Physics 160 Name ________________

Lab Time ________________

Exam 1 – Force and Motion

October 15, 2010

- This is a closed book examination.
- You may use a 3x5 index card that you have made with any information on it that you would like. You must have your name, lab section and the date on your index card.
- There is extra scratch paper available.
- Please fill out the Scantron sheet completely
  - Include your test code.
  - Include your Dragon ID
  - Include your name
- Mark your exam and include explanations where needed. This will help you learn from your exam as well as provide any verification of your scantron sheet.
- Please make sure to fill out each "Problem Solving Sheet" completely
  - Include your test code
  - Include your Dragon ID
  - Include your name
  - Include your lab time
- Your explanation/work for the worked problems is worth ¾ of the points. You must use a separate "Problem Solving Sheet" for each problem.

A general reminder about problem solving:

1. Visualize - draw a picture
2. Pick a coordinate frame
3. Create a simplified picture – schematic with vectors describing motion
   a. 2D Motion: separate vectors into components
   b. Force Problem: create a simplified free body diagram
   c. Energy Problem: create energy level diagram(s)
4. Write down what you know – create separate columns for different directions
5. Write down what you don't know and/or what you want to know
6. List mathematical relationships
7. Combine mathematical formulas, Simplify and Solve
8. Check your answer – Is it reasonable? Are the units correct?

- Show all work!

You throw a soccer ball as fast as you can straight up into the air. Use a coordinate system where up is in the positive direction. The next two questions refer to this ball after it has left your hand but before you catch it again. Do not ignore air drag.

1. The acceleration of the ball on the way down is
   a) Greater than 9.81 m/s^2 in the downward direction.
   b) Greater than 9.81 m/s^2 in the upward direction.
   c) Less than 9.81 m/s^2 in the downward direction.
   d) Less than 9.81 m/s^2 in the upward direction.
   e) Not enough information is given.

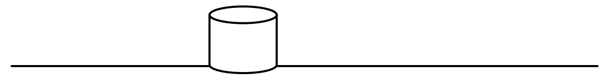
2. The velocity of the ball at the very top of its throw (just before it starts back down) is
   a) negative (in the downward direction).
   b) zero.
   c) positive (in the upward direction).
   d) proportional to the gravitational acceleration.
   e) not possible to determine.

3. You are swinging a bucket of water vertically beside yourself. When is the string holding the bucket most likely to break (i.e. when does it experience the greatest tension)
   a) When the bucket is in front of you travelling up.
   b) When the bucket is directly overhead.
   c) When the bucket is in front of you travelling down.
   d) When the bucket is behind you travelling up.
   e) When the bucket is traveling past your feet.
   f) When the bucket is behind you travelling down.

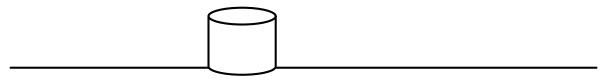
4. If the radius of a planet were to suddenly double and the density stayed constant (i.e. the mass would also change)
   a) The gravitational force would decrease $F_{new} = \frac{1}{4} F_{old}$
   b) The gravitational force would decrease $F_{new} = \frac{1}{2} F_{old}$
   c) The gravitational force would not change $F_{new} = F_{old}$
   d) The gravitational force would increase $F_{new} = 2 F_{old}$
   e) The gravitational force would increase $F_{new} = 4 F_{old}$

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

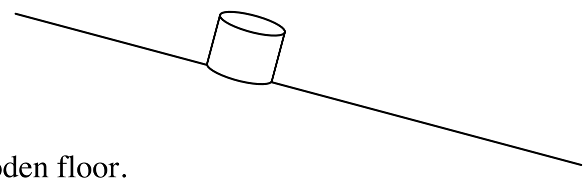
5. A hockey puck sitting on the ice (assume frictionless surface)



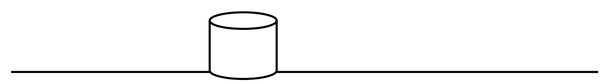
6. A hockey puck sliding across the ice at a constant velocity (assume frictionless surface)



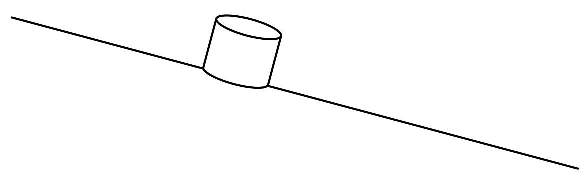
7. A hockey puck sliding down an inclined ice sheet (assume frictionless surface)



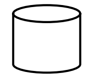
8. A hockey puck sliding across a wooden floor.



9. A hockey puck sliding down an inclined wooden floor.



10. A hockey puck dropped out of a stationary (hovering) helicopter.



The next two questions involve two carts that are identical except they have different masses. The mass of cart 1 is twice the mass of cart 2 ($m_1 = 2m_2$).

11. The two carts are pushed with the same force for the same amount of <u>time</u>. Which cart has a greater velocity?
   a) Cart 1 is traveling faster: $v_1 = 2v_2$
   b) Cart 1 is traveling faster: $v_1 = \sqrt{2}v_2$
   c) Both carts have the same velocity. $v_1 = v_2$
   d) Cart 2 is traveling faster: $v_1 = \frac{1}{\sqrt{2}}v_2$
   e) Cart 2 is traveling faster: $v_1 = \frac{1}{2}v_2$

12. The two carts are pushed with the same force for the same <u>distance</u>. Which cart has a greater velocity?
   a) Cart 1 is traveling faster: $v_1 = 2v_2$
   b) Cart 1 is traveling faster: $v_1 = \sqrt{2}v_2$
   c) Both carts have the same velocity. $v_1 = v_2$
   d) Cart 2 is traveling faster: $v_1 = \frac{1}{\sqrt{2}}v_2$
   e) Cart 2 is traveling faster: $v_1 = \frac{1}{2}v_2$

13. You drop a golf ball from a roof and immediately throw a baseball straight up into the air. Assume the mass of the baseball is 3 times the mass of the golf ball and ignore air drag. When the baseball is at the top of its trajectory,
   a) the acceleration of the golf ball is <u>greater than</u> the acceleration of the baseball.
   b) the acceleration of the golf ball is <u>equal to</u> the acceleration of the baseball.
   c) the acceleration of the golf ball is <u>less than</u> the acceleration of the baseball.

14. Two objects are dropped from a hot air balloon. The objects are identical except $m_B > m_A$. The first object ("A") reaches terminal velocity much faster than the second object ("B"). It follows that force due to air drag on object A is
   a) <u>greater</u> than the force due to air drag on object B.
   b) the <u>same</u> as the force due to air drag on object B
   c) <u>smaller</u> than the force due to air drag on object B

15. Two objects are on a turntable. The objects are identical except $m_B > m_A$. The first object ("A") is at twice the radius than the second object ("B"). It follows that linear velocity of object A is
   a) greater than the linear velocity on object B.
   b) the same as the linear velocity on object B
   c) smaller than the linear velocity on object B.
   d) not possible to determine since their masses are different.

Answer the following TRUE or FALSE questions.

16. Angular velocity and angular acceleration are always in the same direction.
   a) TRUE
   b) FALSE

17. The angular velocity is the slope of the angle vs time graph.
   a) TRUE
   b) FALSE

18. The area under the angular acceleration vs time graph is the change in angular velocity.
   a) TRUE
   b) FALSE

Do the next two problems using separate problem solving sheets. There are extra problems solving sheets available if you need one.

19. A record is spinning at 70 rev/sec. You decide to stop the record rotating by applying an angular acceleration of magnitude 2 rad/s^2. How many revolutions does the record make before it stops?

20. Your instructor has a flying pig (a conical pendulum) that you would like to swing really fast. The pig has a mass of 1 kg and is hooked to a 1.2 meter long string (assume the string is massless) that has a tensile strength of 16.7 N. Basically the string will break if you exert a tension greater than 16.7 N on it. Will the string break if you swing the pig really fast? If so at what angle will the string break and how fast will the pig be "flying"?

21. You are helping a friend move into a new apartment. A box of mass 70 kg needs to be moved to make room for a couch. You are taller than the box, so you reach down to push it at an angle of 50 degrees from the horizontal. The coefficient of static friction between the box and the floor is 0.50 and the coefficient of kinetic friction between the box and the floor is 0.30.

a) If you want to exert the minimum force necessary, how hard would you push to keep the box moving across the floor?
b) Suppose you bent your knees so that your push was horizontal. How hard would you push to keep the box moving across the floor?
c) Would it take less force to keep the box moving across the floor if you were to pull instead of push? (assume the same angle in both cases)