Observational Astronomy - Spring 2014
Homework 6 - The Solar System

1. What two elements do the gas giant planets like Jupiter have in abundance that make them so much larger than the Earth? What percentage of the matter in the universe is made up by these two elements? For now, we are only talking about ordinary matter (atoms), so ignore any consideration of "dark matter".

   - Hydrogen and Helium. They make up 98% of the ordinary matter (atoms) in the universe.

2. Given your weight on Earth, fill in the following table giving your weight on various planets:

   - Of course it depends on your weight. Your weight is just your Earth weight multiplied by the surface gravity in g's. I've filled it in for my weight.

Planet	Surface Gravity (g)	Weight (lbs)
Mercury	0.38	68
Venus	0.90	162
Earth	1.00	180
Moon	0.17	31
Mars	0.38	68
Ceres	0.03	5.4
Jupiter	2.53	455
Saturn	1.06	191
Uranus	0.89	160
Neptune	1.14	205

3. Remembering that escape velocity is given by:

$$\mathrm{V_{esc}} = \sqrt{\frac{2\mathrm{GM}}{\mathrm{R}}},$$

   what is the escape velocity from Ceres, the largest asteroid, which has a radius of about 500 km, and a mass of about 9.4×10^{20} kg? If you were standing on it, could you jump off of it? What if you were standing on a small asteroid with a radius of 1km and a mass of 2×10^{13} kg? What would be the escape velocity from this body? How much would you weigh on this small asteroid? Could you jump off of it?

   - For Ceres:

$$\mathrm{V_{esc}} = \sqrt{\frac{2\mathrm{GM}}{\mathrm{R}}} = \sqrt{\frac{2 \times 6.67 \times 10^{-11} \frac{\mathrm{m^3}}{\mathrm{kg\ sec^2}} \times 9.4 \times 10^{20}\mathrm{kg}}{500 \times 10^3\mathrm{m}}} = 500\frac{\mathrm{m}}{\mathrm{sec}}$$

   - For the smaller asteroid:

$$\mathrm{V_{esc}} = \sqrt{\frac{2\mathrm{GM}}{\mathrm{R}}} = \sqrt{\frac{2 \times 6.67 \times 10^{-11} \frac{\mathrm{m^3}}{\mathrm{kg\ sec^2}} \times 2.0 \times 10^{13}\mathrm{kg}}{1000\mathrm{m}}} = 1.6\frac{\mathrm{m}}{\mathrm{sec}}$$

     Since you can run at about 15 miles/hour, which is about 7 meters/second, you could easily jump off the small asteroid, but you couldn't jump off Ceres.

- To calculate your weight on the smaller asteroid, use the equation that the surface gravity is given by:

$$g = \frac{GM}{R^2} = \frac{6.67 \times 10^{-11} \frac{m^3}{kg\ sec^2} \times 2.0 \times 10^{13} kg}{(1000m)^2} = .0013 \frac{m}{sec^2}$$

  The Earth's surface gravity is $9.8 m/sec^2$, which we define as 1 g. So I would weigh (given my weight on Earth of 180 lbs):

$$180 \text{ lbs} \times \frac{.0013}{9.8} = .024 \text{ lbs} = 0.38 \text{ ounces}$$

4. What's the only body in the solar system known to have flowing liquid on it, other than the Earth? What planet does it orbit around?

   - Titan. It has lakes and rivers of liquid hydrocarbons (probably methane or ethane). It orbits Saturn.

5. How do the surface pressures of Venus, Earth and Mars compare?

   - Venus has about 90 times higher surface pressure than the Earth, while Mars surface pressure is only about 0.6% that of Earth.

6. What is Jupiter's Great Red Spot?

   - It is a giant storm, like hurricanes or cyclones on Earth.