momentum mass velocity change in momentum

Physics 100
Momentum and Impulse Practice Quiz

Name: Answers

Formulas: $p = mv$ $Ft = \Delta p$ $Ft = m\Delta v$ mass x change in velocity

impulse

1. Impulse is equal to the change of
   - A. Velocity
   - B. Mass
   - C. Force
   - [✓ D. Momentum]
   - E. Force x Velocity

2. An object's momentum is always equal to
   - A. its average acceleration
   - B. the force applied to the object
   - C. its velocity multiplied by the applied force
   - D. the impulse imparted to the object
   - E. Work done on the object
   - [✓ E. its mass multiplied by its velocity]

3. The change in an object's momentum is equal to
   - A. its average acceleration
   - B. the force applied to the object
   - C. its velocity multiplied by the applied force
   - [✓ D. the impulse imparted to the object]
   - E. Work done on the object
   - E. its mass multiplied by its velocity

4. The correct units for momentum are:
   [✓ a. kgm/s] b. Nm/s c. kgm/s² d. Nm/s²

5-7. Three eggs of equal mass are thrown with the same horizontal velocity at three different walls. The walls are identical in every aspect except for their hardness. The first egg splatters against a hard wall and comes to a stop. The second egg hits a soft wall and comes to a stop without splattering. The third egg bounces backward off of a springy wall.

5. Compared to the first egg (hard wall), the second egg (soft wall) experiences…
   - a. Greater force and the same impulse
   - [✓ b. Less force and the same impulse] $\Delta p = Ft$
   - c. Greater force and greater impulse
   - d. Less force and greater impulse
   - e. Same force and impulse

6. Which egg experiences the greatest change in momentum?
   A. First egg B. Second egg [✓ C. Third egg] D. None of them

7. Now consider the walls in number 4. Which wall is most likely to be knocked over by the egg impact?
   a. Hard wall b. Soft wall [✓ c. Springy wall] d. None of them

8. A 1kg ball is dropped to the ground. It hits the ground with a velocity of -6m/s and bounces back up with a velocity of +4m/s. What impulse did the ball experience?
   A. -2kgm/s B. 4 kgm/s C. -6kgm/s [✓ D. 10kgm/s] E. 24kgm/s

$p = mv$

$\Delta Ft = \Delta p$

$p_0 = 1kg(-6m/s) = -6kgm/s$

$\Delta Ft = m\Delta v$

$p_f = 1kg(4m/s) = 4kgm/s$

$= (1kg)\,10m/s = 10kgm/s$

$\Delta p = p_f - p_0 = 4kgm/s - (-6kgm/s)$

$= 10kgm/s$

$p = mv = 1200\text{kg}(30\text{m/s}) = 36000\text{kgm/s}$

9. A 1,200-kilogram car traveling at 30 meters per second hits a huge pile of cardboard boxes and is brought to rest in 6 seconds. What is the magnitude of the average force acting on the car to bring it to rest?
A. 6×10^2 N B. 6×10^3 N C. 6×10^4 N D. 6×10^5 N E. 6×10^6 N

$Ft = \Delta p$

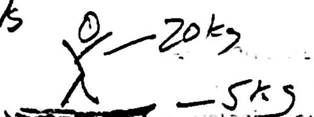
$F = \frac{\Delta p}{t} = \frac{36{,}000\text{kgm/s}}{6s} = \boxed{6{,}000N}$

10. A 20kg child is riding a long board. The mass of the long board is 5kg. Both the child and the long board are traveling leftward. Their velocities are both -5m/s. As the child jumps off the long board, the long board speeds up to a velocity of -9m/s. What is the child's new velocity when she jumps off (before she hits the ground). ~~You can~~ ignore air resistance.

$\boxed{V = -4\text{m/s}}$

Before

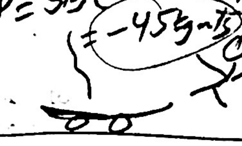
$V = -5\text{m/s}$



$P_{Net} = 25\text{kg}(-5\text{m/s}) = -125\text{kgm/s}$ ⟹ $P_{Net} = -125\text{kgm/s}$

After

$p = 5\text{kg}(-9\text{m/s}) = -45\text{kgm/s}$



$p = -125\text{kgm/s} - (-45\text{kgm/s}) = -80\text{kgm/s}$

$p = mv$

$v = \frac{p}{m} = \frac{-80\text{kgm/s}}{20\text{kg}} = -4\text{m/s}$

11. A bocce ball was rolling with a velocity of 4m/s. The ball collided with a traffic cone, which applied a force of -5N to the bocce ball. The force lasted for 0.1 seconds, and the mass of the bocce ball was 0.8kg.

a. What impulse was applied to the ball before the collision?

Impulse $= Ft = -5N(0.1s) = \boxed{-0.5Ns}$

b. What was the ball's momentum before the collision?

$P_0 = mv = 0.8\text{kg}(4\text{m/s}) = \boxed{3.2\text{kgm/s}}$

c. What was the ball's momentum after the collision?

$Ft = \Delta p \Rightarrow -0.5Ns = \Delta p$

$P_{New} = P_0 - 0.5Ns$
$= 3.2\text{kgm/s} - 0.5\text{kgm/s}$
$= \boxed{2.7\text{kgm/s}}$

d. What was the ball's velocity after the collision?

$p = mv$

$v = \frac{p}{m} = \frac{2.7\text{kgm/s}}{0.8\text{kg}} = \boxed{3.38\text{m/s}}$

12. Use the concepts of momentum, impulse, force, and time to explain how airbags decrease injuries during a collision.

Air bags lengthen impact time, thereby reducing the impact force necessary to stop a human. This safely provides enough impulse (Ft) to decrease the driver's momentum to zero.

$\Delta p = Ft$
impulse