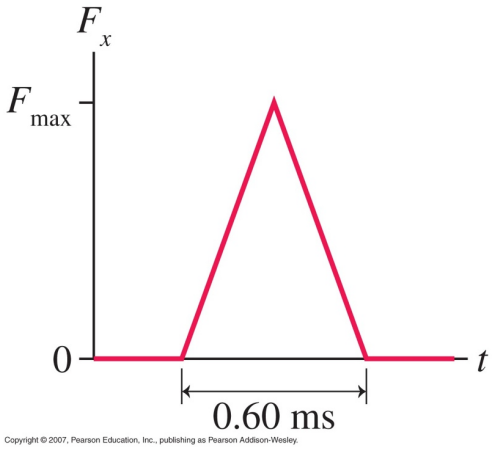
Hitting a cricket ball

A 150g cricket ball is bowled with a speed of 20 ms^{-1}. The batsman hits it straight back to the bowler at 40 ms^{-1}, and the impulsive force of bat on ball has the shape as shown.



(a) What is the maximum force the bat exerts on the ball?

(b) What is the average force the bat exerts on the ball?

From the impulse-momentum theorem,

$J = \Delta p$ = area under force curve

= ½ x 0.6ms x F_{max} (½ x base x height)

= 3×10^{-4} F_{max}

Now, the change in momentum of the ball is

$\Delta p = p_f - p_i$

$= m (v_f - v_i)$

= 0.15 x (40 – (–20))

= 0.15 x 60

= 9 kg m s^{-1}

and since $J = \Delta p$, then

3×10^{-4} F_{max} = 9 kg m s^{-1}

so the maximum force the bat exerts on the ball is

$F_{max} = 9 / 3 \times 10^{-4}$

= 30,000 N

The average force the bat exerts on the ball is

$F_{av} = \Delta p / t$

$= 9 / 0.6 \times 10^{-3}$

= 15,000 N