MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

1) A rubber ball and a lump of clay have equal mass. They are thrown with equal speed against a wall. The ball bounces back with nearly the same speed with which it hit. The clay sticks to the wall. Which one of these objects experiences the greater momentum change?
   A) the clay
   B) the ball
   C) Both of them experience the same non-zero momentum change.
   D) Both of them experience zero momentum change.  

2) A small car meshes with a large truck in a head–on collision. Which of the following statements concerning the magnitude of the momentum change during the collision is correct? (There could be more than one correct choice.)
   A) The magnitude of the momentum change experienced by each is inversely proportional to its mass.
   B) The magnitude of the momentum change experienced by each is directly proportional to its mass.
   C) The truck experiences the greater magnitude momentum change.
   D) The small car experiences the greater magnitude momentum change.
   E) The small car and the truck experience the same magnitude momentum change.

3) A rocket explodes into two fragments, one 25 times heavier than the other. The magnitude of the momentum change of the lighter fragment is
   A) 25 times as great as the momentum change of the heavier fragment.
   B) 1/25 as great as the momentum change of the heavier fragment.
   C) 5 times as great as the momentum change of the heavier fragment.
   D) The same as the momentum change of the heavier fragment.
   E) 1/4 as great as the momentum change of the heavier fragment.

4) In the figure, determine the character of the collision. The masses of the blocks, and the velocities before and after, are shown. The collision is

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<th>1.6 m/s</th>
<th>0.2 m/s</th>
<th>0.6 m/s</th>
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A) completely inelastic.
B) perfectly elastic.
C) characterized by an increase in kinetic energy.
D) not possible because momentum is not conserved.

5) A rubber ball bounces off of a wall with an initial speed \( v \) and reverses its direction so its speed is \( -v \) right after the bounce. As a result of this bounce, which of the following quantities of the ball are conserved? (There could be more than one correct choice.)
   A) the momentum of the ball
   B) both the momentum and the kinetic energy of the ball
   C) the kinetic energy of the ball
   D) None of the above quantities are conserved.
6) If you want to double the momentum of a gas molecule, by what factor must you increase its kinetic energy?
   A) \(2\sqrt{2}\)  
   B) 4  
   C) 16  
   D) \(\sqrt{2}\)  
   E) 2

7) Three objects are moving along a straight line as shown in the figure. Taking the positive direction to be to the right, what is the total momentum of this system?
   \[5.00 \text{ m/s} \quad 4.00 \text{ m/s} \quad 2.00 \text{ m/s}\]
   - 8.00 kg
   - 15.0 kg
   - 3.00 kg
   A) 0.00 kg \cdot \text{m/s}  
   B) +106 kg \cdot \text{m/s}  
   C) -106 kg \cdot \text{m/s}  
   D) -14.0 kg \cdot \text{m/s}  
   E) +14.0 kg \cdot \text{m/s}

8) A 0.10-kg ball, traveling horizontally at 25 m/s, strikes a wall and rebounds at 19 m/s. What is the magnitude of the change in the momentum of the ball during the rebound?
   A) 72 kg \cdot \text{m/s}  
   B) 1.8 kg \cdot \text{m/s}  
   C) 1.2 kg \cdot \text{m/s}  
   D) 4.4 kg \cdot \text{m/s}  
   E) 5.4 kg \cdot \text{m/s}

9) Two ice skaters suddenly push off against one another starting from a stationary position. The 45-kg skater acquires a speed of 0.375 m/s relative to the ice. What speed does the 60-kg skater acquire relative to the ice?
   A) 0.38 m/s  
   B) 0.00 m/s  
   C) 0.50 m/s  
   D) 0.28 m/s  
   E) 0.75 m/s

10) The graph in the figure shows the \(x\) component \(F\) of the net force that acts for 10 s on a 100-kg crate. What is the change in the momentum of the crate during the 10 s that this force acts?
   \[F\]
   \[0\]  
   \[5.0\]  
   \[10\]
   \[\text{t}\]
   A) 25 kg \cdot \text{m/s}  
   B) -100 kg \cdot \text{m/s}  
   C) -75 kg \cdot \text{m/s}  
   D) -25 kg \cdot \text{m/s}  
   E) 75 kg \cdot \text{m/s}
11) A super dart of mass 20 g, traveling at 350 m/s, strikes a steel plate at an angle of 30° with the plane of the plate, as shown in the figure. It bounces off the plate at the same angle but at a speed of 320 m/s. What is the magnitude of the impulse that the plate gives to the bullet?

A) 4.3 N \cdot s  
B) 6.7 N \cdot s  
C) 0.30 N \cdot s  
D) 300 N \cdot s  
E) 0.52 N \cdot s

12) A golf club exerts an average horizontal force of 1000 N on a 0.045-kg golf ball that is initially at rest on the tee. The club is in contact with the ball for 1.8 ms. What is the speed of the golf ball just as it leaves the tee?

A) 30 m/s  
B) 45 m/s  
C) 35 m/s  
D) 50 m/s  
E) 40 m/s

13) A block of mass $m = 34$ kg and speed $V$ is behind a block of mass $M = 81$ kg and speed of 0.50 m/s, as shown in the figure. The surface is frictionless and the blocks collide and couple. After the collision, the blocks have a common speed of 0.90 m/s. What is the magnitude of the impulse on the 34-kg block due to the collision?

A) 41 N \cdot s  
B) 14 N \cdot s  
C) 57 N \cdot s  
D) 32 N \cdot s  
E) 73 N \cdot s

14) A block of mass $m = 4.4$ kg, moving on frictionless surface with a speed $v_i = 9.2$ m/s, makes a sudden perfectly elastic collision with a second block of mass $M$, as shown in the figure. The second block is originally at rest. Just after the collision, the 4.4-kg block recoils with a speed of $v_f = 2.5$ m/s. What is the mass $M$ of the second block?

A) 0 kg  
B) 0 kg  
C) 0 kg  
D) 7.7 kg  
E) 0 kg
15) As shown in the figure, a bullet of mass 0.010 kg moving horizontally suddenly strikes a block of wood of mass 1.5 kg that is suspended as a pendulum. The bullet lodges in the wood, and together they swing upward a vertical distance of 0.40 m. The length of the string is 2.0 m. What was the speed of the bullet just before it struck the wooden block?

A) 67 m/s  B) 420 m/s  C) 650 m/s  D) 250 m/s  E) 370 m/s

16) In the figure, four point masses are placed as shown. Assume that all the numbers in the figure are accurate to two significant figures. What are the x and y coordinates of the center of mass (or center of gravity) of this arrangement?

A) (2.3 m, 2.6 m)  B) (2.3 m, 2.8 m)  C) (2.2 m, 2.7 m)  D) (2.2 m, 2.6 m)  E) (2.3 m, 2.7 m)

17) Consider two less-than-desirable options. In the first you are driving 30 mph and crash head-on into an identical car also going 30 mph. In the second option you are driving 30 mph and crash head-on into a stationary brick wall. In neither case does your car bounce back from the thing it hits, and the collision time is the same in both cases. Which of these two situations would result in the greater impact force on your car?

A) hitting the other car  B) The force would be the same in both cases.  C) hitting the brick wall  D) None of the above choices are correct.

18) During World War I, Germany used a "Big Bertha" cannon to hurl shells into Paris 30 miles away. This gun also had a very long barrel. What was the reason for using a long barrel in these guns?

A) to increase the force exerted on the bullet due to the expanding gases from the gunpowder  B) to reduce the force exerted on the bullet due to the expanding gases from the gunpowder  C) to exert a larger force on the shells  D) to reduce frictional losses  E) to allow the force of the expanding gases from the gunpowder to act for a longer time
19) Two friends are standing on opposite ends of a canoe that is initially at rest with respect to a frictionless lake. The person in the front throws a very massive ball toward the back, and the person in the back catches it. After the ball is caught, the canoe is
A) moving forward.  B) moving backward.  C) stationary.

20) A small car meshes with a large truck in a head–on collision. Which of the following statements concerning the momentum during the collision are correct? (There could be more than one correct choice.)
A) The momentum of the truck is conserved.  
B) The car and the truck must undergo the same change in speed.  
C) The momentum of the car is conserved.  
D) The momentum of the car–truck system is conserved, but the momentum of each one separately is not conserved.  
E) The momentum of the car and the momentum of the truck are each conserved.

21) You are standing on a skateboard, initially at rest. A friend throws a very heavy ball towards you. You have two choices about what to do with the ball: either catch the ball or deflect it back toward your friend with the same speed as it was originally thrown. Which choice should you make in order to maximize your speed on the skateboard?
A) Deflect the ball back.  
B) Catch the ball.  
C) Your final speed on the skateboard will be the same regardless whether you catch the ball or deflect the ball.

22) A very elastic rubber ball is dropped from a certain height and hits the floor with a downward speed $v$. Since it is so elastic, the ball bounces back with the same speed $v$ going upward. Which of the following statements about the bounce are correct? (There could be more than one correct choice.)
A) The ball's momentum was conserved during the bounce.  
B) The ball had the same momentum just before and just after the bounce.  
C) The magnitude of the ball's momentum was the same just before and just after the bounce.  
D) None of the above statements are correct.

23) Three cars, car X, car Y, and car Z, begin accelerating from rest at the same time. Car X is more massive than car Y, which is more massive than car Z. The net accelerating force exerted on each car is identical. After 10 seconds, which car has the most amount of momentum?
A) They all have the same amount of momentum.  
B) Car X  
C) Car Y  
D) Car Z

24) A rocket explodes into two fragments, one 25 times heavier than the other. The magnitude of the momentum change of the lighter fragment is
A) The same as the momentum change of the heavier fragment.  
B) 1/4 as great as the momentum change of the heavier fragment.  
C) 5 times as great as the momentum change of the heavier fragment.  
D) 25 times as great as the momentum change of the heavier fragment.  
E) 1/25 as great as the momentum change of the heavier fragment.
25) A 1200-kg car moving at 15.6 m/s suddenly collides with a stationary car of mass 1500 kg. If the two vehicles lock together, what is their combined velocity immediately after the collision?
   A) 6.9 m/s    B) 5.5 m/s    C) 8.6 m/s    D) 12.1 m/s

26) A 5-kg ball collides inelastically head-on with a 10-kg ball, which is initially stationary. Which of the following statements is true? (There could be more than one correct choice.)
   A) The magnitude of the change of the momentum of the 5-kg ball is equal to the magnitude of the change of momentum of the 10-kg ball.
   B) The magnitude of the change of velocity the 5-kg ball experiences is less than that of the 10-kg ball.
   C) The magnitude of the change of velocity the 5-kg ball experiences is equal to that of the 10-kg ball.
   D) The magnitude of the change of velocity the 5-kg ball experiences is greater than that of the 10-kg ball.
   E) Both balls lose all their momentum since the collision is inelastic.

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

27) A 2200-kg auto moving northward at 12.0 m/s runs into a 3800-kg truck which is also moving northward, but at 5.00 m/s. If the vehicles lock bumpers, how fast are they moving just after the collision?

28) An 80-kg man is skating northward and happens to suddenly collide with a 20-kg boy who is ice skating toward the east. Immediately after the collision, the man and boy are seen to be moving together at 2.5 m/s in a direction 60° north of east. How fast was the boy moving just before the collision?

29) In a police ballistics test, a 2.00-g bullet traveling at 700 m/s suddenly hits and becomes embedded in a stationary 5.00-kg wood block. What is the speed of the block immediately after the bullet has stopped moving relative to the block?

30) A 475-gram ball is traveling horizontally at 12.0 m/s to the left when it is suddenly struck horizontally by a bat, causing it to reverse direction and initially travel at 8.50 m/s to the right. If the bat produced an average force of 1275 N on the ball, for how long (in milliseconds) was it in contact with the ball?

31) Jennifer hits a stationary 0.20-kg ball, and it leaves her racket at 40 m/s. Time-lapse photography shows that the ball was in contact with the racket for 40 ms.
   (a) What average force did the ball exert on the racket?
   (b) What is the ratio of this force to the weight of the ball?
32) Find the magnitude and direction of the net momentum of the system shown in the figure. Express the direction by giving the angle the net momentum makes with the $+x$-axis.
Answer Key
Testname: MOMENTUM AND IMPULSE PRACTICE TEST

1) B
2) E
3) D
4) B
5) C
6) B
7) D
8) D
9) D
10) C
11) B
12) E
13) D
14) D
15) B
16) B
17) B
18) E
19) C
20) D
21) A
22) C
23) A
24) A
25) A
26) A, D
27) 7.57 m/s
28) 6.3 m/s
29) 0.280 m/s
30) 7.64 ms
31) (a) 0.20 kN (b) 100
32) 123 kg m/s, 212°