Physics Name: _____

Kepler's Third Law Practice

SHOW ALL WORK FOR CREDIT

Mass of Sun **1.99×10^{30} kg** **Radius of Earth** **6.4×10^{6} m**
Mass of Earth **6.0×10^{24} kg**

1. Mercury is observed to have an orbital period of 88 days. Use the mass of the Sun to calculate how far Mercury is from the Sun.

2. The moon Phobos orbits Mars in just 8 hours at an average distance of 9380 km. Calculate the mass of the planet Mars. (Make sure you use the correct units!)

3. The Sun (and our solar system) is about 1.0×10^{21} meters from the center of the Milky Way galaxy and it takes approximately 225,000,000 years. (a) How much mass is there in the Milky Way galaxy? (b) If all of the mass was composed of stars exactly like our Sun, how many Suns would that be?

4. The International Space Station only orbits at an altitude of 400,000 meters above the Earth's surface. (a) How far from the Earth's center is the space station? (b) How long should it take the space station to complete one orbit around the Earth?

5. Illustrate below that a planet orbits in an ellipse and sweeps out equal areas in equal amounts of time as it orbits the Sun. (Draw the orbital path of a planet and shade in multiple areas.) Identify where the planet is moving the fastest.

Read: Kepler's third law describes the relationship between the orbital period of any planet and that planet's average distance to the Sun. The average distance from the Earth to the Sun is known as 1 astronomical unit (AU) = 1.496×10^{11} m. Using the unit "AU" and knowing that the Earth takes exactly 1 year to orbit the Sun (by definition), we can simplify Kepler's third law to the form to the right.

Using "AU" and "years" as our units, the relationship between orbital distance and period can be expressed simply.

$$T^2 = r^3$$
(years) (AU)

	Average Distance from Sun (AU)	Orbital Period (Years)
Mercury	0.387	
Venus	0.722	
Earth	1.00	1.00
Mars		1.87
Jupiter		11.86
Saturn	9.58	
Uranus		84.1
Neptune	30.1	
Pluto		248
Eris	67.8	

6. Use the simplified equation, complete the table of orbital periods of the eight planets (and Pluto) and the average distance to the Sun. Show your work below.