EXAM 2

14-16 November 2001

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.
- Unless we make other arrangements, you should get the exam back to me by 10pm Thursday.
- Remember to include units.
- To receive full credit on these problems you must show your work clearly.

1. Consider the velocity vs. time plot shown in Fig. 1. Sketch the position (x) and acceleration (a) as a function of time.
2. A student runs off a cliff at 10 m/s. Make qualitatively accurate free body diagram and net-force diagrams. Neglect air resistance.
3. A 50 kg physics student on rollerblades is skating at 5 m/s and runs into a wall. She bounces off the wall with a speed of 3 m/s and a direction directly opposite her original direction. She is in contact with the wall for approximately .15 seconds. What is the force that the wall exerted on the student?
4. A 500 kg car drives counterclockwise around a circular race track at 10 mi/hr. The radius of the track is 20 m.
   (a) What is the car's angular velocity (direction and magnitude)?
   (b) What is the acceleration of the car (direction and magnitude)?
5. A 20 kg child is standing on the edge of a merry-go-round that is makes one revolution every 4 seconds. The merry-go-round has a mass of 100 kg and a radius of 2 meters. The child moves so that she's now must .25 meters from the center of the merry-go-round. How fast is the merry-go-round turning now?

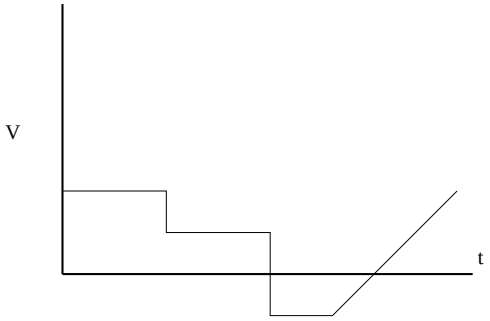

Figure 1: Velocity vs. time

6. Estimate how much it costs to heat the water when you do a medium-sized load of dishes by hand. State your assumptions clearly. (Don't worry too much about whether or not your assumptions are realistic — just make it clear what it is you're assuming.)

7. Consider the motion diagram of Fig. 2. The time interval between dots is 0.2 seconds. Estimate the magnitude of the acceleration at point 3.

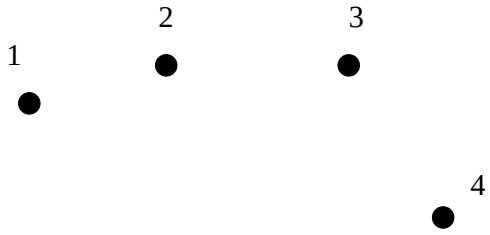

Figure 2: A motion diagram

8. A 0.4 kg piece of Aluminum at 90 C is placed in 1 kg of 30 degree Celsius water in a well insulated container. What is the final temperature of the water?

9. (a) How much energy is required to melt 5 kg of ice?
   (b) How much would this energy cost in Maine?
   (c) How much natural gas would you have to burn to melt 5 kg of ice?

10. 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. State any assumptions you need to make to do the problem. (If something doesn't affect the final solution (perhaps the mass of the ball), you should state that, too.)

    (b) Do you think the final speed poses a hazard?

    (c) If the bowling balls slid instead of rolled down, would they reach the bottom with a greater speed? Why or why not? (No calculations are necessary for this part of the question.)