General Physics
Physics 101
Test #3 – Fall 2013
Friday 11/15/13
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. A ping-pong ball collides head-on with a steel ball traveling in the opposite direction with equal speed. Which ball receives a larger impulse (magnitude)?

(a) The ping-pong ball
(b) Both receive the same magnitude of impulse.
(c) The steel ball
(d) Need more information

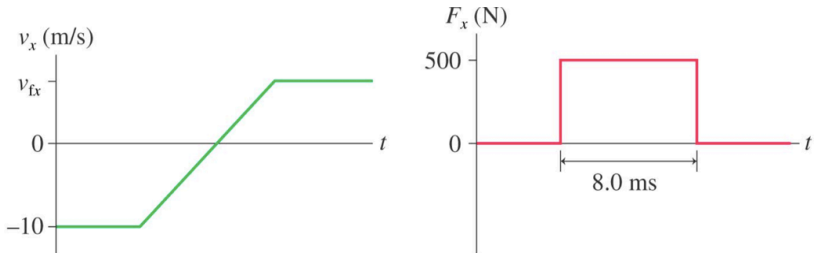
2. A student is asleep on the top bunk, which is 2.20 m from the floor. If he roles off the bed with an initial horizontal velocity of 1.10 m/s, what is his impact speed when he reaches the floor?

(a) 6.56 m/s
(b) 6.66 m/s
(c) 6.47 m/s
(d) 4.77 m/s

3. The normal force equals the magnitude of gravitational force as a roller coaster car crosses the top of a 40 m diameter loop-the loop. What's the car's speed at the top of the loop? Assume the car is upside-down at the top of the loop.

(a) 19.79 m/s
(b) 28 m/s
(c) 14 m/s
(d) 20 m/s

4. 250 g ball collides with a wall. The figure shows the ball's velocity and the force exerted on the ball by the wall. What is the v_{fx}, the ball's rebound velocity?



(a) 6.0 m/s
(b) 1.5 m/s
(c) 5.1 m/s
(d) 6.5 m/s

5. A 20g ball of clay traveling west at 2.0 m/s collides with a 30g ball of clay traveling to the south at 3.0 m/s. What is the momentum of the combined 50 g ball of clay in the x-direction after the collision?

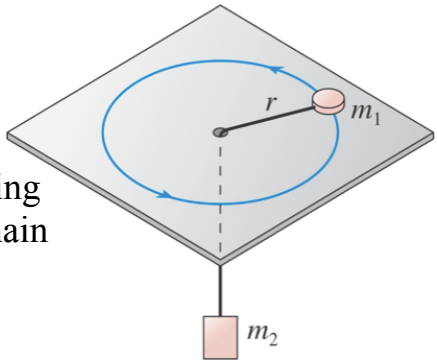
(a) 0.090 N/s
(b) -0.13 kg m/s
(c) -0.040 Ns
(d) -0.090 kg m/s

6. A spring-loaded gun shoots a plastic ball with a speed of 4 m/s. If the spring is compressed twice as far, the ball's speed will be?

(a) $\sqrt{2}$ m/s
(b) 2 m/s
(c) 8 m/s
(d) 16 m/s

7. A 2.0 kg ball traveling to the left at a speed of 2.0 m/s collides elastically with a 1.0 kg ball traveling to the right at a speed of 3.0 m/s. What is the velocity of the 2.0 kg ball after the collision?

(a) 1.3 m/s
(b) -3.6 m/s
(c) 4.7 m/s
(d) -2.6 m/s

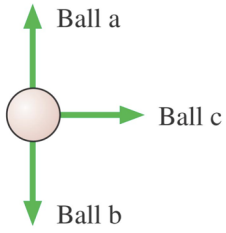


8. Mass m_1 on the frictionless table shown is connected by a string through a hole in the table to a hanging mass m_2. For m_2 to remain motionless, while m_1 spins with a speed v at radius r, which of the following is true?

(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.

9. A 10 g bullet is fired at 400 m/s toward a stationary 500 g wood block. The bullet passes all the way through the block, and the speed of the block is now 6.0 m/s. What is the speed of the bullet after it leaves the block?

(a) 1.0×10^2 m/s
(b) 700.0 m/s
(c) 14 m/s
(d) It is not possible for the bullet to leave the block



10.The three balls shown have equal masses and are fired with equal speeds from the same height above the ground. Which ball hits the ground with the largest speed?

(a) Ball a
(b) Ball b
(c) Ball c
(d) All speeds are the same

11. A vertical spring is compressed 100 cm and is used to launch a 10.0 kg package 10.0 m vertically from the point it leaves contact with the spring. What is the kinetic energy of the package the moment it is not in contact with the spring?

(a) 490 Nm
(b) 980 J
(c) 1.08×10^3 J
(d) Need more information

12. As is typically the case in this semester's exams, a Sharknado, a tornado filled with sharks, is spinning with many sharks at different radii from the center of the tornado. If the shark has a mass of 500 kg spins in a circle with a diameter of 20 m, at 3.0 rad/s, what is the centripetal force experienced by the shark?

(a) 450 kN
(b) 45 kN
(c) 9.0×10^4 N
(d) 30 kN

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)**

A 5000 kg open train car is rolling on frictionless horizontal rails at +20 m/s second when it approaches a second train car of equal mass that is traveling at +10 m/s.

(a) If the train cars stick together after the collision, what is the velocity of the combined system post collision?

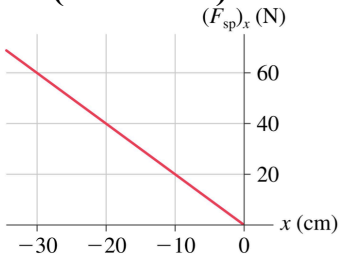
(b) If the collision lasted 10 ms, what is the magnitude of the force on the train car traveling at 20 m/s?

(c) Explain whether or not kinetic energy is conserved in this collision. Words and possibly equations are necessary in your answer, but no calculations are required.

(d) The combined cars still traveling with the velocity found in (a) begin to climb a steep hill. What is the maximum vertical height the cars attain before turning back around?

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

A 50 g rock is placed in a slingshot and the rubber band is stretched. The force of the rubber band on the rock is shown in the graph.



(a) Calculate the spring constant of the rubber band in units of N/m.

(b) Explain whether the rubber band obeys Hooke's Law. Words and equations are necessary in your explanation, but calculations are not.

(c) The rubber band is stretched 30 cm and then released. What is the speed of the rock as it leaves the slingshot?

(d) For the launch described in (c), what is the kinetic energy of the rock when the rubber band is halfway through the launch (which corresponds to a stretch of 15 cm)?

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

A 500 g ball swings in a vertical circle at the end of a 1.5 m long string. When the ball is at the bottom of the circle, the tension in the string is 15 N. Assume the ball is undergoing uniform circular motion.

(a) When the ball is at the bottom of its motion, draw a force diagram showing the Tension and Force of Gravity acting on the ball drawn to scale. These do not need to be exact, but a larger force should have a larger length. Also explain the direction of the net force using your diagram.

(b) What is the centripetal force acting on the ball at the bottom of the motion? Be sure to explicitly state the direction of the centripetal force.

(c) Calculate the tension in the string, when the ball is at the top of its motion.

(d) If you decrease the speed at which the ball is spinning, what is the minimum angular speed for the ball that will allow it to remain in circular motion?

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

In hockey practice, a 50 g hockey-puck is sitting motionless on ice.
(a) If the 1.0 kg hockey stick that strikes the puck is traveling at 20 m/s before the hit and 19 m/s after the hit, what is the velocity of the puck after the hit?

(b) Another player on the team was about to hit another stationary 50 g puck but it was struck by the puck hit in (a) prior to him being able to hit it. If the pucks collide elastically, what is the velocity of the second stationary puck after the collision?

Of course, the two players that hit the pucks are now mad at each other, and decide to get into a fight (it is hockey after all). One player drops his 1.0 kg stick from rest and it lands 1.5 m on the ice below, and then skates towards the other player.
(c) What is the velocity (mag + dir) of the stick immediately before it lands on the ice? Please use Energy conservation in this calculation.

(d) At one point during the fight, the 75 kg player pushes the 100 kg player with a horizontal 100 N force. If they were not moving horizontally prior to the push, who moves off with a larger speed? Please explain with words and equations, but no numeric answers are required. Friction between the skates and the ice is minimal.