PHYS 111
HOMEWORK #1

Due : 28 August 2014

Please review the rules regarding submitting homework assignments in the syllabus. Remember that all problems must be accompanied by complete solutions.

1. The gravitational force F between two masses a distance r apart is given by :

$$F = \frac{G\, m_1\, m_2}{r^2}$$

where :

G is the Newtonian gravitational constant;

m_1 and m_2 are the masses of the objects and r is the distance between their centers.

Use the data in the back of the book (or other easily accessible sources) and determine the **ratio** of gravitational force between the moon and the Earth and the moon and the Sun. In other words, compute F(moon Earth)/F(moon Sun). (Hint: If you feel the need to separately compute two gravitational forces, rethink your strategy.)

2. Consider a projectile fired vertically from the surface of the Earth with an initial speed of v_0. The projectile's height y(t) above the Earth is given by:

$$y(t) = v_0 t - \frac{1}{2} g t^2$$

where t is the time elapsed from launch and g is the acceleration due to the Earth' s gravity. Call t_1 the time at which the projectile reaches a height H on its ascent phase, and t_2 the time the projectile is at H during its descent. Use your knowledge of solving quadratic equations to find an expression for t_2 - t_1. What should you choose for the value of H to determine the total time of flight for this projectile? Make this subsitution and determine the total time of flight.

3. Density is mass/volume. Consider two planets A and B (assume planets, like cows, are spherical). Planet A has 10 times the mass of Planet B; the radius of Planet A is twice the radius of Planet B. What is the density of Planet A compared to the density of Planet B?

4. The value of surface gravity on a planet is given by :

$$g = G M / R^2$$

where M is the mass of the planet and R is the planetary radius (g and G have the same meanings in previous problems). What is the ratio of g on planet A to g on planet B?

5. The intensity of sound can be mathematically described via :

$$I\,(\text{dB}) \;=\; 10 \log_{10}\left(\frac{I}{I_0}\right)$$

where I (dB) is the intensity measured in decibels,

I is the intensity of the sound in Watts / square meter $\left(W \,/\, m^2\right)$

and I_0 is the threshold of human hearing $\left(\text{which is } 10^{-12}\ W \,/\, m^2\right)$.

Consider a sound that is 100 times more intense than the threshold of human hearing. What is the intensity of that sound in decibels?

6. The equation :

$$R \;=\; \frac{2\, v_0{}^2 \sin\theta \cos\theta}{g}$$

describes the horizontal distance (range) traveled by a projectile over level ground that was launched with an initial velocity of v_0 at an angle of θ with respect to the ground. Use simple trig identities to write this equation in terms only of the sin function, and determine the launch angle that yields the maximum range.

7. Set x = cos θ. Use trig identities to write cos (3 θ) as a polynomial in powers of x. Make sure you show all your steps (and do not merely find a table of identities and copy down the result).