Name: _____ Student ID: _____

Quiz 7 Momentum

1. An official major league baseball has a mass of 0.14 kg. A pitcher throws a 40 m/s fastball which is hit by the batter straight back up the middle at a speed of 46 m/s.

a. What is the impulse of the ball during the collision with the bat?

In this problem, a pitcher throws a baseball (at some speed) at the batter and the batter hits the ball with his bat. The ball leaves the bat (at some speed).

Givens:

$m_{baseball} = 0.14kg$

$v_{initial} = 40\frac{m}{s}\ towards\ home\ plate = +40\frac{m}{s}$ (defining towards home plate as +)

$v_{final} = 46\frac{m}{s}\ away\ from\ home\ plate = -46\ m/s$ (so away from home plate as -)

$J = ?$

Equation: $J = \Delta p\ and\ \Delta p = p_{final} - p_{initial}\ and\ p = mv$

Calculations:

$J = \Delta p$

$J = p_{final} - p_{initial}$

$J = mv_{final} - mv_{initial}$

$J = (0.14kg)\left(-46\frac{m}{s}\right) - (0.14kg)\left(+40\frac{m}{s}\right)$

$\boxed{J = -12.04\frac{kg * m}{s}}$

b. If this collision occurs during a time of 0.012 seconds, what is the average force exerted by the bat on the ball?

Since the ball is hitting the bat, there will be some impulse as related to the force and time.

Givens:

$m_{baseball} = 0.14kg$

$v_{initial} = 40\frac{m}{s}\ towards\ home\ plate = +40\frac{m}{s}$ (defining towards home plate as +)

$v_{final} = 46\frac{m}{s}\ away\ from\ home\ plate = -46\frac{m}{s}$ (so away from home plate as -)

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$J = -12.04 \frac{kg * m}{s}$

$\Delta t = 0.012s$

Equation: $F = \frac{\Delta p}{\Delta t}$ and $J = \Delta p$

Calculations:

$F = \frac{\Delta p}{\Delta t}$

$F = \frac{J}{\Delta t}$

$F = \frac{-12.04 \frac{kg * m}{s}}{0.012s}$

$F = -1000.83 \frac{kg * m}{s^2}$

$\boxed{F = -1000.83\ N}$

2. A tennis ball may leave a top player's racket on the serve with a speed of 65.0 m/s. The ball's mass is 0.0600 kg and it is in contact with the racket for 0.0300 s. Assume the ball begins at rest.
What is the change in momentum of the tennis ball during the collision with the racket?

Here, a tennis ball is hit by a tennis racket. The ball starts at rest and, when hit, leaves the racket with some velocity.

Given:

$v_{final} = 65.0 \frac{m}{s}$

$m = 0.0600\ kg$

$\Delta t = 0.0300s$

$v_{initial} = 0 \frac{m}{s}$

$\Delta p = ?$

Equation: $\Delta p = p_{final} - p_{initial}$ *and* $p = mv$

Calculations:

$\Delta p = p_{final} - p_{initial}$

$\Delta p = mv_{final} - mv_{initial}$

$\Delta p = (0.0600kg)\left(65.0 \frac{m}{s}\right) - (0.0600kg)\left(0 \frac{m}{s}\right)$

$\boxed{\Delta p = 3.9 \frac{kg * m}{s}}$