AP Physics 1 Name: _____

Unit 4 Test: Momentum

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1. a) Jack Sparrow is sailing in a pirate ship when he is pursued by a British Man-O-War. To help his boat gain speed, he orders his crew to dump cargo off the ship.

i. Use physics to explain how this will help him escape.

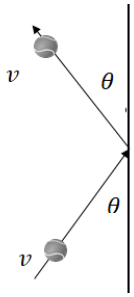
ii. What happens to the kinetic of the ship as cargo is dumped?

b) As captain's ship is traveling due north, a cannonball splits his ship into 3 pieces of equal mass. One piece of his ship travels due south while another piece travels due east.

i. What is the direction of the other fragment?

ii. What direction does the center of mass of the ship fragment move after the collision?

2. A tennis ball of mass m travelling at v collides with a wall at an angle θ and then rebounds at the same angle and speed as shown.



a) What is the direction of the impulse of the ball on the wall?

b) Was momentum conserved when the ball bounced off the wall? Justify your answer.

c) Another tennis ball of mass m = 0.3 kg is traveling at 12 m/s when it collides horizontally with a wall and bounces off at 6 m/s.

i. Calculate the impulse of the wall on the ball.

ii. How would the final speed of the ball compare if it were in contact with the wall for a shorter time?

_____Greater than 5m/s _____Less than 5 m/s _____Equal to 5 m/s

Justify your answer.

3. Two mine-carts roll towards each other on a track with negligible friction. A cart of mass M rolls to the right with a velocity of $6v$. A cart of mass $2M$ rolls to the left with a velocity of v. The cart carts collide. After the collision, the cart of mass M is observed moving to the left with a velocity of $2v$.

a) Find the direction and speed of the larger cart after the collision. Show your work.

b) If the carts are in contact for time t, find the magnitude of the force that the small cart exerts of the larger cart. Show your work.

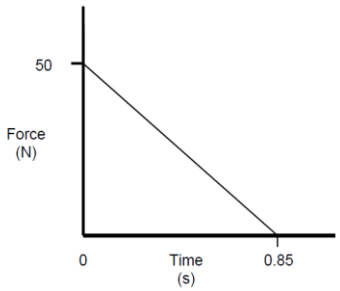
4. Waluigi shoots a bullet bill of mass m at a speed of $10v$ to the right as shown. The bullet passes through a block of mass $5m$, which is initially at rest. The bullet passes through the block. After the bullet passes completely through the block, the bullet's velocity has dropped to $5v$.

a) What is the velocity of the block after the bullet passes through?

b) What is the maximum height the block travels up the incline?

c) Would the answer to a) increase, decrease, or remain the same if the bullet sticks in the block and becomes embedded in it instead of passing through? Justify your answer qualitatively.

5. An arrow resting on a bow string experiences a variable force for 0.85 s as it is shot from the bow, as shown in the graph provided.



a) Determine the impulse imparted on the arrow.

b) Given the mass of the arrow as m_{arrow} = 0.20 kg, use graph to calculate the speed of the arrow at the instant it leaves the bow string.

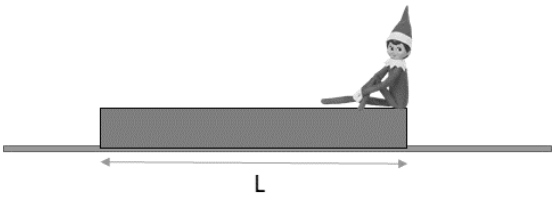
The arrow then travels in a straight path until it hits an apple. The arrow and apple stick together and fly off. The mass of the apple is 0.4 kg.

b) Determine the speed of the apple/arrow system after the arrow sticks in it.

c) The archer states, "The momentum of the arrow and the apple could not be conserved during the collision because of the large frictional forces between the apple and the entering arrow." Do you agree with this statement? Why or why not?

d) Is this collision elastic? Justify your answer.

6. An elf (mass m = 5 kg) is on a shelf (mass M = 10 kg). Since elf on a shelf is kind of annoying, the shelf with the elf is stranded in the minute of a (frictionless) large frozen lake in the Alaskan wilderness. The elf is on the right most end of the shelf.



a) The elf walks at a rate of 4 m/s to the left. Determine the velocity of the shelf.

b) Determine how far the shelf moves when the elf has reach the left edge of the shelf.

c) Santa says "The elf can move the shelf by walking on it until the shelf reaches the edge of the frozen lake." Do you agree with this reasoning? Why or why not?