Momentum Unit Test Sample Name: Key

Multiple Choice. Select the best response to each question below.

1. Momentum is an important quantity in physics because it tells you about an object's
   a. Mass
   b. Direction of motion
   c. Speed
   d. All of the above

$\vec{p} = m\vec{v}$

2. Which has the greatest momentum?
   a. A skateboard (m = 10.0 kg) slowly rolling up a hill.
   b. A semi-truck (m = 9000 kg) parked at Hardee's. — $p = 0$
   c. A Honda Civic (m = 1000 kg) cruising down I-65. ✓
   d. They all have the same momentum.

3. A pitcher throws a baseball towards a batter at a speed of +35.0 m/s. Which of the following situations represents the highest impulse applied to the ball?
   a. The catcher bringing the ball to a clean, dead stop.
   b. The batter bunting the ball back toward the pitcher at -5.0 m/s.
   c. The batter hitting a line drive over the pitcher at -50.0 m/s.
   d. The all have the same impulse.

largest impulse implies greatest change in momentum

4. How much force is necessary to bring a 0.50 kg ball moving at 10.0 m/s to a stop in 0.20 seconds?
   a. 25 N
   b. 10.7 N
   c. 1.0 N
   d. 0.010 N

$Ft = m(v_f - v_i)$

$F(.20s) = (.50kg)(0 - 10.0m/s)$

$F(.20s) = -5\ kg\ m/s$

$5/2 = 25$

5. Automotive engineers need to design a car that minimizes the force on the car during a collision. Which of the following ideas would be most successful?
   a. Increasing the amount of time of the collision by making bumpers that compress and crumple
   b. Strengthening the bumpers of the car so that the car will bounce in the opposite direction in a crash
   c. Adding weights to the rear of the car to increase the car's inertia
   d. Using 22-inch tires instead of 18-inch tires

more time to stop = less force required

6. During the Great Snow Storm of 2015, your car is stuck in the snow. You sit inside your car and push against the dashboard with a force of +150 N. Which of the following is true?
   a. The total momentum of the car (with you inside) is conserved.
   b. The dashboard pushes on your hand with a force of -150 N.
   c. There are no external forces so the car (with you inside) does not accelerate.
   d. All of the above.

7. A 38 kg kid sitting motionless on a playground swing catches a 2 kg ball moving horizontally at 5 m/sec. How fast will the combination kid-and-ball move just after the catch?
   a. 0.25 m/s
   b. 0.50 m/s
   c. 1.0 m/s
   d. 2.0 m/s

$mv + mv = mv$

$(38)(0) + (2)(5) = (38+2)(v)$

$10 = 40v \quad v = .25 m/s$

8. Consider a soccer ball sliding on a frozen lake (frictionless) towards a stationary basketball. For which system is momentum conserved before and after the collision?
   a. Soccer Ball System
   b. Basketball System
   c. Soccer Ball—Basketball System
   d. Momentum is conserved for any system

$P_{soccer\ ball}$ will change

$P_{basketball}$ will change

$P_{Soc.+basketball}$ = will remain same.

Puzzles (Show all calculations and equations..)

9. A car with mass 1500 kg moves at 25 m/s. Use the impulse-momentum theorem to determine the final speed of the car if a braking force of 2900 N is applied for 11 s in order to decrease its speed.

$Ft = m(v_f - v_i)$

$-(2900N)(11s) = 1500(v_f - 25m/s)$

$-31900\ N\cdot s = 1500v_f - 37{,}500$

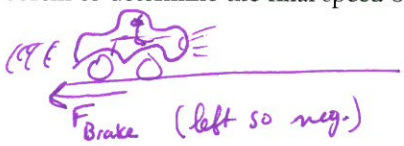
$+37{,}500 \qquad +37{,}500$

$5600 = 1500v_f$

$v_f = 3.73$

2 s.g figs.

3.7 m/s



10. A 150 g dart moving horizontally at 14 m/s strikes and sticks to a stationary wood block of mass 8850 g, which then slides across a friction-free level surface. What is the speed of the block and dart after the collision?

Conserve $\vec{p}$ (inelastic collision)

$mv + mv = mv$

$(150g)(14) + (8850)(0) = (8850+150)(v)$

$2100 = 9000v$

$9000 \qquad 9000$

$v = 0.23$ 2 s.g. figs.

0.23 m/s

11. Physics often "takes a back seat" in comic books like Superman. But let's take physics into account in the following situation: Imagine Superman (m = 125 kg) is simply holding an asteroid (m = 125,000 kg) in outer space. In the comic, Superman throws the asteroid forward at 1.00 x 10^2 m/s and is at rest afterward...but what does physics say Superman's recoil speed *should* be?

"explosion", conserve $\vec{p}$

$mv = mv + mv$

$(125{,}125kg)(0) = (125{,}000\,kg)(100\,m/s) + (125kg)(v)$

$0 = 12{,}500{,}000 + 125v$

$-12{,}500{,}000 = 125v$

$\frac{-12{,}500{,}000}{125} = v$

$v = 100{,}000\ m/s$!

3 s.f.

$1.00 \times 10^5\ m/s$

12. Two green Vernier low-friction dynamics carts are on a black track. One cart of mass 1.03kg is at rest in the middle of the track. A second cart of mass 0.515 kg is moving at +2.00 m/s and collides elastically with the other cart. The after collision velocity of the 1.03 kg cart is +1.33 m/s. Find the after collision velocity of the 0.515 kg cart.

"elastic" Collision - conserve $\vec{p}$

$mv + mv = mv + mv$

$(.515)(2) + (1.03)(0) = (.515)(v) + (1.03)(1.33)$

$1.03 = .515v + 1.3699$

$-1.3699 \qquad -1.3699$

$-.3399 = .515v$

$\frac{-.3399}{.515} = \frac{.515v}{.515}$

$v = -0.66\ m/s$

3 s.g. figs

$-0.660\ m/s$