AP Physics Study Guide   Chapter 7   Impulse and Momentum Name_______________

Circle the vector quantities below and underline the scalar quantities below

Force   time   Impulse   momentum   change in momentum

Write the equation that defines each quantity, **INCLUDE UNITS FOR ALL QUANTITIES**

Impulse   I   Momentum

Impulse-Momentum Theorem   Conservation of Momentum

Explain how to use a force - time graph to determine impulse and change in momentum.

Explain the conservation of momentum principle using words. What is the primary condition that is applied in using it?

Explain the difference between elastic and inelastic collisions using words. Include the two equations that apply to elastic collisions.

Explain how a totally inelastic collision is defined. Explain what the energy "lost" during the collision is used to perform or is transferred into.

The impulse-momentum theorem can be used to explain how a person jumping and landing on the floor can survive or how a person involved in a car crash with the air bag deployed can survive or how a watermelon dropped from a diving board can survive. Explain this in detail for any of these three situations, using the impulse-momentum theorem.

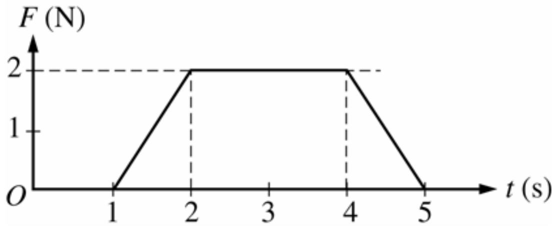
Explain what a ballistic pendulum is and how both momentum conservation and energy conservation are used to determine the high speed of a bullet.

Explain how to apply the law of conservation of momentum to 2-dimensional collisions. Include a simple diagram of a two-dimensional collision.

For the two-dimensional collision diagrams shown in the text explain what is known about the total final momentum in the y-direction and why.

Explain how two moving objects, like two skaters that have pushed off of each other or a bullet and a recoiling rifle, can have a total momentum equal to zero.

No process is required for these multiple choice questions. Put answers on lines at right.



1. A 2 kg object, initially moving with a constant velocity, is subjected to a force of magnitude F in the direction of motion. A graph of F as a function of time t is shown above. What is the increase, if any, in the velocity of the object during the time the force is applied

A) 0 m/s B) 2.0 m/s C) 3.0 m/s D) 4.0 m/s E) 6.0 m/s

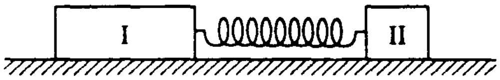
1)__________

2. Which of the following quantities is a scalar that is always positive or zero?
(A) Power (B) Work (C) Kinetic energy (D) Linear momentum (E) Angular momentum

2)__________

3. Which of the following is true when an object of mass m moving on a horizontal frictionless surface hits and sticks to an object of mass M > m, which is initially at rest on the surface?
(A) The collision is elastic.
(B) All of the initial kinetic energy of the less massive object is lost.
(C) The momentum of the objects that are stuck together has a smaller magnitude than the initial momentum of the less-massive object.
(D) The speed of the objects that are stuck together will be less than the initial speed of the less massive object.
(E) The direction of motion of the objects that are stuck together depends on whether the hit is a head-on collision.

3)___________



4) Two pucks are attached by a stretched spring and are initially held at rest on a frictionless surface, as shown above. The pucks are then released simultaneously. If puck I has three times the mass of puck II, which of the following quantities is the same for both pucks as the spring pulls the two pucks toward each other?

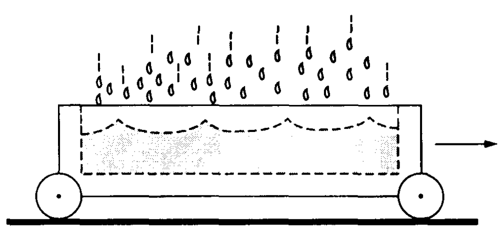
(A) Speed (B) Velocity (C) Acceleration (D) Kinetic energy (E) Magnitude of momentum

4)__________

5. A solid metal ball and a hollow plastic ball of the same external radius are released from rest in a large vacuum chamber. When each has fallen 1m, they both have the same
a. inertia b. speed c. momentum d. kinetic energy e. change in potential energy

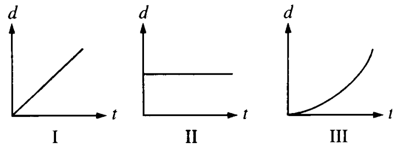
5)__________

6. A railroad car of mass *m* is moving at speed *v* when it collides with a second railroad car of mass *M* which is at rest. The two cars lock together instantaneously and move along the track. What is the speed of the cars immediately after the collision?
a. $v/2$ b. mv/M c. Mv/m d. $(m + M)v/m$ e. $mv/(m+M)$ *6)*__________



7. An open cart on a level surface is rolling without frictional loss through a vertical downpour of rain, as shown above. As the cart rolls, an appreciable amount of rainwater accumulates in the cart. The speed of the cart will
a. increase because of conservation of momentum
b. increase because of conservation of mechanical energy 7)___________
c. decrease because of conservation of momentum
d. decrease because of conservation of mechanical energy
e. remain the same because the raindrops are falling perpendicular to the direction of the cart's motion

An object can only move along a straight, level path. The graphs below show the position *d* of the object plotted as a function of time *t*.



8. The magnitude of the momentum of the object is increasing in which of the cases?

a. II only b. III only c. I and II only d. I and III only e. I, II, and III

8)___________

9) Two objects having the same mass travel toward each other on a flat surface, each with a speed of 1.0 meter per second relative to the surface. The objects collide head-on and are reported to rebound after the collision, each with a speed of 2.0 meters per second relative to the surface. Which of the following assessments of this report is most accurate?

9)_______

(A) Momentum was not conserved. therefore the report is false.
(B) If potential energy was released to the objects during the collision. the report could be true.
(C) If the objects had different masses. the report could be true.
(D) If the surface was inclined. the report could be true.
(E) If there was no friction between the objects and the surface, the report could be true.

10) Two bodies of masses 5 and 7 kilograms are initially at rest on a horizontal frictionless surface. A light spring is compressed between the bodies, which are held together by a thin thread. After the spring is released by burning through the thread, the 5 kilogram body has a speed of 0.2 m/s. The speed of the 7 kilogram body is (in m/s)

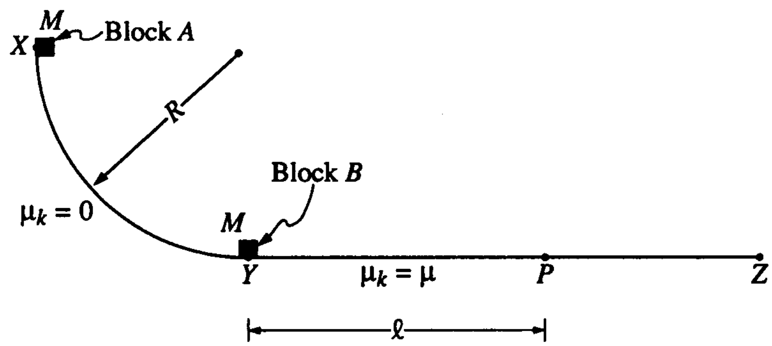
(A) $\frac{1}{12}$ (B) $\frac{1}{7}$ (C) $\frac{1}{\sqrt{35}}$ (D) $\frac{1}{5}$ (E) $\frac{7}{25}$

10)_______

11) 11)________

A person applies an impulse of 5.0 kg•m/s to a box in order to set it in motion. If the person is in contact with the box for 0.25 s, what is the average force exerted by the person on the box?

(A) 1.25 N
(B) 2.00 N
(C) 12.5 N
(D) 20.0 N
(E) 200 N



Side View

1) A track consists of a frictionless arc XY, which is a quarter-circle of radius R, and a rough horizontal section YZ. Block A of mass M is released from rest at point X, slides down the curved section of the track, and collides instantaneously and inelastically with identical block B at point Y. The two blocks move together to the right, sliding past point P, which is a distance *l* from point Y. The coefficient of kinetic friction between the blocks and the horizontal part of the track is μ
Express your answers in terms of M, *l*, μ, R, and g.

a. Determine the speed of block A just before it hits block B.

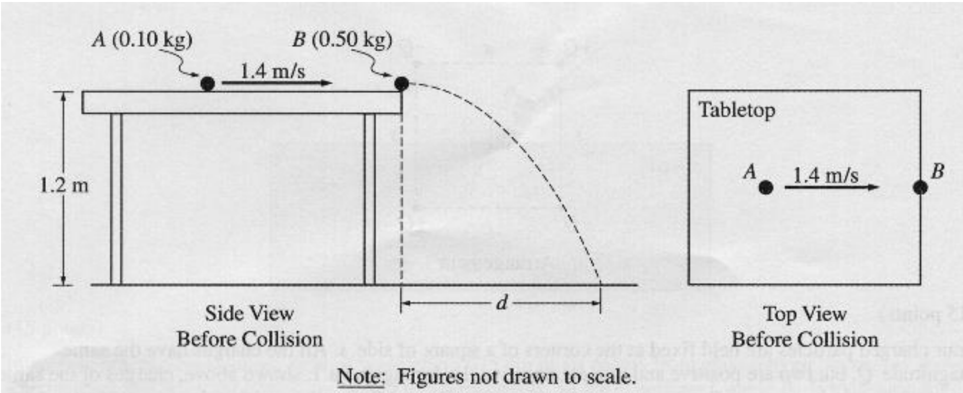
a)_____________

b. Determine the speed of the combined blocks immediately after the collision.

b)____________

c. Determine the amount of kinetic energy lost due to the collision.

c)____________



2) An incident ball *A* of mass 0.10 kg is sliding at 1.4 m/s on the horizontal tabletop of negligible friction shown above. It makes a head-on collision with a target ball *B* of mass 0.50 kg at rest at the edge of the table. As a result of the collision, the incident ball rebounds, sliding backwards at 0.70 m/s immediately after the collision.

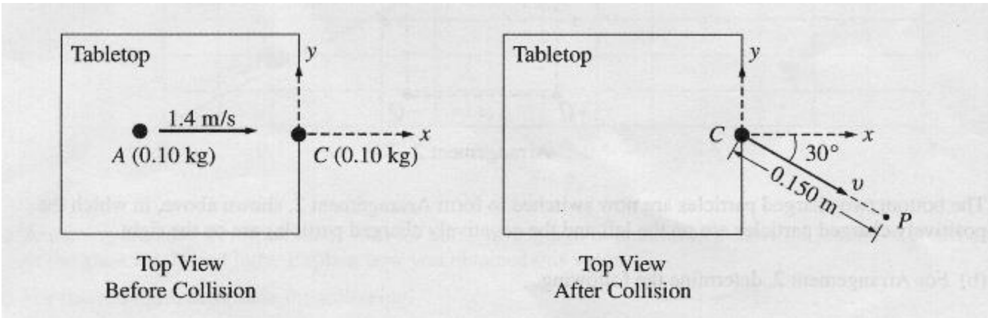
(a) Calculate the speed of the 0.50 kg target ball immediately after the collision.

a)_____________

The tabletop is 1.20 m above a level, horizontal floor. The target ball is projected horizontally and initially strikes the floor at a horizontal displacement *d* from the point of collision.

(b) Calculate the horizontal displacement *d.*

b)_____________



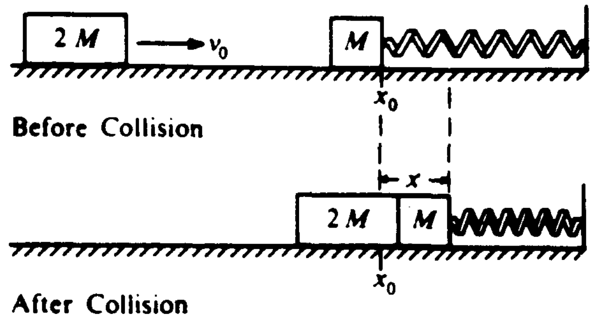
In another experiment on the same table, the target ball *B* is replaced by target ball *C* of mass 0.10 kg. The incident ball *A* again slides at 1.4 m/s, as shown above left, but this time makes a glancing collision with the target ball *C* that is at rest at the edge of the table. The target ball *C* strikes the floor at point *P*. which is at a horizontal displacement of 0.15 m from the point of the collision, and at a horizontal angle of 30° from the +x-axis, as shown above right.

(c) Calculate the speed *v* of the target ball *C* immediately after the collision.

c)_____________

(d) Calculate the y-component of incident ball *A's* momentum immediately after the collision.

d)____________



3) A block of mass M is resting on a horizontal, frictionless table and is attached as shown above to a relaxed spring of spring constant k. A second block of mass 2M and initial speed v_o collides with and sticks to the first block.
Develop expressions for the following quantities in terms of M, k, and v_o

a. v, the speed of the blocks immediately after impact

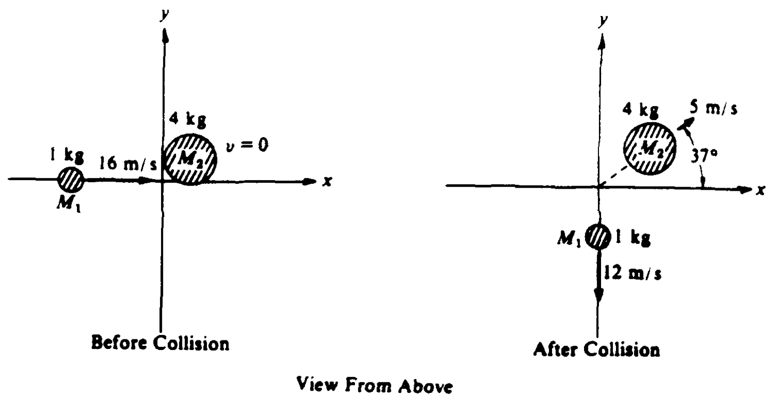
a)____________

b. x, the maximum distance the spring is compressed

b)___________

c) the ratio of total kinetic energy before the collision to total kinetic energy after the collision

c)_____________



4) Two objects of masses M_1 = 1 kilogram and M_2 = 4 kilograms are free to slide on a horizontal frictionless surface. The objects collide and the magnitudes and directions of the velocities of the two objects before and after the collision are shown on the diagram above.

a. Calculate the x and y components (p_x and p_y, respectively) of the momenta of the two objects before and after the collision, and write your results in the proper places in the following table.

	M_1 = 1 kg		M_2 = 4 kg	
	$p_x \left(\frac{kg \cdot m}{s}\right)$	$p_y \left(\frac{kg \cdot m}{s}\right)$	$p_x \left(\frac{kg \cdot m}{s}\right)$	$p_y \left(\frac{kg \cdot m}{s}\right)$
Before Collision				
After Collision				

b. Show using the data that you listed in the table, that linear momentum is conserved in this collision.

c. Calculate the kinetic energy of the two-object system before and after the collision.

____

____

d. Is kinetic energy conserved in the collision? Explain your answer.

____

5) A 2-kilogram block initially hangs at rest at the end of two 1-meter strings of negligible mass as shown on the left diagram above. A 0.003-kilogram bullet, moving horizontally with a speed of 1000 meters per second, strikes the block and becomes embedded in it. After the collision, the bullet/ block combination swings upward, but does not rotate.

a. Calculate the speed v of the bullet/ block combination just after the collision.

a)_______________

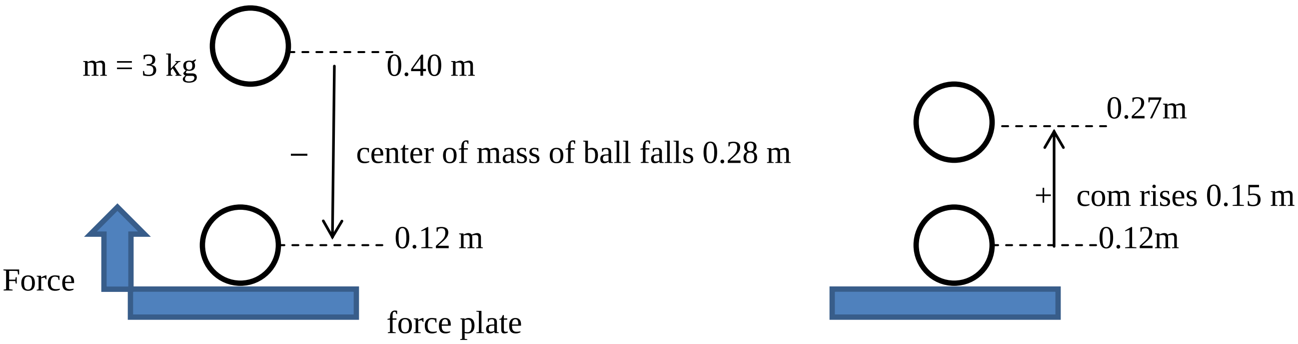
b. Calculate the ratio of the initial kinetic energy of the bullet to the kinetic energy of the bullet/ block combination immediately after the collision.

b)______________

c. Calculate the maximum vertical height above the initial rest position reached by the bullet/block combination.

c)__________________

Impulse – Momentum   Force plate example

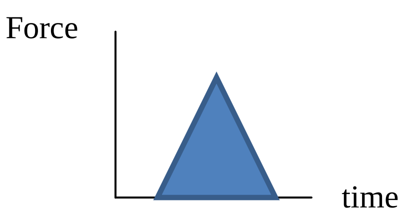


Down is negative direction   up is positive direction

Calculate v_i = ______   Calculate pi = _________

Calculate v_f = ______   Calculate p_f = _________

Calculate $\Delta p = p_f - p_i$ = ____________



Measured area under Force – time graph from CBL/calculator = Impulse = ____________