HW 2
Due October 13, 2006

Please answer all questions clearly and concisely. While you need not transcribe the question completely, it should be clear from your answer alone what you are talking about.

You are strongly encouraged to discuss the homework with your classmates, but you must complete the written homework by yourself, and of course, the material you submit must be your own.

Remember, show all of your work!

1) A small asteroid is circling a central star of mass 4×10^{30} kg at a distance of 10^{12} m.

    a. What is the gravitational acceleration on the asteroid?

    b. What is the speed of the asteroid?

    c. What is the period of the asteroid's orbit (how long will it take to traverse the distance all the way around the star)?

    d. Express this period in years.

2) A 10 kg weight is hung from a spring. The length of the spring with the 10 kg weight attached is 1 m. The 10 kg weight is removed, and 20 kg weight is attached. The length of the spring is now 1.1 m.

    a. What is the spring constant of the spring?

    b. How long is the spring with no weight attached?

    c. If the 20 kg weight is attached, and stretched slightly, with what frequency will it oscillate (remember the units!)?

    d. How long would a pendulum have to be to oscillate with the same frequency?

3) Near the surface of the earth, the force due to gravity is nearly constant: $\vec{F}_g = -mg\hat{j}$.

Recall that with a constant force, a projectile which starts from position $\vec{r}_0$, and with velocity $\vec{v}_0$, will have a velocity of:
$$\vec{v}(t) = \vec{v}_0 + \vec{a}t \tag{1}$$

and be at a position of:
$$\vec{r}(t) = \vec{r}_0 + \vec{v}_0 t + \frac{1}{2}\vec{a}t^2 \tag{2}$$

You throw a ball from the origin at time t=0. It has a velocity of $\vec{v}_0 = 20$ m/s $\hat{i} + 10$ m/s $hatj$.

    a. What is the height of the ball after 1 second?

    b. What is the *speed* of the ball after 1 second?

    c. What is the (vector) momentum of the ball after 1 second?

    d. At what time does the ball hit the ground?

4) Problem 2b.2 – You must get this from the chapter posted on the course webpage.

5) Problem 2b.13 – See the note above.