EXAM 2

18-19 November 1999

Directions

- This exam is open notes, open book.
- You may not collaborate on this exam; do not work with others.
- When you are done with the exam, give it to me or put it in my office. Don't put it in my mailbox.
- Remember to include units.
- To receive full credit on these problems you must show your work clearly.

1. Consider the velocity vs. time plot on the other side of this paper. Sketch the position (x) and acceleration (a) as a function of time. (10 points)
2. An airplane is flying perfectly horizontally and accelerates, remaining horizontal. Make a qualitatively accurate free body diagram for the rocket. (5 points)
3. A student throws a .3 kg ball straight up, exerting a force of 100 N on it. The ball leaves his hand at 30 m/s. Draw a free body diagram showing the forces acting on the ball 2 seconds after it is released. Neglect air resistance. (5 points)
4. A 700 kg car drives around a circular race track at 20 mi/hr. The radius of the track is 30 m. (10 points)
   (a) What is the car's angular velocity (direction and magnitude)?
   (b) What is the acceleration of the car (direction and magnitude)?
5. A 75 kg merry-go-round with a radius of 2 meters is at rest. A 20 kg child runs at 6 m/s and jumps on the merry-go-round as shown below. What is the angular speed of the merry-go-round after it's been jumped on? (20 points)

6. The following problems refer to figure C11.4 on page 161 of book C. (10 points)

   (a) Imagine that the little atom approaches the big atom from infinity with an initial kinetic energy of 10 x 10^{-21} J. Describe the motion of the little atom. Is the little atom bound to the big atom? f yes, how much energy must the little atom gain so that it is unbound?

   (b) At $t = 0$ the little atom is at rest at $x = .1$ nm. Describe the motion of the little atom. Is the little atom bound to the big atom? If yes, how much energy must the little atom gain so that it is unbound?

7. A .2 kg piece of ice at 0 C is placed in 1 kg of 80 degree Celsius water. Does all the ice melt? If so, what is the temperature of the water. (10 points)

8. Assuming that energy costs fifteen cents per kilowatt hour, how much does it cost to raise 50 kg of water from 30 degrees C to 80 degrees C? (5 points)

9. You are standing at the base of a building. On the second story of the building is a bowling alley owned by a friend of yours. It's time to take the bowling balls to get cleaned. Your friend has the following idea: Construct a ramp that goes out of the window and then onto the ground. The bowling balls can then be rolled down the ramp onto the level ground and you can stop them. This will be a lot easier than carrying the bowling balls down the stairs. Is this safe?

   (a) Estimate the speed of the bowling balls when they reach you at ground level. (15 points)

   (b) Estimate the force you'll need to exert to stop the bowling balls. (10 points)

   To answer these questions you'll need to make some assumptions and some estimates. Be sure you state your assumptions clearly.