Problem Set # 3

Reading: Chapter 4, Sections 4-6, Chapter 21, Sections 1-3 and 5
Problem Set, Due at beginning of Class, Sept. 22
Chapter 4 # 52, 56, 72, 76, 78
Chapter 21 # 2, 4,
Supplemental Problems S1, S2, S3, S4

If you are having trouble with concepts or problem solving, you might find it helpful to see a different approach in the supplemental material:

Circular motion and relative motion, Reif, Ch. 8; Moore Unit N, Ch. 9 and 10

S1. Vector description of circular motion.

a) Suppose we describe the position of a particle with a vector $\vec{r} = r\cos\theta\hat{x} + r\sin\theta\hat{y}$, where r is the distance of the particle from the origin of the reference frame, θ is the angle measured counterclockwise from the positive x axis, and $\hat{x}$ and $\hat{y}$ are the unit vectors in the x and y directions respectively. If the particle is moving in a circle with constant speed, the value of r remains constant, and the angle θ changes linearly with time according to $\theta = \alpha t$. Given $\alpha = 360^{o}$ per second, and r = 2m, make three plots:

Plot the x position of the particle vs. time

Plot the y position of the particle vs. time

Plot the trajectory of the particle (its path in the xy plane), labeling the positions corresponding to $\theta = 45^{o}$, 180^{o} and 315^{o} with the time at which each of those positions is reached. Draw arrows indicating the directions of the velocity vector and the acceleration vector at each of those three points as well.

S2. A firecracker explodes 30 km away from an observer sitting next to a certain clock A. The light from the firecracker explosion reaches the observer at exactly t = 0, according to clock A. Imagine that the flash of the firecracker explosion illuminates the face of another clock B which is sitting next to the firecracker. What time would clock B register at the moment of illumination, if it is correctly synchronized with clock A? Express your answer in milliseconds.

S3. Imagine that you are in an inertial frame in empty space with a clock, a telescope and a powerful strobe light. A friend is sitting in the same frame a very large (unknown) distance from your clock. At precisely 12:00:00 noon, according to your clock, you set off the strobe lamp. Precisely 30.0 seconds later, you see in your telescope the flash of your friend's clock illuminated by your strobe flash. How far away is your friend? What should you see on the face of your friend's clock if that clock is synchronized with yours?

S.4 Physical Understanding of Trajectories

2. The trajectory of a particle is shown below. The particle is moving from lower left to upper right.

a. On the graph, draw the direction of the velocity vector at point B.

b. If the speed at point B is a constant of 5 m/s, write a vector expression for the velocity at point B, giving the most accurate values for the two components that you can.

c. On the graph, draw a vector that shows the direction of the acceleration at point B.

d. If the speed at point A is decreasing, draw vectors showing the directions of the tangential, and centripetal acceleration.

e. With the information given, what is the most you can say about the value and direction of the total acceleration at point A?