I. Objectives

1. Investigate the relationship between a, a Jovian moon's average distance from Jupiter and P, its orbital period around Jupiter.
2. Determine whether or not Kepler's Third Law applies to the Jovian satellites**.**

II. Introduction

The purpose of this lab is to determine whether or not Kepler's Third Law can be used to express similar relationships in other parts of the solar system, specifically, the Jovian moons.

III. Theory

Remember that Kepler's Third Law states that the ratio of the squares of the revolutionary periods for two planets is equal to the ratio of the cubes of their semimajor axes. Mathematically, this simply means that if we divide the square of the time it takes for a planet to go around the Sun in years, P^2, by the cube of its distance from the Sun in AU, a^3, the result should be the same for each planet, $P^2 = a^3$ or $P^2/a^3 = 1$.

In this lab we are not using the planets and the Sun, but the Jovian moons and Jupiter. In order to simplify the calculations, we will use Metis' average distance from Jupiter as our distance unit, a, and Metis' orbital period around Jupiter as our time unit, P. Note that we could select any one of the moons for this purpose, but we choose Metis simply because it is closest to Jupiter.

IV. Prelab Definitions

1. semimajor axis

2. astronomical unit

3. orbital period

4. revolution

5. rotation

6. prograde

7. retrograde

8. Roche limit

9. resonant orbit

V. Prelab Questions

1. What do Metis and Adrastea have in common? Where are they located relative to Jupiter?

2. What is unique about the color of Amalthea?

3. What do Leda, Himalia, Lysithea and Elara have in common? What is their most likely origin?

4. The orbits for Ananke, Carme, Pasiphae, and Sinope, Jupiter's outermost moons, are listed as negative numbers because these 4 moons have retrograde orbits. What does this tell us about the way they orbit Jupiter?

5. Why might their orbits be different than those of Jupiter's other moons?

VI. Lab Procedure

1. Complete the *Jovian Moon Average Distances and Orbital Periods* table below. Calculate the average distance, a, of each moon from Jupiter using "Metis distances" by dividing each moon's average distance from Jupiter by 128,000 km, the average distance of Metis from Jupiter. C = B/128,000.

2. Calculate a^3 for each moon using Metis distances from step 1. D = C^3.

3. Calculate the orbital period, P, of each moon using "Metis orbital periods" by dividing each moon's orbital period by 0.29 days. F = E/0.29.

4. Calculate P^2 for each moon using Metis units from step 3. G = F^2.

5. Calculate the ratio P^2/a^3 for each moon. H = G/D.

Jovian Moon Average Distances and Orbital Periods

A	B	C	D	E	F	G	H
Moon	Average distance a from Jupiter in km	Average distance a from Jupiter in Metis units	a^3	Orbital period P in days	Orbital period P in Metis units	P^2	P^2/a^3
Metis	128,000			0.29			
Adrastea	129,000			0.30			
Amalthea	181,000			0.50			
Thebe	222,000			0.67			
Io	421,600			1.769			
Europa	670,900			3.551			
Ganymede	1,070,000			7.155			
Callisto	1,883,000			16.689			
Leda	11,094,000			238.72			
Himalia	11,480,000			250.57			
Lysithea	11,720,000			259.22			
Elara	11,737,000			259.65			

A	B	C	D	E	F	G	H
Moon	Average distance a from Jupiter in km	Average distance a from Jupiter in Metis units	a^3	Orbital period P in days	Orbital period P in Metis units	P^2	P^2/a^3
Ananke	21,200,000			-631			
Carme	22,600,000			-692			
Pasiphae	23,500,000			-735			
Sinope	23,700,000			-758			

VII. Lab Discussion

1. Write this out in words: $P^2 = a^3$.

2. What do the numbers in column H represent? What number are they close to?

3. Do the Jovian moons seem to follow Kepler's Third Law? Why or why not? Explain your answer.

4. Do other bodies in our solar system also follow Kepler's Third Law? Why or why not? Explain your answer.