Physics 120
Term Test #1
Wednesday February 4, 2004

This exam sheet is double-sided. Please attempt all questions. No calculators or any other electronic devices are allowed. You have 80 minutes to complete this test. Your work must be neat and easy to follow. If what you are doing is not clear, you will not get full marks even if you did the question correctly. Please explain all steps carefully and simplify as much as possible. Have you read and understood this? [1 pt]

1. Two carts, each of mass m_c, are at rest at $x = 0$ m. Cart A is given a kick at $t = 0$ s in the positive x-direction with an initial speed of v_{Ai}. At $t = t_1$, cart B is also given a kick in the positive x-direction with initial speed v_{Bi}. After it starts moving, cart B experiences a constant force of magnitude F_0 in the negative x-direction. Cart A experiences *no* forces in the x-direction.
   a) On a position-time graph sketch the graph of the motion of carts A and B for $t > 0$ (label your graph).
   b) On a velocity-time graph sketch the graph of the motion of carts A and B for $t > 0$ (label your graph).
   c) On an acceleration-time graph sketch the graph of the motion of carts A and B for $t > 0$ (label your graph).
   d) Calculate the minimum initial speed (v_{Bi}) that cart B must have so that, when it reaches cart A, cart B will have a speed of v_0 m/s.

2. Consider the top view of a race-track shown. The section $B - C - D$ is semi-circular and the car travels on the track at constant speed v_{car}.
   a) What is the acceleration of the car when it is at the point A? at C? at E?
   b) Calculate the position and velocity of the car as a function of the angle θ when the car is past the point B but before the point D (use $\mathcal{O}$ as the origin).
   c) If it takes t_0 seconds for the car to travel from B to C, calculate the average velocity of the car between the points B and D. Draw the picture of the track on your answer sheet and include this vector on it. Label it clearly.
   d) On your diagram, draw the position velocity vectors for the car when it is at the point C. Also, write out these vectors in $\hat{i}$, $\hat{j}$ notation.

3. Consider the system shown below. There is friction between blocks m_1 and m_2 but *not* between m_2 and the platform. The coefficient of static friction between the blocks is μ_s.
   a) Perform the "five step program" to solve force problems, as discussed in class, for each of the objects in this problem (you do **not** have to solve for anything yet... just set up the problem and equations). Eliminate as many unknowns as possible using physical intuition.
   b) Calculate the largest value for the mass of m_3 that can be released from rest so that the blocks m_1 and m_2 do not slide relative to each other. (Assume the values of m_1 and m_2 are known.)

PART-B. Short answer/conceptual questions

4. Consider the expression $v = At^3 + \frac{Bx}{t} + C\sin(\omega t)$ where v is speed in meters-per-second, x is position (in meters) and t is time (in seconds). What are the units of the constants A, B, C, and ω? (hint: the argument of a trigonometric function must be unitless).

5. Below is a graph of the position of a particle vs time. Indicate on the graph the points where the speed of the particle is the same as point A. Also, indicate where the speed is greatest and where the particle is at rest.

6. Consider a cart with a mass attached to it as shown. The cart is initially held at rest. At $t = 0\ s$, someone pushes the cart to the left with a constant force of magnitude F_0 ($F_0 > mg$). At $t = t_1$ seconds, the person lets go of the cart. The mass is tied to the cart at the force sensor (the person *does not* push the cart at the force sensor).
   a) Sketch the position-time graph for the cart from $t = 0$ seconds until the cart reaches its starting position again. Also, sketch the velocity-time graph and acceleration-time graph.
   b) For the same interval of time, sketch the output graph for the force detector.
   c) Next, the same experiment is repeated but now the person pushes *on* the force sensor, sketch the output graph from the force sensor.

7. A basketball is dropped from rest. It falls on a spring, compressing it. The basketball is launched back up into the air by the spring and falls back down a second time.
   Draw a free-body-diagram for the ball at the following times:
   a) Just after it is first let go. b) When it has fully compressed the spring. c) When it has reached its maximum height after being launched by the spring.
   Also, indicate the direction of the acceleration on each diagram (if non-zero).

8. For this question take the origin as the place you are standing. You shoot an arrow in a high arc towards a target located some distance away. At the highest point of its flight, which quantities (which we discussed in class) are zero (if any). If there is not enough information to answer his question state so.