General Physics
Physics 101
Test #3 – Fall 2009
Friday 11/20/09
Prof. Bob Ekey

Name (print):________________________

I hereby declare upon my word of honor that I have neither given nor received unauthorized help on this work.

Signature:___________________________

Part I. Multiple Choice (3 pts each)

Instructions:

Please clearly circle one and only one answer for each of the following.
Show all of your work. Partial credit may be given if you include your work.

Questions:

1. Your roommate is working on his bicycle and has the bike upside down. He spins the 60 cm diameter wheel, and you notice that a 10 g pebble stuck in the tread goes by three times every second, and calculate the angular velocity to be 19 rad/s.
What is the pebbles centripetal force?

(a) 1.1 N
(b) 12 N
(c) 2.2 N
(d) 1.1 x 10^2 N

2. A 1000 kg safe is 2.0 m above a heavy-duty spring when the rope holding the safe breaks. The safe hits the spring and compresses it by 50 cm. What is the spring constant of the spring?

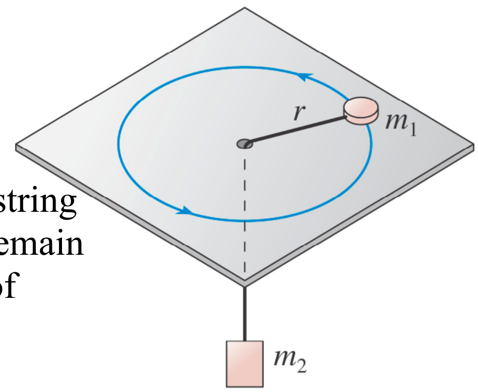
(a) 156800 Nm
(b) 2.0 x 10^5 N/m
(c) 2.0 x 10^4 N/m
(d) 1.6 x 10^5 N/m

3. You lift a 10 kg box from the floor to a shelf of a bookcase. If the shelf is 12 in from the floor, what is the change in potential energy of the box?

(a) 3.0 x 10^3 J
(b) 1.2 x 10^3 J
(c) 4.6 x 10^4 J
(d) 3.0 x 10^1 J

4. A truck traveling towards the east with a momentum of 5.0×10^3 kg m/s collides with a compact car traveling towards the south with a momentum of 5.0×10^3 kg m/s. What is the magnitude and direction of the truck/car system, after the collision assuming they stick together?

(a) 7071 kg m/s towards the northwest.
(b) 1.0×10^4 kg m/s toward the southeast.
(c) 7.1×10^3 kg m/s towards the southeast.
(d) 5.0×10^3 kg m/s towards the northwest.



5. Mass m_1 on the frictionless table shown is connected by a string through a hole in the table to a hanging mass m_2. For m_2 to remain motionless, while m_1 spins with a speed v at radius r, which of the following is true?

(a) The system is in equilibrium
(b) The velocity of m_1 is constant.
(c) The tension in the string supplies a radially outward force on m_1.
(d) The angular acceleration of m_1 is zero.

6. You're stuck in the middle of an icy no-friction pond. Since you have no traction, you can't walk. To get off the ice you decide to throw your 10 kg backpack in the negative x direction with a speed of 4.0 m/s. Assuming your mass is 80 kg, what is your final velocity?

(a) 0.50 m/s
(b) -0.50 m/s
(c) -2.0 m/s
(d) 32 m/s

7. A block initially at rest is allowed to slide down a frictionless ramp and attains a speed v at the bottom. To achieve a speed of 2v at the bottom, how many times as high must a new ramp be?

(a) $\sqrt{2}$ times as high
(b) 2 times as high
(c) 4 times as high
(d) 8 times as high

8. Suppose rain falls vertically into an open cart rolling along a straight horizontal track with negligible friction. As a result of the accumulating water, the speed of the cart

(a) increases.
(b) does not change.
(c) decreases.
(d) need more information.

9. You and a friend are participating in an egg toss competition. Your friend throws a 75 g egg towards you with a velocity of 1.0 m/s. The egg breaks if it experiences a Force greater than 2.0 N when it is stopped. In order to not break the egg, what must your stop time be greater than?

(a) 3.8×10^{-2} s
(b) 3.8 ms
(c) 2.7 s
(d) 38 s

10. A 0.50 kg mass is placed on the end of a vertical spring that has a spring constant of 75 N/m and eased down into its rest position. By how much has the length of the spring changed?

(a) 0.006667 m
(b) 0.065 m
(c) 6.7 mm
(d) 15 cm

11. A 5.0 g coin is placed 15 cm from the center of a turntable. The coin has a static and kinetic coefficients of friction with the turntable surface of μ_s =0.80 and μ_k =0.50. The turntable very slowly speeds up to 70 rpm. What happens to the coin?

(a) It stays rotating on the turntable
(b) It slides off the turntable
(c) It remains motionless
(d) Impossible to determine

12. You and a friend are playing with air-hockey pucks (all 1D). You send the 1.0 kg puck with a velocity of 1.0 m/s and your friend sends the 2.0 kg puck in the opposite direction with a velocity of -2.0 m/s. Assuming the pucks bounce off each other, what is the speed of the 2.0 kg puck following the collision?

(a) 3.0 m/s
(b) 1.3 m/s
(c) 1.0 m/s
(d) 0.0 m/s

Part II. Short answer problems (12 pts each)

Instructions:

Solve three of the following four problems. If you try to solve all four problems, please clearly indicate which problems you wish to have graded. If you do not indicate this, I will assume you want me to grade problems one, two and three.

Please show all of your work, including equations without numbers.
Please provide units with all answers.
Partial credit may be given if you include your work.

Question 1. **Grade this problem? Yes or No (circle one)**

Sifting through a box of junk, you discover a 1.0 kg ball and a 1.5 m long piece of string. You attach the ball to the string, and spin it vertically in a circle with a constant speed of 2.0 m/s.

(a) Calculate the centripetal force on the ball.

(b) Calculate the tension in the string at the top and bottom of the loop.
Please provide a force diagram for each location..

Unfortunately, you break the string… so you go back to looking through the junk, and find a spring, that you can attach the mass. If you hang the mass/spring system vertically and ease it into equilibrium, the spring stretches 10 cm.

(c) What is the spring constant of the spring?

Question 2. **Grade this problem? Yes or No (circle one)**

Upon graduating from Mount, you decided to get a job as a mud ball tester at MUD, INC, whose motto is “We know mud”. In the testing facility you take a 1.0 kg mud ball and drop it from rest at a height of 10 m to observe it go splat on the ground.

(a) What is the velocity of the ball right before it strikes the ground?
Please use energy conservation to solve this.

(b) What is impulse (magnitude and direction) exerted on the ball by the ground as it comes to rest?

(c) If the impact between the ball and ground lasts 0.50s, what is the average net force (magnitude and direction) exerted by the ground on the mudball?

(d) Explain whether or not the earth’s momentum changed due to the collision, and whether it is smaller, larger or the same as the momentum change as the ball.

Question 3. **Grade this problem? Yes or No (circle one)**

You fire a 50.0 g bullet into a 10.0 kg block of wood that sits on a slippery surface. The bullet leaves the gun with an initial speed of 300 m/s and has a kinetic energy of 2.25×10^3 J. The bullet and the block collide. After the collision, the block has a velocity of 1.00 m/s, and the bullet (free of the block) travels at a reduced speed. For simplicity, assume that all motion is in one-dimension.

(a) What is the velocity of the bullet after it leaves the block?

(b) Calculate the total kinetic energy of the system after the collision.

(c) Is momentum conserved in this collision? Is total mechanical energy conserved? Justify your answers with words. Equations and further calculations are not necessary

(d) The bullet now strikes a 1.0 kg block and the bullet is imbedded in the block. What is the velocity of the combined block/bullet after the collision?

Question 4. **Grade this problem? Yes or No (circle one)**

As a kid, I played with Matchbox™ toy cars. I had this really cool set that had a giant ramp that you sent cars sliding down. Later in life, I revisited this experience to create an exam question. I measured the top of the ramp to be 1.00 meters from the floor and the mass of the car to be 0.50 kg. As usual, we'll ignore the effects of friction.

(a) If I released a red car from rest at the top of the ramp, what speed would the red car have at the bottom of the ramp?

After the ramp, the red car traveled along a horizontal track on the floor coasting along before it would hit a blue stationary 0.25 kg mass car.

(b) If the collision was elastic, what would the velocity of the blue car be post collision?

Following the collision, the blue car travels off and hits a spring. The surprisingly detailed instructions indicated that the spring had a 100 N/m spring constant.

(c) What would the kinetic energy of the car be, when the spring is compressed a distance of 0.20 m from its equilibrium length?

Instead of the spring, I could attach a 0.50 m diameter loop.

(d) How fast would the car have to be traveling at the top of the loop so that it will not fall off the track?