Astronomy 1102/1104 30 March, 2009
Exercise 10—Due in section from 6 April

Name: _____

The Kirkwood Gaps

Section: _____

Jupiter's mass dominates the Solar System beyond Mars. The best example of Jupiter's impact is the Asteroid Belt, which is full of material that might have formed into a planet had Jupiter not interfered. To investigate Jupiter's influence on the Asteroid Belt, we start with Kepler's Third Law, which has the general form:

$$p^2 = (4\pi^2/GM)\, a^3,$$

If we express the period p in years, the semi-major axis a in AU, and set $M = 1\ M_{Sun}$ (since the asteroids and Jupiter are orbiting the Sun), all of the constants disappear and Kepler's Third Law simplifies to:

$$p^2 = a^3,$$

1. Solve this equation for p as a function of a. p = _____.

2. The Kirkwood Gaps are places in the Asteroid Belt where there are no asteroids. For several gaps, the semi-major axis a is given below. Find the period of an object orbiting in that gap (in years).

a (AU)	p (yr)	period ratio	resonance
2.064	_____	_____	_____
2.501	_____	_____	_____
2.824	_____	_____	_____
2.957	_____	_____	_____
3.277	_____	_____	_____

3. Jupiter's orbital period is 11.864 years. For each Kirkwood gap above, find the ratio 11.864/p, and put your answer in the column for period ratio. In the final column, describe the resonance as 2:1, 3:2, etc. For example, if the period ratio is 2.999, then the resonance is 3:1.

4. On the back of this page, explain why the Kirkwood Gaps occur at orbital resonances with Jupiter. Hint: What is an orbital resonance? How will a resonance affect Jupiter's gravitational influence on an asteroid?