Momentum

Inertia of a moving object

How much it wants to keep moving
"Quantity of motion"

Property (tendency) of moving matter

https://www.youtube.com/watch?v=Lg2dqFCU67Q

Completes our understanding of Newton's 1st Law

Momentum

$$p = mv$$

p = kg x m/s

speeding bullet

v_b = 500. m/s

m_b = 30.0 g

p = mv

p = .0300 kg x 500. m/s

p = 15.0 kg x m/s

a walking Geo

p = mv

p = 75.0. kg x 1.5 m/s

p = 110 kg x m/s

speeding car:

v_c = 65 km/hr → 18 m/s

m_c = 1000. kg

p = mv

p = 1000. kg x 18 m/s

p = 18,000 kg x m/s

2nd Law

$\Sigma F = ma$

$a = \Delta v/t$

$\Sigma F = m\Delta v/t$

$Ft = mv$

impulse momentum

$Ft = mv$

N s = kg m/s

kg m/s^2 (s) = kg m/s

kg m/s = kg m/s

bullet from slide #3

The gun pushes the bullet with 3750 N of force. What time did the gun act on the bullet?

speeding bullet
$v_b = 500.\ m/s$
$m_b = 30.0\ g$
$d_g = 1.0\ m$

$Ft = mv$

$t = mv/F$

$$t = \frac{.0300\ kg(500.\ m/s)}{3750\ N}$$

$t = 0.00400\ s$

Impulse - Momentum Theorem

$Ft = \Delta p$

$Ft = p_2 - p_1$

$m_b = 400.0$ g Baseball thrown and hit

$v_{b1} = 76.0$ mph
↳ ? m/s

$v_{b2} = -130.0$ mph
↳ ? m/s

Ft = ?

F =?

A 400 g baseball is thrown at 76 mph and then hit at 130 mph in the opposite direction.

$Ft = \Delta mv$

$m_b = 400.0$ g Baseball thrown and hit

$v_{b1} = 76.0$ mph
↳ 34.0 m/s

$v_{b2} = 130.0$ mph
↳ -58.0 m/s

Ft = ?

A 400 g baseball is thrown at 76 mph and then hit at 130 mph in the opposite direction.

$Ft = \Delta mv$

$Ft = mv_{b2} - mv_{b1}$ $m_{b2} = m_{b1}$

$Ft = m(v_{b2} - v_{b1})$

Baseball thrown and hit

$m_b = 400.0$ g

A 400 g baseball is thrown at 76 mph and then hit at 130 mph in the opposite direction.

$v_{b1} = 76.0$ mph → 34.0 m/s

$v_{b2} = 130.0$ mph → -58.0 m/s

Ft = ?

$Ft = \Delta mv$

$Ft = mv_{b2} - mv_{b1}$

$Ft = m(v_{b2} - v_{b1})$

$Ft = .400 \text{ kg}[(-58 \text{ m/s}) - (34 \text{ m/s})]$

$Ft = -36.8 \text{ kg m/s}$

contact time = 0.7 ms ... F = ?

Baseball thrown and hit

$m_b = 400.0$ g

A 400 g baseball is thrown at 76 mph and then hit at 130 mph in the opposite direction.

$v_{b1} = 76.0$ mph → 34.0 m/s

$v_{b2} = 130.0$ mph → -58.0 m/s

Ft = ?

$Ft = \Delta mv$

$Ft = mv_{b2} - mv_{b1}$

$Ft = m(v_{b2} - v_{b1})$

$Ft = .400 \text{ kg}[(-58 \text{ m/s}) - (34 \text{ m/s})]$

$Ft = -36.8 \text{ kg m/s}$

contact time = 0.00070 s ... F = ?

$F = \Delta mv/t = -36.8 \text{ kg m/s}/.0007 \text{ s}$

$F = -52{,}600$ N

$Ft = \Delta mv$

$-52{,}600\text{N}(.0007 \text{ s}) = .400 \text{ kg}[(-58 \text{ m/s}) - (34 \text{ m/s})]$

$-36.8 \text{ kg m/s} = -36.8 \text{ kg m/s}$

Your book (2.6 kg)falls off the table and hits the floor (-4.4 m/s) and does not bounce. What impulse does the floor apply?

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$Ft = \Delta mv$

$Ft = mv_{b2} - mv_{b1}$

$Ft = m(v_{b2} - v_{b1})$

$Ft = 2.600\ kg[(0\ m/s) - (-4.4\ m/s)]$

$Ft = 11.4\ kg\ m/s$

contact time = 0.060s ... F = ?

$F = \Delta mv/t = 11.4\ kg\ m/s / .060\ s$

$F = 190\ N$