Class problems - Oct 4, 2007

① (a) Each bullet carries momentum mv

In one second, r bullets hit the block so $\frac{\Delta p}{\Delta t} = mvr = F_{avg}$.

(b) $\Delta p = F_{avg}\,\Delta t = (mvr)(T)$ change in momentum in time T

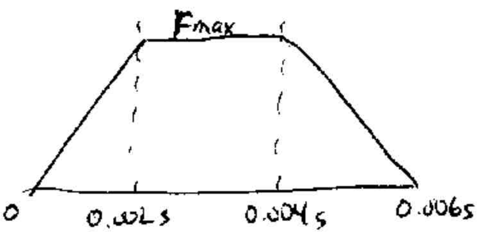
$= M(v_f - v_i) \Rightarrow v_f = \frac{mvrT}{M}$

② Initial momentum of the two skaters is zero

$\Rightarrow$ Final momentum $= 0 = m_1 v_1 + m_2 v_2$

$$v_2 = -v_1 \frac{m_1}{m_2} = -(3.0\,m/s)\frac{75\,kg}{50\,kg} = -4.5\,\frac{m}{s}$$

③



$\Delta p = m(v_f - v_i) = (0.058\,kg)(44\,m/s - 12\,m/s)$

$= 1.856\,kg\cdot m/s$

$F_{avg} = \frac{\Delta p}{\Delta t} = \frac{1.856\,kg\cdot m/s}{0.006\,s} = 309.3\,N$

From 0 to 0.002 s $F_{avg} = \frac{1}{2}F_{max}$ (also from 0.004s to 0.006s)

From 0.002s to 0.004 s, $F_{avg} = F_{max}$

Overall average $= \frac{1}{3}\left(\frac{1}{2}F_{max} + F_{max} + \frac{1}{2}F_{max}\right) = \frac{2}{3}F_{max}$

$F_{max} = \frac{3}{2}F_{avg} = 464\,N$

④ (a) $\Delta\vec{p} = \vec{F}_{avg}\,\Delta t = \left(\langle -7\times10^3, -9.2\times10^2, 0\rangle N\right)(0.2\,s)$

$= \langle -1.4\times10^2, -1.84\times10^2, 0\rangle\ kg\cdot m/s$

$\vec{p}_f = \vec{p}_i + \Delta\vec{p} = \langle 4.4\times10^4, -7.6\times10^3, 0\rangle + \langle -1.4\times10^2, -1.84\times10^2, 0\rangle$

$= \langle 4.26\times10^4, -7.78\times10^3, 0\rangle\ kg\cdot m/s$

(b) $\vec{v}_{avg} = \frac{1}{2}(v_i + v_f) = \frac{1}{2}\,\frac{\langle 4.4\times10^4, -7.6\times10^3, 0\rangle + \langle 4.26\times10^4, -7.78\times10^3, 0\rangle}{240}$

$= \langle 180, -32, 0\rangle\ m/s$

$\vec{r}_f = \vec{r}_i + \vec{v}_{avg}\,\Delta t = \langle 4.3\times10^3, 8.7\times10^3, 0\rangle + \langle 180, -32, 0\rangle(.2)$

$= \langle 4336, 864, 0\rangle\ m$