Momentum Unit Review

Name______________________ Period: ________

1. What is an SI unit of momentum?
   a. N/m b. Nm c. N/s d. Ns
2. A child falls sideways off a sled while sledding on frictionless ice. What happens to the velocity of the sled?
   a. It remains the same.
   b. It decreases significantly.
   c. It increases significantly.
   d. It cannot be determined from the information given.
3. When a cannon fires a cannonball, the cannon will recoil backward because the…
   a. energy of the cannon is greater than the energy of the cannonball.
   b. energy of the cannonball and cannon is conserved.
   c. momentum of the cannonball and cannon is conserved.
   d. momentum of the cannon is greater than the momentum of the cannonball.
4. A rubber ball and a lump of putty have equal mass. They are thrown with equal speed against a wall. The ball bounces back at nearly the same speed with which it hit. The putty sticks to the wall. Which object(s) experience the greater momentum change?
   a. the ball
   b. the putty
   c. Both experience the same momentum change.
   d. It cannot be determined from the information given.
5. Which of the following is an **accurate** statement?
   a. If the kinetic energy of an object is doubled, its momentum will also double.
   b. If an object is acted on by a non-zero external force, its momentum will not remain constant.
   c. The momentum of a moving object is constant.
   d. The momentum of a projectile is constant
6. A 3.0 kg object moves to the right at 4.0 m/s. It collides head-on with a 6.0 kg object moving to the left at 2.0 m/s. Which statement is correct?
   a. The total momentum before the collision is 24 kg·m/s, and after the collision is 0 kg·m/s.
   b. The total momentum both before and after the collision is 24 kg·m/s.
   c. The total momentum both before and after the collision is 0 kg·m/s.
   d. None of the above are true
7. In an elastic collision, if the momentum is conserved, then which of the following statements is true about kinetic energy?
   a. Kinetic energy is gained.
   b. Kinetic energy is also conserved.
   c. Kinetic energy is lost.
   d. None of the above.
8. A 100 kg football linebacker moving at 2.0 m/s tackles head-on an 80 kg halfback running 3.0 m/s. Neglecting the effects due to digging in of cleats…
   a. the halfback will drive the linebacker backward.
   b. the linebacker will drive the halfback backward.
   c. this is a simple example of an elastic collision.
   d. neither player will drive the other player backward.
9. A very light object moving with a speed v collides head-on with a very heavy object at rest, in a frictionless environment. The collision is almost perfectly elastic. The speed of the heavy object after the collision is
   a. slightly greater than v
   b. slightly less than v
   c. much less than v
   d. equal to v

10. In an elastic collision, if the momentum is conserved, then which of the following statements is true about kinetic energy?
    a. Kinetic energy is gained.
    b. Kinetic energy is also conserved.
    c. Kinetic energy is lost.
    d. None of the above.
11. A small object collides with a large object and sticks. Which object experiences the larger magnitude of momentum change?
    a. the small object
    b. the large object
    c. Both objects experience the same magnitude of momentum change.
    d. It cannot be determined from the information given.
12. A 0.060 kg tennis ball, initially moving at a speed of 12m/s, is struck by a racket causing it to rebound in the opposite direction at a speed of 18 m/s. What is the change in momentum of the ball?
    a. 1.1 kg·m/s b. 1.8 kg·m/s c. 0.72 kg·m/s d. 0.36 kg·m/s
13. A constant 8.0 N net force acts for 4.0 s on an 8.0 kg object. What is the object's change of velocity?
    a. 16 m/s b. 8.0 m/s c. 260 m/s d. 4.0 m/s

For #14-17: A bug and the windshield of a fast-moving car collide. Indicate whether each of the following statements is

A. True

B. False.

14. The forces of impact on the bug and on the car are the same size.
15. The impulses on the bug and on the car are the same size.
16. The change in the speed of the bug and the car are the same.
17. The changes in momentum of the bug and the car are the same size.

For #18 and 19: Mighty Mike weighs 200 N and is running down a football field at 8 m/s. Speedy Gonzales weighs only 100 N but runs at 16 m/s, while Ponderous Pancho weighs 400 N and runs only 4 m/s.

18. In an encounter, who will be more effective in stopping Mike?
    a. both the same b. Ponderous Pancho c. Speedy Gonzales
19. Who is more likely to break Mike's bones?
    a. Speedy Gonzales b. both the same c. Ponderous Pancho

For #20-21: Suppose an open railroad car is rolling without friction in a vertically falling downpour and an appreciable amount of rain falls into the car and accumulates there. Consider the effect of the accumulating rain on the momentum and the kinetic energy of the car and the water in the car.

20. The momentum of the car will
    a. Increase b. decrease c. not change

21. The kinetic energy of the car will
    a. Increase b. decrease c. not change

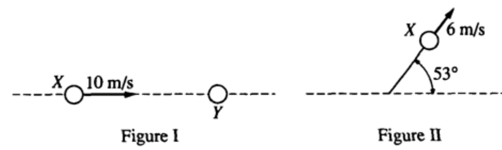
For #22-25: A continuous force is acting on a block that is on a frictionless surface. After the force has acted on the block for some time, the speed of the block has increased a certain amount.

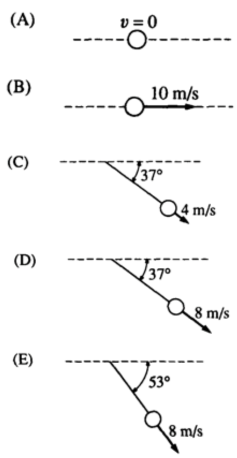
22. If the force and mass of the block are unchanged, but the time the force acts is doubled, the increase in speed will be:
    a. doubled b. four-fold c. unchanged d. tripled e. cut in half
23. Next, if the force and action time are unchanged, but the mass of the block is doubled, then the speed increase will be
    a. unchanged b. cut in half c. four-fold d. cut to one forth e. doubled
24. Now suppose that only the force is doubled while the mass and action time are unchanged. Then the increase in speed will be
    a. cut to one-fourth b. doubled c. four-fold d. unchanged e. cut in half
25. Finally, suppose the applied force, mass, and action time are all as they were initially, but somehow the force of gravity is doubled (i.e. the experiment was carried out on another planet). Then the increase in speed will be
    a. cut in half b. doubled c. unchanged d. cut to one-fourth e. four-fold

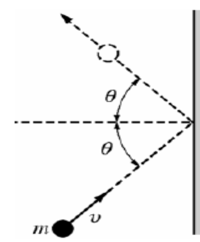
26. Two blocks of masses ***M*** and ***2M*** as shown initially travel at the same speed ***v*** but in opposite directions. They collide and stick together. How much kinetic energy is lost to other forms of energy during the collision?

a. Zero b. ½ Mv^2 c. ¾ Mv^2 d. 4/3 Mv^2 e. 3/2 Mv^2

27. Two balls are on a frictionless horizontal tabletop. Ball X initially moves at 10 meters per second, as shown in Figure I above. It then collides elastically with identical ball Y which is initially at rest. After the collision, ball X moves at 6 meters per second along a path at 53° to its original direction, as shown in Figure II above. Which of the following diagrams best represents the motion of ball Y after the collision?



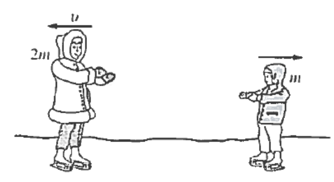




28. A ball of mass ***m*** with speed ***v*** strikes a wall at an angle ***θ*** with the normal, as shown in the diagram on the right. It then rebounds with the same speed and at the same angle. The impulse delivered by the ball to the wall is:

(A) zero (B) mv sin θ (C) mv cos θ (D) 2mv sin θ (E) 2mv cos θ

28. A boy of mass ***m*** and a girl of mass ***2m*** or initially at rest at the center of a frozen pond. They push each other so that she slides to the left at speed ***v*** across the frictionless ice surface and he slides to the right as shown. What is the total work done by the children (the sum of the work of each child)?



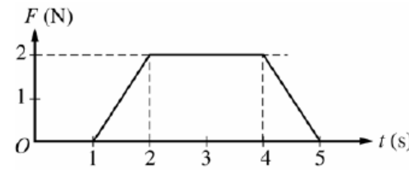
a. Zero b. 1 mv c. 1 mv^2 d. $2mv^2$ e. $3mv^2$

29. A spring is compressed between two objects with unequal masses, ***m*** and ***M***, and held together. The objects are initially at rest on a horizontal frictionless surface. When released, which of the following is true?
(A) Kinetic energy is the same as before begin released.
(B) The total final kinetic energy is zero.
(C) The two objects have equal kinetic energy.
(D) The speed of one object is equal to the speed of the other.
(E) The total final momentum of the two objects is zero.

30. Two toy cars with different masses originally at rest are pushed apart by a spring between them. Which of the following statements would NOT be true?
(A) both toy cars will acquire equal but opposite momenta
(B) both toy cars will acquire equal kinetic energies
(C) the more massive toy car will acquire the least speed
(D) the smaller toy car will experience an acceleration of the greatest magnitude
31. A ball is thrown straight up in the air. When the ball reaches its highest point, which of the following are true?

(A) It has at its point of maximum momentum
(B) It has zero acceleration and therefore at equilibrium
(C) It has zero velocity and therefore zero momentum
(D) It has maximum kinetic energy.
(E) It has maximum gravitational energy.

32. 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. What is the increase, if any, in the velocity of the object during the time the force is applied?

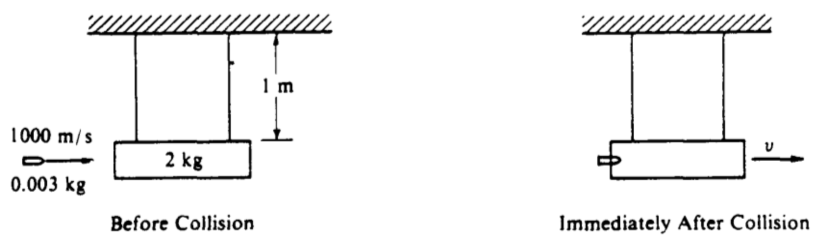


(A) 0 m/s (B) 2.0 m/s (C) 3.0 m/s (D) 4.0 m/s (E) 6.0 m/s

33. An object of mass ***M*** travels along a horizontal air track at a constant speed ***v*** and collides elastically with an object of identical mass that is initially at rest on the track. Which of the following statements is true for the two objects after the impact?
(A) The total momentum is Mv and the total kinetic energy is ½ Mv^2
(B) The total momentum is Mv and the total kinetic energy is less than ½ Mv^2
(C) The total momentum is less than Mv and the total kinetic energy is ½ Mv^2
(D) The momentum of each object is ½ Mv
(E) The kinetic energy of each object is ¼ Mv^2

Written Review

1. A 2 kg block initially hangs at rest at the end of two 1 m strings of negligible mass as shown on the left side of the diagram. A 0.003 kg bullet, moving horizontally with a speed of 1,000 m/s, strikes the block and becomes embedded in it. After the collision, the bullet/ block combination swings upward but does not rotate.

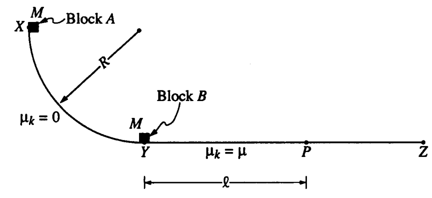


a. Calculate the speed ***v*** of the bullet/ block combination just after the collision.

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.

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

2. 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***.



Side View

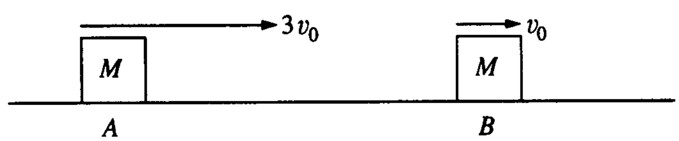
a. Determine the speed of Block A just before it hits Block B.

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

c. Assuming that no energy is transferred to the track or to the air surrounding the blocks. Determine the amount of internal energy transferred in the collision

d. Determine the additional thermal energy that is generated as the blocks move from ***Y*** to ***P***.

3. Two identical objects ***A*** and ***B*** of mass ***M*** move on a one-dimensional, horizontal air track. Object ***B*** initially moves to the right with speed v_o. Object ***A*** initially moves to the right with speed $3v_o$, so that it collides with Object ***B***. Friction is negligible. Express your answers to the following in terms of ***M*** and v_o.



a. Determine the total momentum of the system of the two objects.

b. A student predicts that the collision will be totally inelastic (the objects stick together on collision). Assuming this is true, determine the following for the two objects immediately after the collision.

i. The speed

ii. The direction of motion (left or right)

When the experiment is performed, the student is surprised to observe that the objects separate after the collision and that object B subsequently moves to the right with a speed $2.5v_o$.

c. Determine the following for object A immediately after the collision.

i. The speed

ii. The direction of motion (left or right)

d. Determine the kinetic energy dissipated in the actual experiment.

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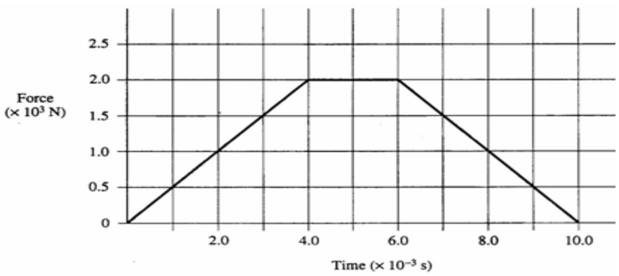
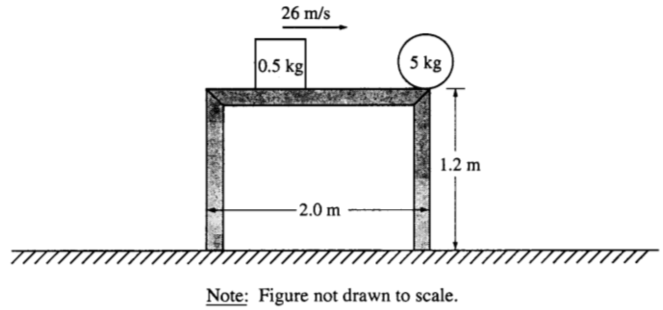
4. A 5 kg ball initially rests at the edge of a 2 m long, 1.2 m high frictionless table, as shown below. A hard plastic cube of mass 0.5 kg slides across the table at a speed of 26 m/s and strikes the ball, causing the ball to leave the table in the direction in which the cube was moving. The figure below shows a graph of the force exerted **on the ball** by the cube as a function of time (in ms!).





a. Determine the total impulse given to the ball.

b. Determine the horizontal velocity of the ball immediately after the collision.

c. Determine the following for the cube immediately after the collision.

i. Its speed

ii. Its direction of travel (right or left), if moving

d. Determine the kinetic energy dissipated in the collision.

e. Determine the distance between the two points of impact of the objects with the floor.