## Section 19: Impulse (Continued)

$Impulse = F_{Net}\Delta t$ but $F_{net} = ma$

$Impulse = ma\Delta t$ but $a = \frac{\Delta v}{\Delta t}$

$Impulse = m\left(\frac{\Delta v}{\Delta t}\right)\Delta t$

$Impulse = m\Delta v$ but $\Delta v = v_2 - v_1$

$Impulse = m(v_2 - v_1)$

$Impulse = mv_2 - mv_1$

Impulse = $F_{net}\Delta t = mv_2 - mv_1$
(J)

1. A) What impulse is given to a golf ball by a club if they are in contact for $5.0 \times 10^{-3}$ s, and the force exerted on the ball is $5.0 \times 10^2$ N?

t

F

Impulse = $F_{net}\, \Delta t$

$= (5 \times 10^2 N)(5.0 \times 10^{-3} s)$

$= 2.5$ N s

B) What is the ball's change in momentum?

$\Delta p = 2.5$ N s

* Impulse = change in momentum

2. What average force will stop a $1.0 \times 10^3$ kg car in 1.5 s if the car is moving at 22 m/s?

$F_{net} = ?$

$m = 1000$ kg

$t = 1.5$ s

$V_1 = 22$ m/s

$V_2 = 0$ m/s

$F_{net}\Delta t = mv_2 - mv_1$

$F_{net}(1.5 s) = -(1000 kg)(22 m/s)$

$F_{net} = -15000$ N

3. A 150 g baseball travelling at 24 m/s [W] is struck by a bat. It then travels at 40.0 m/s [E]. Calculate:
   A) the impulse imparted by the bat on the ball.
   B) the change in the ball's momentum.
   C) the time of contact if the average force exerted by the bat is 7.0 x $10^3$ N [E].

A)

$m = 0.150 kg$

$V_1 = -24 m/s$

$V_2 = 40 m/s$

Impulse = $J = ?$

$J = mV_2 - mV_1$

$= 0.15 kg (40 m/s) - 0.15 kg (-24 m/s)$

$J = 9.6 kgm/s$

B) 9.6 Kgm/s

C) $J = F_{net} \Delta t$

$9.6 kgm/s = (7 \times 10^3 N) \Delta t$

$1.4 \times 10^{-3} s = \Delta t$

4. A parachutist flexes her knees and rolls in order to stop. Calculate the impact force on a 70.0 kg parachutist falling at 10.0 m/s if the time to stop was 0.80s. Compare the force of impact if the parachutist lands in a rigid position and the stopping time was decreased to 0.050s.

$m = 70kg$
$v_1 = 10 m/s$
$v_2 = 0 m/s$
$t = 0.80 s$
$t = 0.050 s$
$F_{net}$

① $F_{net}\Delta t = mv_2 - mv_1$

$F_{net}(0.80s) = 0 - (70kg)(10m/s)$

$F_{net} = -875 N$

② $F_{net}\Delta t = mv_2 - mv_1$

$F_{net}(0.05s) = 0 - (70kg)(10m/s)$

$F_{net} = -14\,000 N$