as safe as possible. Student *horseplay* and off-task behaviors should not be tolerated.

Suggestions, Precautions, Notes:

1. To accomplish the purpose of this lab, students will need to know the equation which relates the T^2/R^3 ratio of a satellite to the mass of the object which the satellite is orbiting.
2. The last column in the provided table is blank in order for students to calculate the ration of T^2/R^3 for all the moons of Saturn's.
3. Perhaps the biggest difficulty with this lab will be the treatment of units. The distance will have to be converted to meters and the period will have to be converted to seconds.

The Laboratory

4. Some interesting information about the moons of Saturn is available online. For instance, see Wikipedia's Moons of Saturn.

Auxiliary Materials:

The following page is provided to the student for completion and inclusion in the Data section of their lab notebook.

Satellite	Mean Distance (km)	Period (days)	
Pan	134000	0.58	
Prometheus	139000	0.61	
Pandora	142000	0.63	
Janus	151000	0.69	
Mimas	186000	0.94	
Enceladus	238000	1.37	
Calypso	295000	1.89	
Helene	377000	2.74	
Rhea	527000	4.52	
Titan	1222000	15.95	
Hyperion	1481000	21.28	
Iapetus	3561000	79.33	
		Average ----->	

Scoring Rubric:

CG9. **Mass of Saturn Analysis**	**Score**
___ Included, labeled and organized all parts of the lab report. ___ Data section includes the provided table with the last column completed; at least one sample calculation is clearly shown and labeled; conversion from km and days to kg is clearly demonstrated. ___ Conclusion/Discussion answers the *question* posed in the Purpose and describes the supporting evidence.	____/____

Connections to The Physics Classroom Tutorial:

The following reading is a suitable accompaniment to this lab:

http://www.physicsclassroom.com/Class/circles/u6l4a.cfm

Connections to Minds on Physics Internet Modules:

Sublevel 10 of the Circular and Satellite Motion module is a suitable accompaniment to this lab:

http://www.physicsclassroom.com/mop/module.cfm