General Physics
Physics 101
Test #3 – Spring 2017
Friday 4/7/17
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. In deep space, a mischievous astronaut decides to push another astronaut from behind. If both are initially at rest, which of the following is not a possible scenario after the push?

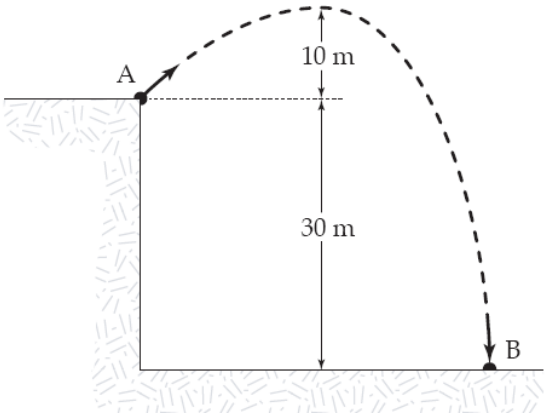
(a) One astronaut travels off at a larger speed than the other.
(b) One astronaut is at rest after the push
(c) Both astronauts travel off with the same speed in opposite directions
(d) Both astronauts have the same magnitude of momentum.

2. 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

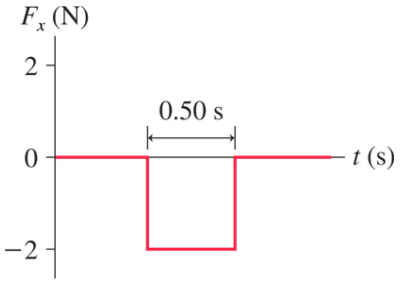
3. Morgan and Hannah are playing with air-hockey pucks (all 1D). Morgan sends the 1.0 kg puck with a velocity of -1.0 m/s and Hannah sends the 2.0 kg puck in the opposite direction with a velocity of 2.0 m/s. Assuming the pucks bounce off each other, what is the speed of the 2.0 kg puck following the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

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



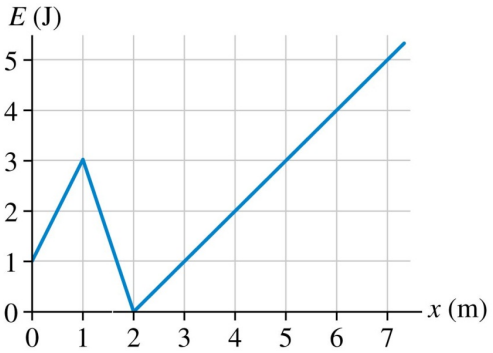
4. A 40 g ball is thrown from a 30-m tall building (point A) at an unknown angle above the horizontal. As shown, the ball attains a maximum height of 10 m above the top of the building before striking the ground at point B. If air resistance is negligible, what is the change in kinetic energy of the ball at B compared to that at the launch?

(a) – 12 Nm
(b) 12 J
(c) -16 J
(d) 16 kg m^2/s^2



5. A 2.0 kg object is moving to the left with a speed of 1.0 m/s when it experiences the force shown. What impulse does the object experience?

(a) -1.0 kg m/s
(b) 0.50 Ns
(c) -0.50 kg m/s
(d) Need more information



6. A particle with the potential energy shown is moving to the right. It has 1.0 J of kinetic energy at x=1.0 m. In the region 1.0 m<x< 2.0 m, the particle is

(a) decreasing in speed.
(b) increasing in speed.
(c) moving at constant speed.
(d) impossible to determine.

7. 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) 1.6×10^5 N/m
(b) 2.0×10^4 N/m
(c) 2.0×10^5 N/m
(d) 9.8×10^5 Nm

8. Two gentlemen are running at each other in Velcro suits: the first (100 kg) is traveling to the right at 5.0 m/s and the second (120 kg) traveling to the left at 3.0 m/s. If they collide and stick together, what is their speed immediately after they collide?

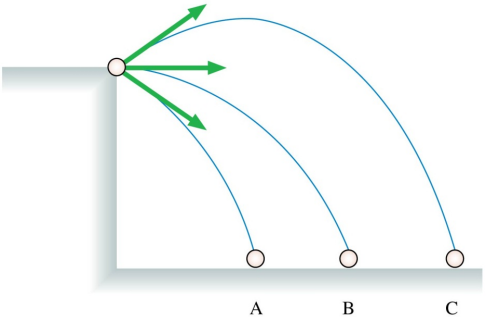
(a) 0.64 m/s
(b) 3.9 m/s
(c) 1.4 m/s
(d) Not possible to determine without impact time.

9. Astronauts on the International Space Station appear weightless because

(a) The net force on them is zero.
(b) The centrifugal force balances the gravitational force.
(c) g is very small, although not zero.
(d) They are in free fall.

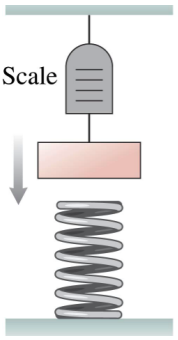
10. You throw a ball straight up in the air with an initial speed of v and the ball reaches a maximum height, h. If you want to reach a height of 4h, at what initial speed do you have to throw the ball?

(a) 4v
(b) 8v
(c) 2v
(d) $\sqrt{2}$ v



11. Three balls are thrown from a cliff with the same speed but at different angles. Which ball has the greatest speed just before it hits the ground?

(a) Ball C
(b) Ball B
(c) Ball A
(d) All balls have the same speed.



12. You gently lower a 20.0 kg object attached to a scale onto a spring (k=500 N/m). What is the reading on the scale in Newtons, when the spring is gently compressed by 10.0 cm?

(a) 196 N
(b) 246 N
(c) 146 N
(d) 50.0 N

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 have a firecracker, coconut, drill and matches for a physics experiments (wear goggles). You conduct your experiment on a level piece of ground and use a computer and camera to record the outcome. The coconut is at rest and explodes into three pieces. The first piece (0.20 kg) travels off at 2.0 m/s at an angle of 30º north of west (v_{1x}=-1.7 m/s, v_{1y}=1.0 m/s). The second piece travels off at 1.0 m/s to the south and the third piece travels off at 0.50 m/s to the east. You don't know the masses of these two pieces since you threw them away. Time for physics to save your experiment.

(a) What is the mass of the second piece?

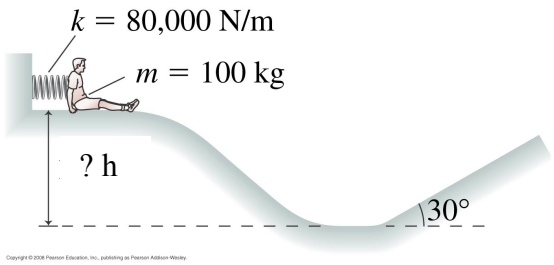
(b) What is the mass of the third piece?

(c) What is the total kinetic energy of the system after the explosion?

(d) What is the total momentum of the system after the explosion?

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

A spring is compressed 50 cm and used to launch a 100 kg physics student. Ignore friction.



(a) If the total mechanical energy of the system at the bottom of the hill is 2.0×10^4 J. Determine the height (h) of the launch point from the bottom of the hill.

(b) Discuss the normal force acting on the man at the bottom of the hill, and whether it is greater than or less than the force of gravity on the man. Words are necessary in your answer, and calculations and a force diagram could help but are not required.

The man begins to ascend the 30º ramp.
(c) What is the velocity of the man when the gravitational and kinetic energy are equal?

(d) Is it possible for the man to ascend to a vertical height of 30 m?
Explain/justify your answer with a calculation. Assume the ramp is long enough.

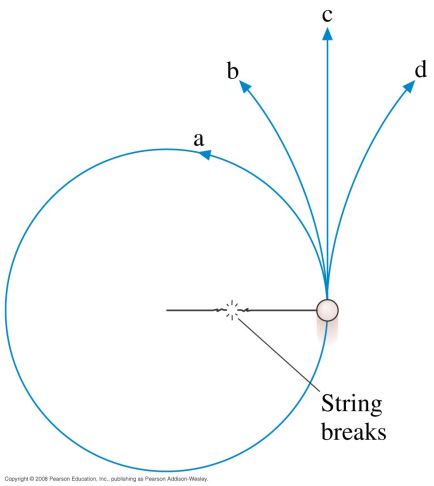
Question 3. **Grade this problem? Yes or No (circle one)**

A 500 g ball moves freely in a vertical circle on a 102-cm-long string.
(a) If the speed at the top is 4.0 m/s, what is the tension in the string when the ball is at the top?

(b) Using energy conservation, determine the speed of the ball at the bottom of the loop (height difference of 204 cm).

(c) What is the net force applied to ball when it is at the bottom of the vertical circle? Explicitly state the direction that the force acts.

(d) Unfortunately, the string breaks when it was parallel to the ground and the ball is moving up. Which of the trajectories does the ball follow? Explain your answer with words and possibly equations. Calculations are not necessary.



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

My son can swing a 1.0 kg bat at a speed of 15 m/s. He can hit a 0.25 kg baseball off a tee (ball initially at rest) and the ball travels off at 15 m/s (exit speed).

(a) What is the speed of the bat after impact with the ball?

(b) If the impact takes 50 ms, what is the force (mag + dir) of the ball on the bat?

(c) If this were an elastic collision, what would the exit speed of the ball be?

(d) Explain why it hurts more to catch a ball with your bare hand rather than a baseball glove. You must explain the background theory in the explanation.