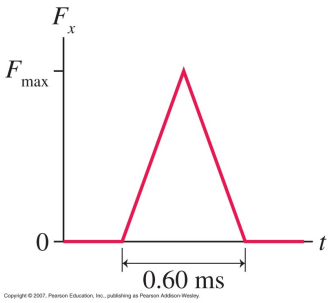
Hitting a cricket ball

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?



Solution: From the impulse-momentum theorem,

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

$= ½ \times 0.6 \times 10^{-3} \times F_{max}$

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

Now

Δp = change in momentum

$= p_f - p_i$

$= m(v_f - v_i)$

$= 0.15 \times (40 + 20) = 9$ kg ms^{-1}

so equating this with the above expression for J, we get

$3 \times 10^{-4} F_{max} = 9$ kg ms^{-1}

so

$F_{max} = 9/3{\times}10^{-4} = 30{,}000$ N

the maximum force that the bat exerts on the ball.

The *average* force F_{av} is

$F_{max} = \Delta p/t = 9/6{\times}10^{-4} = 15{,}000$ N