Key

Physics 100
Momentum and Impulse Practice

Formulas: $p = mv$ $Ft = \Delta p$ $Ft = m\Delta v$ $\Delta p = p_{final} - p_{initial}$

Short Answer:

1. Define momentum Inertia in motion; something's tendency to keep moving
2. State the law of conservation of momentum.
The net momentum in any system remains constant.
3. What are the units for momentum? kg m/s
4. What is the symbol for momentum? p
5. Define impulse.
A force applied during a time interval
Impulse = Ft
5. What are the units for impulse?
Ns or kg m/s

Problems:

6. A 7kg object has a velocity of -4m/s. What is its momentum?
$p = mv = 7kg(-4m/s) = -28 kg\,m/s$

7. 0.65kg basketball is moving with a velocity of 3m/s. It collides with a stationary 0.05kg tennis ball, transferring half of its momentum to the tennis ball.

   a. What is the basketball's velocity after the collision?
$p_{before} = 0.65kg(3m/s) = 1.95 kg\,m/s$ $\frac{1.95 kg\,m/s}{2} = 0.975 kg\,m/s$

   b. What is the tennis ball's velocity after the collision?
$p = mv$ $v = \frac{p}{m} = \frac{0.975 kg\,m/s}{0.05kg} = 19.5 m/s$

8. An impulse of 6kgm/s is applied to a mouse. What is the mouse's change in momentum?
$Ft = \Delta p \Rightarrow 6 kg\,m/s = \Delta p$
↑ impulse

9. A 1,000kg car accelerates from 20m/s to 50m/s.

a. What is the car's Δp? $\Delta p = p_{final} - p_{initial}$

$1000kg(50m/s) - 1000kg(20m/s) = 30,000 kg\,m/s$

b. If this acceleration takes place over a 30 second time period, what force is being applied?

$Ft = \Delta p \qquad F = \frac{\Delta p}{t} = \frac{30,000 kg\,m/s}{30s} = 1000N$

10. Starting from rest, a 200kg motorcycle accelerates over a distance of 90m in a time of 4 seconds, reaching a velocity of 40m/s. Immediately after that, the motorcycle crashes into a series of cardboard boxes and comes to rest in a time of 3 seconds.

a. What is the motorcycle's Δp during its **acceleration** period?

$\Delta p = p_f - p_i = 200kg(40m/s) - 0 = 8,000\ kg\,m/s$

b. What is the motorcycle's Δp during its **deceleration** period?

$\Delta p = p_f - p_i = 0 - 200kg(40m/s) = -8,000\ kg\,m/s$

c. What average net force caused the motorcycle's acceleration?

$Ft = \Delta p$  $F = \frac{\Delta p}{t} = \frac{8000\ kg\,m/s}{4s} = 2000N$

i. What average net force caused the motorcycle's deceleration?

$F = \frac{\Delta p}{t} = \frac{-8000 kg\,m/s}{3s} = -2,670N$

11. Car A has a velocity of -10m/s and a mass of 500kg. Car B has a mass of 800kg and a velocity of 6m/s. If the two cars collide and stick together, what is their shared velocity after the collision?

$p_{Net\ After} = p_{Net\ Before} \qquad p = mv \Rightarrow v = \frac{p}{m}$

$(-10m/s)(500kg) + (800kg)(6m/s) = 1300kg(V) \Rightarrow -5000kg\,m/s + 4800kg\,m/s = 1300kg(V)$

$-200kg\,m/s = 1300kg(V)$

$V = -0.154m/s$

12. Suppose a 3kg steel sphere is moving with a velocity of 4m/s. The steel sphere strikes a second stationary sphere with a mass of 2kg and a velocity of 2m/s. After the collision, the 3kg sphere has a velocity of 3m/s.

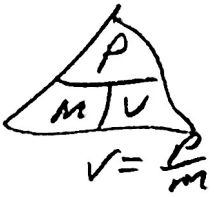
a. What is the net momentum of this system before the collision?

$3kg(4m/s) + 2kg(2m/s) = 12kg\,m/s + 4kg\,m/s = 16kg\,m/s$

b. What is the net momentum of this system after the collision?

$16kg\,m/s$

c. What is the velocity of the 2kg steel sphere, after the collision?



$16kg\,m/s = 3kg(3m/s) + 2kg(v)$

$16kg\,m/s = 9kg\,m/s + 2kg(v)$

$7kg\,m/s = 2kg(v) \Rightarrow v = \frac{7kg\,m/s}{2kg} = 3.5m/s$