EXAM 2

March 9–11 2004

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. A 20 kg child is standing on the edge of a spinning merry-go-round that 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?

2. Consider a spring with a spring constant $k_s = 100 J/m^2$. When relaxed, the spring has a length of 10 cm. The spring is compressed 3 cm. The spring then shoots a 10 g marble straight up in the air. What is the marble's maximum height? Be careful with units.

3. 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.)

4. 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?

5. How much energy is required to melt 50 kg of ice?

6. The mass of the moon is 7.35×10^{22}kg. The radius of the moon is 1740km. An astronaut drops a 2 kg bowl of oatmeal in a spaceship 200 km above the surface of the moon. The oatmeal falls out of the ship and lands on the surface of the moon. What is the oatmeal's speed right before it hits the moon?

7. 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.)