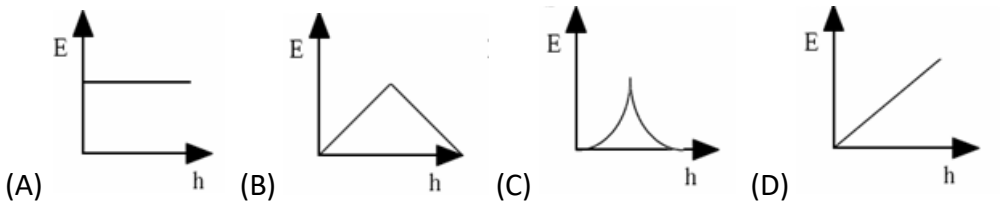
AP Physics – Unit 5 – Momentum & Impulse
Pre-Exam – Unit 5 – MC

1. A car of mass *m*, traveling at speed *v*, stops in time *t* when maximum braking force is applied. Assuming the braking force is independent of mass, what time would be required to stop a car of mass 2*m* traveling at speed *v*?
   (A) ½ *t* (B) *t* (C) √2 *t* (D) 2*t*

2. Two objects, P and Q, have the same momentum. Q can have more kinetic energy than P if it has:
   (A) More mass than P (B) The same mass as P (C) More speed than P (D) The same speed at P

3. A 5000 kg freight car moving at 4 km/hr collides and couples with an 8000 kg freight car which is initially at rest. The approximate common final speed of these two cars is
   (A) 1 km/h (B) 1.3 km/h (C) 1.5 km/h (D) 2.5 km/h

4. A rubber ball is held motionless a height h_o above a hard floor and released. Assuming that the collision with the floor is elastic, which one of the following graphs best shows the relationship between the total energy E of the ball and its height h above the surface.



5. Two carts are held together. Cart 1 is more massive than Cart 2. As they are forced apart by a compressed spring between them, which of the following will have the same magnitude for both carts.
   (A) change of velocity (B) force (C) speed (D) velocity

6. A ball with a mass of 0.50 kg and a speed of 6 m/s collides perpendicularly with a wall and bounces off with a speed of 4 m/s in the opposite direction. What is the magnitude of the impulse acting on the ball?
   (A) 1 Ns (B) 5 Ns (C) 2 m/s (D) 10 m/s

7. A cart with mass 2m has a velocity *v* before it strikes another cart of mass 3m at rest. The two carts couple and move off together with a velocity of
   (A) *v*/5 (B) 2*v*/5 (C) 2*v*/3 (D) $(2/5)^{1/2}\,v$

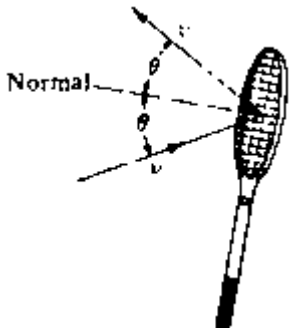
8. A mass m has speed v. It then collides with a stationary object of mass 2m. If both objects stick together in a perfectly inelastic collision, what is the final speed of the newly formed object?
   (A) v/3 (B) v/2 (C) 2v/3 (D) 3v/2

9. A 50 kg skater at rest on a frictionless rink throws a 2 kg ball, giving the ball a velocity of 10 m/s. Which statement describes the skater's subsequent motion?
   (A) 0.4 m/s in the same direction as the ball's motion.
   (B) 0.4 m/s in the opposite direction of the ball's motion.
   (C) 2 m/s in the same direction as the ball's motion.
   (D) 2 m/s in the opposite direction of the ball's motion.

10. A student initially at rest on a frictionless frozen pond throws a 1 kg hammer in one direction. After the throw, the hammer moves off in one direction while the student moves off in the other direction. Which of the following correctly describes the above situation?
   (A) The hammer will have the momentum with the greater magnitude
   (B) The student will have the momentum with the greater magnitude
   (C) The hammer will have the greater kinetic energy
   (D) The student will have the greater kinetic energy

11. Two toy cars with different masses originally at rest are pushed apart by a spring between them. Which TWO of the following statements would 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

12. A tennis ball of mass m rebounds from a racquet with the same speed v as it had initially as shown. The magnitude of the momentum change of the ball is
   (A) 0 (B) 2mv (C) $2mv \sin\theta$ (D) $2mv \cos\theta$



13. 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) $\frac{1}{5}$ (D) $\frac{1}{\sqrt{35}}$

14. **Multiple Correct:** A satellite of mass M moves in a circular orbit of radius R at a constant speed v around the Earth which has mass M_E. Which of the following statements must be true? **Select two answers:**
    (A) The net force on the satellite is equal to $Mv^2/2$ and is directed toward the center of the orbit.
    (B) The net work done on the satellite by gravity in one revolution is zero.
    (C) The angular momentum of the satellite is a constant.
    (D) The net force on the satellite is equal to GMM_E/R

15. 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) The momentum of the objects that are stuck together has a smaller magnitude than the initial momentum of the less-massive object.
    (C) The speed of the objects that are stuck together will be less than the initial speed of the less massive object.
    (D) The direction of motion of the objects that are stuck together depends on whether the hit is a head-on collision

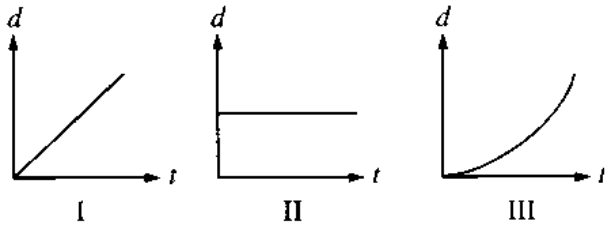
16. Two objects having the same mass travel toward each other on a flat surface each with a speed of 1.0 meter per second relative to the surface. The objects collide head-on and are reported to rebound after the collision, each with a speed of 2.0 meters per second relative to the surface. Which of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

17. 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 1 meter, they both have the same
    (A) inertia (B) speed (C) momentum (D) change in potential energy

18. 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 kinetic energy of the cars immediately after the collision?
    (A) $\frac{1}{2}\, mv^2$ (B) $\frac{1}{2}\,(M+m)(mv/M)^2$ (C) $\frac{1}{2}\,(M+m)(Mv/m)^2$ (D) $\frac{1}{2}\,(M+m)(mv/(m+M))^2$

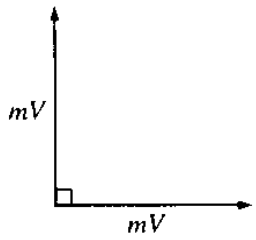
Questions 19-20

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



19. 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

20. The sum of the forces on the object is zero in which of the cases?
    (A) II only (B) III only (C) I and II only (D) I and III only



21. A stationary object explodes, breaking into three pieces of masses *m*, *m*, and *3m*. The two pieces of mass *m* move off at right angles to each other with the same magnitude of momentum mV, as shown in the diagram above. What are the magnitude and direction of the velocity of the piece having mass *3m* ?

Magnitude	Direction
(A) $\frac{V}{\sqrt{2}}$	↗
(B) $\frac{V}{\sqrt{2}}$	↙
(C) $\frac{\sqrt{2}V}{3}$	↗
(D) $\frac{\sqrt{2}V}{3}$	↙

22. Two objects, A and B, initially at rest, are "exploded" apart by the release of a coiled spring that was compressed between them. As they move apart, the velocity of object A is 5 m/s and the velocity of object B is – 2 m/s. The ratio of the mass of object A to the mass object B, m_a/m_b is

(A) 4/25 (B) 2/5 (C) 5/2 (D) 25/4

23. The two blocks of masses M and 2M shown above initially travel at the same speed v but in opposite directions. They collide and stick together. How much mechanical energy is lost to other forms of energy during the collision?

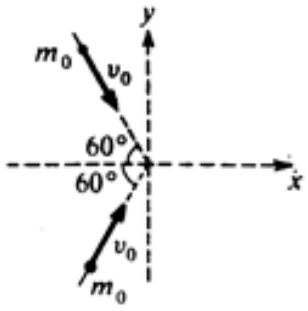
(A) 1/2 M v^2

(B) 3/4 M v^2

(C) 4/3 M v^2

(D) 3/2 M v^2

24. Two particles of equal mass m_o, moving with equal speeds v_o along paths inclined at 60° to the x-axis as shown, collide and stick together. Their velocity after the collision has magnitude



(A) $\frac{v_0}{4}$ (B) $\frac{v_0}{2}$ (C) $\frac{\sqrt{3}v_0}{2}$ (D) v_o

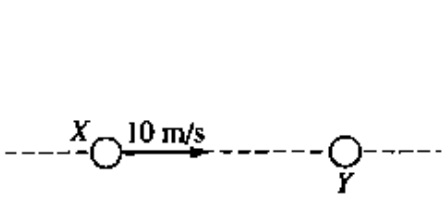


Figure I

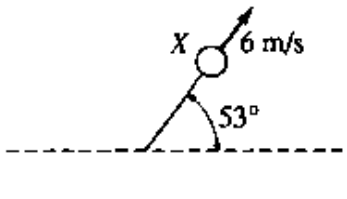
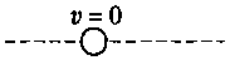
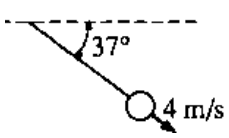
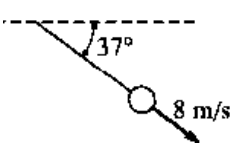


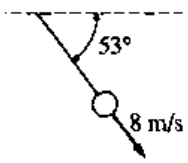
Figure II

25. 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?

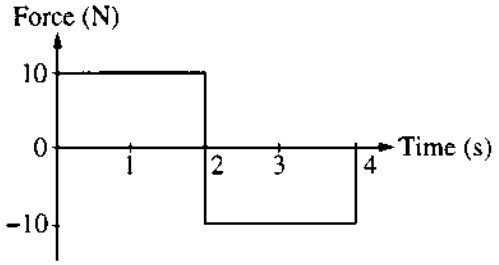
(A) 

(B) 

(C) 

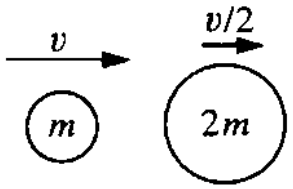
(D) 

26. The graph shows the force on an object of mass M as a function of time. For the time interval 0 to 4 s, the total change in the momentum of the object is



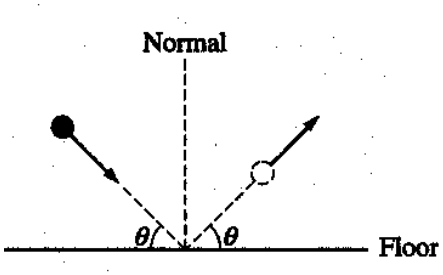
(A) 40 kg m/s (B) 20 kg m/s
(C) 0 kg m/s (D) – 20 kg m/s

27. As shown in the top view, a disc of mass *m* is moving horizontally to the right with speed *v* on a table with negligible friction when it collides with a second disc of mass 2*m*. The second disc is moving horizontally to the right with speed *v*/2 at the moment before impact. The two discs stick together upon impact. The kinetic energy of the composite body immediately after the collision is



Top View

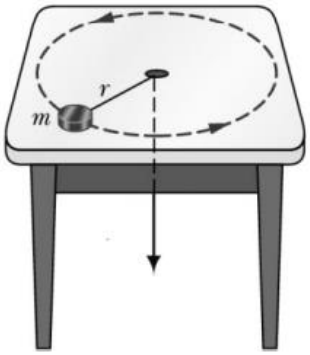
(A) $(1/6)mv^2$ (B) $(1/2)mv^2$ (C) $2/3mv^2$ (D) $(9/8)mv^2$



28. A 2 kg ball collides with the floor at an angle θ and rebounds at the same angle and speed as shown above. Which of the following vectors represents the impulse exerted on the ball by the floor?

(A) ↘ (B) → (C) ↗ (D) ↑

29. An object *m*, on the end of a string, moves in a circle (initially of radius *r)* on a horizontal frictionless table as shown. As the string is pulled very slowly through a small hole in the table, which of the following is correct for an observer measuring from the hole in the table?
(A) The angular momentum of *m* remains constant.
(B) The angular momentum of *m* decreases.
(C) The kinetic energy of *m* remains constant
(D) The kinetic energy of *m* decreases



30. A boy of mass *m* and a girl of mass 2*m* are 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. What is the total work done by the children?
(A) mv (B) mv^2 (C) $2mv^2$ (D) $3mv^2$