General Physics
Physics 101
Test #3 – Spring 2013
Friday 4/12/13
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 50 g ice cube can slide without friction up and down a 30º slope. The ice cube is pressed against a spring at the bottom of the slope, compressing the spring 10 cm. The spring constant is 25 N/m. When the ice cube is released, what vertical distance will it travel up the slope before reversing direction?

(a) 2.6×10^2 mm
(b) 51 cm
(c) 2.6 m
(d) 20 mm

2. A 100g ball moving to the right at 4.0 m/s catches up and collides with a 400 g ball that is moving to the right at 1.0 m/s. If the collision is perfectly elastic, what is the speed and direction of the 400 g ball after the collision?

(a) 1.0 m/s
(b) 2.2 m/s
(c) 1.6 m/s
(d) -8.0×10^{-1} m/s

3. You are whirling a bucket of water in a vertical circle at a speed of 4.0 m/s and at a radius of 0.75 m. If the normal force exerted on the water is 2.0 N when it is at the top of its motion, what is the mass of the water in the bucket?

(a) 0.17 kg
(b) 64 g
(c) 94 g
(d) 0.91 kg

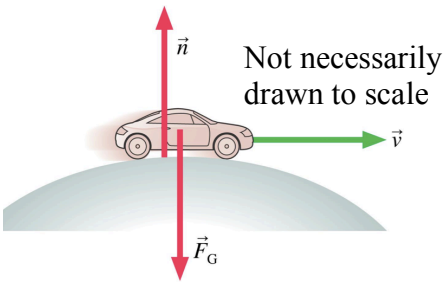
4. Suppose a ping-pong ball and a bowling ball are rolling toward you. You exert the same force over the same time to stop each. How did the initial momentums of each ball compare?

(a) The momentum of the ping-pong ball is larger.
(b) Both have the same amount of momentum.
(c) The momentum of the bowling ball is larger.
(d) Need more information.

5. A spring-loaded gun shoots a plastic ball with a speed of 2.0 m/s. If the spring is compressed twice as far, the ball's speed will be?

(a) $\sqrt{2}$ m/s
(b) 2.8 m/s
(c) 4.0 m/s
(d) 8.0 m/s

6. An out-of-gas car is rolling over the top of a hill at speed v. At this instant,



(a) $n > F_G$
(b) $n = F_G$
(c) $n < F_G$
(d) Impossible to tell without knowing v.

7. A 20 g ball is launched vertically upward 30 m/s from an initial height of 2.0 m. It exhibits beautiful projectile motion. What is the change in kinetic energy of the particle from launch to when it returns to the launch point?

(a) 0.0 J
(b) 9.0×10^3 Ns
(c) 18 Nm
(d) 36 kg m/s

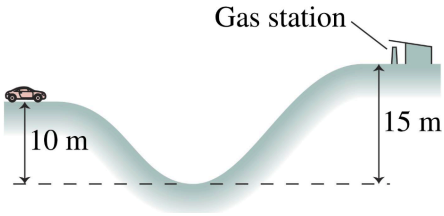
8. Three blobs of equal mass of 1.0 kg are traveling towards each other each with a speed of 1.0 m/s. The first mass is traveling to the north, the second to the south and the third to the west, and they stick together post-collision. What is the system's magnitude of momentum after the collision?

(a) 3.0 kg m/s
(b) 2.2 kg m/s
(c) 2.0 kg m/s
(d) 1.0 kg m/s

9. A 1.5 kg ball on the end of a 2.0 m long string spins with a velocity of twice its critical speed. What is the magnitude of the centripetal force acting on the ball?

(a) 14.52 N
(b) 1.7×10^3 N
(c) 43 N
(d) 58 N

10. A 1500 kg car traveling at 5.0 m/s suddenly runs out of gas while approaching the valley shown. What will be the car's speed as it coasts into the gas station on the other side of the valley?



(a) 1.4 m/s
(b) 8.5 m/s
(c) 2.5 m/s
(d) The car never makes it there.

11. Dan is gliding on his skateboard at 4.0 m/s. He suddenly jumps backward off the skateboard, kicking the skateboard forward at 8.0 m/s. How fast is Dan going as his feet hit the ground? Dan's mass is 50 kg and the skateboard's mass is 5.0 kg.

(a) 5.2 m/s
(b) 3.6 m/s
(c) 6.3 m/s
(d) 0.0 m/s

12. Which of the following statements is true?

(a) One particle that is moving collides with a second particle that is stationary, after the collision, it is possible for both particles to be at rest.

(b) When walking forward from rest, the change in momentum of you is greater than the change in momentum of the earth.

(c) An object undergoing uniform circular motion is not in equilibrium.

(d) In a conservative system, the system's total mechanical energy can change.

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)**

You've entered a circular motion contraption into the "Punkin Chunkin" competition, which is a 3.0 m long cable that spins a 5.0 kg pumpkin. Just to plan ahead for the worst and best case scenarios, consider the following. Ignore the mass of the cable.

(a) What is the minimum angular speed that the pumpkin can spin, and still remain moving in a circle? A numerical answer is required.

(b) Looking at the top of the motion, what happens to the forces acting on pumpkin if it were to approach the critical speed? Words and a net force equation are necessary. A force diagram could help. No calculations are necessary.

At operational speed, the pumpkin makes 1.0 revolution in 1.0 second.

(c) What is the net force acting on the pumpkin as it spins at operational speed? Be sure to explicitly indicate the direction of the force.

(d) What is the tension in the cable when the pumpkin is at the bottom of its motion at operational speed?

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

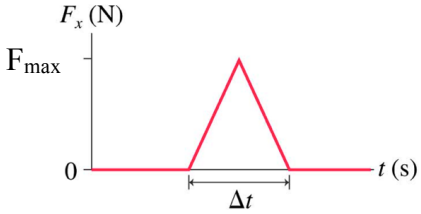
A 0.500 kg Frisbee is stuck 16.0 m above the ground in a tree. To dislodge the Frisbee you have to hit it with a rock traveling at a non-zero velocity. You release the 0.250 kg rock, 2.00 m above the ground with an initial speed of 20.0 m/s.

(a) As long as the rock hits the Frisbee, does it matter what angle you throw the rock initially? Explain your answer in words and possibly equations.

(b) With what speed is the rock traveling right before it hits the Frisbee?

(c) The rock and stationary Frisbee collide, and immediately after the collision the rock is motionless (and then it begins to fall again, but ignore that). What is the velocity of the Frisbee after the collision?

(d) If the impulse lasted for $\Delta t = 3.0$ ms as shown, what is the maximum force experienced by the Frisbee?



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

My son has toy trains. We line them up and smash them together, and while he doesn't know it, he is exploring some great physics. For our purposes, all train cars have identical mass (50 g), and we'll ignore friction.

(a) We built a ramp and he released a car from rest at the top of a ramp. If the velocity of the train car is 3.0 m/s at the bottom of the ramp, what is the vertical height of the ramp?

We of course have setup two train cars connected together at the bottom of the ramp and the one train strikes the two trains and the three trains travel off together.

(b) In this collision is momentum or kinetic energy conserved? Explain your answer using words, and be sure to address both momentum and kinetic energy.

(c) With what velocity does the three train cars travel off with after the collision?

(d) These 3 train cars now strike a stationary lone train car and they bounce away from each other (magnets are cool). What is the velocity of the lone car after the collision?

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

A safe is 2.0 m above a heavy-duty spring ($k=2.0 \times 10^5$ N/m) when the rope holding the safe breaks.

(a) Explain what happens to the gravitational energy, kinetic energy and total mechanical energy as the safe falls towards the spring. Are they increasing, decreasing or remaining constant? Words and equations are necessary in your justification, but no calculations are required.

(b) Using Energy conservation, determine the velocity (mag + dir) of the safe right before it hits the spring.

The safe hits the spring and compresses it by 50 cm from its uncompressed length.
(c) What is the mass of the safe?

(d) The safe bounces up and down on the spring, and you stop the motion causing it to be in equilibrium. How much is the spring now compressed from its uncompressed length?