Momentum
(Chapter 5 - Page 195)

Momentum - "quantity of motion"
- measure of an object's ability to resist a change in its motion
- how much "oomph" an object has
- the product of an object's mass and its velocity

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

p -> momentum (kgm/s)
m -> mass (kg)
v -> velocity (m/s)

Momentum is a vector quantity. It has the same direction as the velocity of the object.

Model Problem - Page 197

Determine the momentum of a 0.300 kg hockey puck travelling across the ice at a velocity of 5.55 m/s, north. (1.67 kgm/s, north)

$m = 0.300\text{ Kg}$
$v = 5.55\text{ m/s}$

$p = mv$
$= (0.300)(5.55\text{ m/s})$
$\boxed{= 1.67\text{ Kg m/s}}$

Example:

Determine the mass of an object that has a momentum of 8.39 x 10^7 kgm/s [S] and a velocity of 755 km/h south.
(4.00 x 10^5 kg)

$m = ?$
$p = 8.39 \times 10^7\text{ Kg}\,\underline{\text{m/s}}$
$v = 755\text{ Km/h} \div 3.6 = 209\text{ m/s}$

$p = mv$

$$\frac{8.39 \times 10^7\text{ Kg}\,\cancel{\text{m/s}}}{209\,\cancel{\text{m/s}}} = \frac{m(209\text{ m/s})}{209\text{ m/s}}$$

$$\boxed{4.0 \times 10^5\text{ Kg}}$$

Impulse

(Page 198)

Starting with Newton's second law of motion, we can derive a formula for impulse which is the product of the force exerted on an object and the time interval over which the force acts.

Impluse = $F \times t$

$\mathbf{F} = m\mathbf{a}$

v_f = Final

v_0 = Initial

t = time

Remember: $\mathbf{a} = \dfrac{\mathbf{v}_f - \mathbf{v}_0}{t}$

$$F = ma$$

$$F \overset{\times t}{=} m\frac{(v_f - v_0)}{t} \times t$$

$$Ft = m(v_f - v_0)$$

$$\underset{\text{Impulse}}{Ft} = \underbrace{\underbrace{mv_f}_{\text{Final momentum}} - \underbrace{mv_0}_{\text{Initial momentum}}}_{\Delta P \text{ change in momentum}}$$

$$Ft = \Delta P$$

$$Ft = m(v_f - v_0)$$

Impulse is a vector quantity and has the same direction as the force that causes it.

Average forces are used for short intense interactions.

Textbook: Page 200, PP #30-32

It is difficult to make precise measurements of force and time in order to calculate impulse.

Impulse - Momentum Theorem

$$Ft = m(v_f - v_0)$$

Textbook: Page 203, PP #33-34

$\#35$

$\mathbf{J} = \mathbf{F}t$

Start with $\mathbf{J} = \mathbf{F}t$.

Using this form of the equation, impulse has the same direction as the change in momentum of the object.

30. A sledgehammer strikes a spike with an average force of 2125 N[down] over a time interval of 0.0205 s. Calculate the impulse of the interaction.

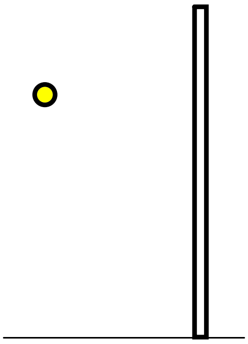
31. In a crash test, a car strikes a wall with an average force of 1.23×10^7 N[S] over an interval of 21.0 ms. Calculate the impulse.

÷1000 = seconds

32. In a crash test similar to the one described in problem 31, another car, with the same mass and velocity as the first car, experiences an impulse identical to the value you calculated in problem 31. However, the second car was designed to crumple more slowly than the first. As a result, the duration of the interaction was 57.1 ms. Determine the average force exerted on the second car.

Model Problem - Page 201

A student practices her tennis volleys by hitting a tennis ball against a wall.
a) If the 0.060 kg ball travels 48 m/s before hitting the wall and then bounces directly backward at 35 m/s, what is the impulse of the interaction? (-5.0 kgm/s)
b) If the duration of the interaction is 25 ms, what is the average force exerted on the ball by the wall? (-2.0 x 10^2 N)



Textbook: Page 208, #37-45

Attachments

Song - Momentum.jpg