Physics 200 Name _____

Exam 1 – Kinematics and Force

September 29, 2005

This is a closed book examination. There is extra scratch paper available.

A general reminder about problem solving:

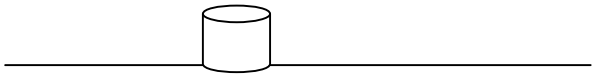
1. Draw a picture then create a simplified free body diagram with all forces
2. Write down what you know including coordinate frame
3. Write down what you don't know and/or want to know
4. List mathematical relationships
5. Simplify and solve
6. Check your answer – Is it reasonable? Are units correct?

- Show all work!

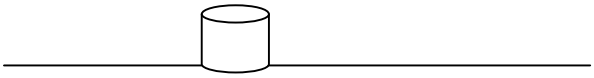
1. [12 PTS] You are driving down the street at a constant velocity and approach a stop sign. You slow down, stop and then resume driving down the street at the same constant velocity. The magnitude of your acceleration when you are stopping and starting is the same. Neglecting friction, draw y(t), v_y(t) and a_y(t). Indicate when the car is stopped and when the car is moving at a constant velocity on each graph.

Draw free body diagrams (i.e. label all forces) for the following situations.

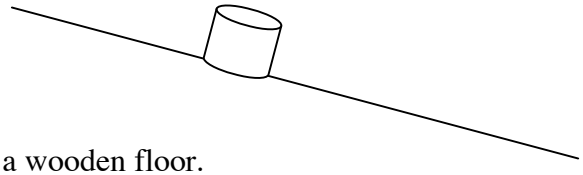
2. [2 PTS] A hockey puck sitting on the ice (assume frictionless surface)



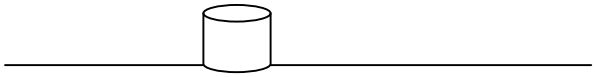
3. [2 PTS] A hockey puck sliding across the ice at a constant velocity (assume frictionless surface)



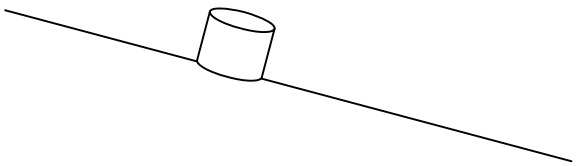
4. [2 PTS] A hockey puck sliding down an inclined ice sheet (assume frictionless surface)



5. [2 PTS] A hockey puck sliding across a wooden floor.



6. [2 PTS] A hockey puck sliding down an inclined wooden floor.



7. [2 PTS] A hockey puck dropped out of a stationary (hovering) helicopter.

You throw a rather old black and white soccer ball as hard as you can straight up into the air. Assume up is the positive direction. The next six questions refer to this ball after it has left your hand. Please explain your answers (your explanation is worth 2/3 of the points).

8. [3 PTS] The acceleration of the ball on the way up is
   a) 9.81 m/s2 in the upward direction.
   b) zero (no acceleration).
   c) 9.81 m/s2 in the downward direction.
   d) Can not tell. It depends on the initial velocity.

9. [3 PTS] The velocity of the ball on the way up is
   a) positive (in the upward direction).
   b) zero.
   c) negative (in the downward direction).
   d) Can not tell. It depends on the initial position.

10. [3 PTS] The acceleration of the ball at the very top of its throw (just before it starts back down) is
   a) 9.81 m/s2 in the upward direction.
   b) zero (no acceleration).
   c) 9.81 m/s2 in the downward direction.
   d) Can not tell. It depends on how high it was thrown.

11. [3 PTS] The velocity of the ball at the very top of its throw (just before it starts back down) is
   a) positive (in the upward direction).
   b) zero.
   c) negative (in the downward direction).
   d) Can not tell. It depends on the initial position.

12. [3 PTS] The acceleration of the ball on the way down is
   a) 9.81 m/s2 in the upward direction.
   b) zero (no acceleration).
   c) 9.81 m/s2 in the downward direction.
   d) Can not tell. It depends on where you catch it.

13. [3 PTS] The velocity of the ball on the way down is
   a) positive (in the upward direction).
   b) zero.
   c) negative (in the downward direction).
   d) Can not tell. It depends on the initial position.

The next three problems can be done on the back of your exam or on additional paper.

14. [10 PTS] On a field trip to New York City you visit the 102nd floor of the Empire State Building. Standing on the observation deck you wonder how fast an object would be traveling when it hit the ground if it were dropped over the railing. You notice that the sign says that the observation deck is 1224 feet above the street.
    a) Ignoring air drag how fast would a penny (mass = 6 grams) be traveling when it hit the ground?
    b) How long would it take to hit the ground?
    c) Is your answer reasonable?

15. [10 PTS] A wooden block is sitting on a ramp. You are able to tilt the ramp 33° from the horizontal before the block starts sliding.
    a) Determine the coefficient of static friction between the block and the ramp.
    b) If you were to triple the mass of the wooden block (by stacking mass on top of it), at what angle would the block start sliding now?

16. [10 PTS] Determine the horizontal distance (range) an object travels as a function of initial velocity and angle. Assume you are standing on the ground and ignore air drag.
    a) Write the range as a function of velocity and angle.
    b) At what angle would you throw an object to maximize the range?
    c) If you were standing on the top of a building would you now throw the object at a larger or smaller angle to maximize the range? Explain.

Useful mathematical (trigonometric) relationships:

$$\sin^2(\theta) + \cos^2(\theta) = 1$$

$$\cos(2\theta) = \cos^2(\theta) - \sin^2(\theta) = 2\cos^2(\theta) - 1 = 1 - 2\sin^2(\theta)$$

$$\sin(2\theta) = 2\sin(\theta)\cos(\theta)$$