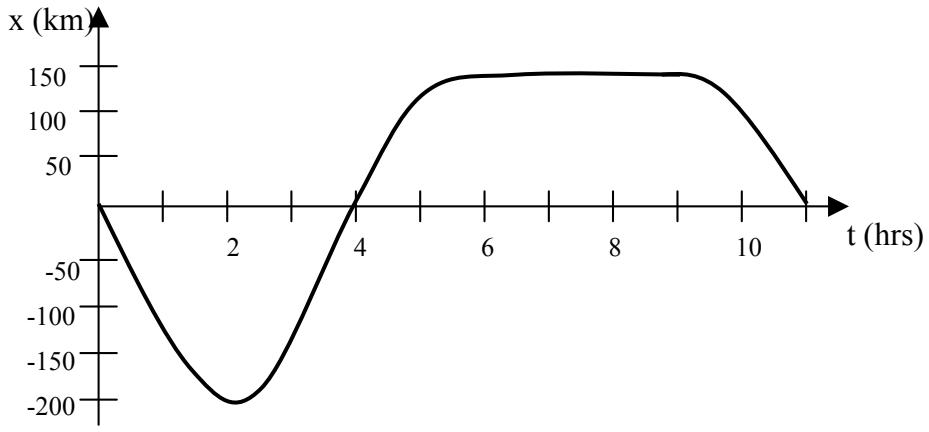
Physics 121 - Spring 2008 - workshop module 1
1D, 2D, and 3D Kinematics

1. The position of your car during a recent road trip on the interstate highway (essentially a straight line) is described by the position-time graph below, where North is assigned to be positive. You should begin this problem by redrawing the graph on a whiteboard or blank sheet of paper. Draw it large!
   (a) When is the car's *speed* zero?
   (b) Determine the car's approximate *average velocity* for the intervals
      (i) from 0 to 6 hrs
      (ii) from 2 to 4 hrs
      (iii) from 4 to 11 hrs
   (c) Determine the car's *average speed* for its entire 11-hour motion.
   (d) Sketch the velocity versus time graph corresponding to this motion.
   (e) From the graph below, estimate the average acceleration in the interval from 1 to 3 hours.



   (f) At what times is the magnitude of the acceleration large? When is it positive? When is it negative?

2. Smoky the cat is relaxing on the arm of a couch, one meter above the ground, when he is startled by something and jumps straight up in the air with initial speed 4 m/s. Coming down, he misses the couch and lands on the ground. You can neglect air resistance in your answers below.

   (a) What is Smoky's *acceleration*…
      (i) …just after his paws leave the couch and he is on his way up?
      (ii) …at the exact instant when he is at his maximum height?
      (iii) …just before he hits the ground on his way back down?

   (b) What is Smoky's maximum height above the ground during his motion?
   (c) What is Smoky's velocity just before he hits the ground?
   (d) How long is Smoky in the air?

3. You are on the roof of the lecture hall, 50 m above the ground. As your physics professor, who is 1.8 m tall, walks toward the hall at a constant speed of 1.20 m/s. If you wish to drop an egg on your professor's head (and commit P121 suicide), where should the professor be when you release the egg? Assume the egg is in free fall (i.e., you can ignore air resistance). (*Actual experimentation is discouraged*.)

4. A player kicks a football at an angle of 40 degrees above the horizontal with an initial speed of 14 m/s. Air resistance may be ignored. A second player standing at a distance of 26 m from the first (in the direction of the kick) starts running to meet the ball at the instant it is kicked. How fast must the second player run in order to catch the ball just before it hits the ground? How would this answer change if the football game took place on the moon? (Assume "g" on the moon is 1/6 that on the surface of the earth. Can you calculate that on your own?)

5. A moving sidewalk in an airport terminal building moves at 1.0 m/s and is 40.0 m long. If a woman steps on at one end and walks at 2.0 m/s relative to the moving sidewalk, how much time does she require to reach the opposite end if she walks a) in the same direction the sidewalk is moving? b) in the opposite direction? Suppose this is an escalator instead of a moving sidewalk. Suppose the escalator rises at an angle of 30 degrees with the floor. Suppose a woman walks up the escalator with a speed of 2 m/s, what is her horizontal speed with respect to the floor? What is her vertical speed with respect to the floor? What is her total speed with respect to the floor?