Physics 1090 Homework #8

Due Thursday, November 5, 2:00 pm

Reading assignment: Chapters 17, 18, 19, 20 of the notes.

Kepler’s Laws

1. Use the Kepler’s Laws flashlet to put a planet in an elliptical orbit. Sketch the orbit as accurately as you can (or, you can use the computer to draw it somehow).

(a) At the planet’s nearest point to the Sun, the speed reaches a maximum. Take two points close together **on either side** of this point, and draw the two velocity vectors for these points. By finding the change in velocity between the points (putting the tails of your vectors together and drawing a vector from head to head) find the direction of the acceleration.

(b) Now do the same thing for the *farthest* point from the Sun. By watching the flashlet, how would you say the accelerations at these two points (nearest and farthest) compare? Is one obviously greater? What about the direction of the acceleration?

(c) Now consider some point halfway or so between these points. Now *speed* as well as *direction* is changing! Try to draw the direction of acceleration here.

2. (a) The satellites that transmit TV signals for home dish reception are all in what are called “geosynchronous” orbits, the satellites go once around the earth in circular orbits in 24 hours. Why do you think they were placed in those particular orbits? In other words, how does that help reception of the TV signal?

(b) Use Kepler's Third Law and what you already know (or can look up) about the Moon to predict the *radius* of the orbit of a geosynchronous satellite. Compare your result with the data given at the Kepler's Laws site, and explain any differences.

(c) To be precise, they actually go around once in 23 hours and 56 minutes. What’s *that* about?

Newton and Newton’s Laws

3. For Newton’s cannon shooting at a low speed, it’s clear that the cannonball follows the usual path, accelerating towards the ground. Explain *in your own words* how it can be that, at the right fast speed, shot above the atmosphere, the cannonball will stay at the same height, and never reach the ground. Make clear whether or not it is accelerating, and in what direction. (It might help to look at the applet).

4. State Newton's Second Law.

Suppose you are standing on a spring bathroom scale in an elevator which is at rest. What is your acceleration? What forces are acting on you? What is the reading on the bathroom scale?

Suppose now you push the button for a higher floor, and the elevator begins to move. After three seconds it is going up at a steady one meter per second. Did you accelerate? Are you still accelerating? How do you think the reading on the scale will vary as the elevator begins to move then settles to a steady speed? (Just answer qualitatively—no numbers expected.)

Now imagine disaster - the rope holding the elevator snaps, there are no safety features, and the elevator plunges down the shaft in free fall. You avail yourself of this golden opportunity to check Newton's Laws further, since it is unlikely to be repeated, at least for you personally. You stay calmly on the spring scale. What does it read?

Read the second selection from *Two New Sciences* I've put on the Web until you find a sentence or two relevant to the above disaster scenario, and explain the connection.

5. A sky diver jumps out of a plane and is in free fall. Air resistance increases with speed, and her downward velocity approaches a limit of 80 meters per second (about 160 mph, terminal velocity). After falling at close to this speed for several seconds, she opens a parachute and her speed quickly drops to about 3 meters per second, and remains the same until she lands.

Plot a graph showing *qualitatively* her downward acceleration from the moment she leaves the plane until after she's landed on the ground. (Qualitatively means you should get the direction right, and some idea of where the acceleration is large, where it's very large, and where it's small).

State what forces were acting on her at each stage in the descent.