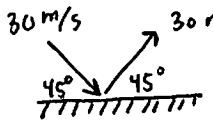
NAME: KEY

Momentum & Impulse

1. A 5.0 kg object with a speed of 30 m/s strikes a steel plate at an angle of 45° and rebounds with the same speed and angle. What is the change (magnitude and direction) of the linear momentum of the ball (relative to the steel plate.)



$\Rightarrow \vec{p}_i = 5.30\cos45\,\hat{i} - 5.30\sin45\,\hat{j} = 106\,\hat{i} - 106\,\hat{j}$ kg·m/s

$\vec{p}_f = 5.30\cos45\,\hat{i} + 5.30\sin45\,\hat{j} = 106\,\hat{i} + 106\,\hat{j}$ kg·m/s

$\Delta\vec{p} = \vec{p}_f - \vec{p}_i = (106\,\hat{i} + 106\,\hat{j}) - (106\,\hat{i} - 106\,\hat{j}) = \boxed{0\,\hat{i} + 212\,\hat{j}\ \text{kg m/s}}$

2. A 3 kg ball with an initial velocity of 15i m/s experiences an impulse of –20i + 30j Ns over a time interval of 0.04 seconds. What is the final velocity of the ball?

$p_i = 3\cdot15\,\hat{i} = 45\,\hat{i}$ kg·m/s

$J = -20\,\hat{i} + 30\,\hat{j}$ N·s

$p_f = ?$

$J = \Delta p$

$-20\,\hat{i} + 30\,\hat{j} = p_f - 45\,\hat{i}$

$p_f = 25\,\hat{i} + 30\,\hat{j}$

$mv_f = (3)v_f = 25\,\hat{i} + 30\,\hat{j}$

$\boxed{v_f = 8.3\,\hat{i} + 10\,\hat{j}\ \text{m/s}}$

3. A super ball (mass = 0.035 kg) is thrown with a velocity of 15 m/s into a wall. It bounces back with a speed of 10 m/s. The ball and wall were in contact for only 0.02 seconds. ~~What was the~~ average force of the wall on the ball?

$v_i = +15$ m/s

$v_f = -10$ m/s

$m = 0.035$ kg

$t = 0.02$ s

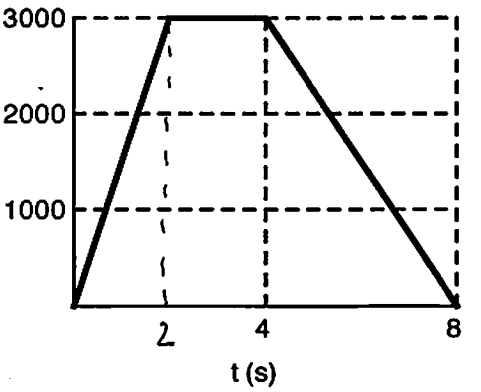
$J = \Delta p$

$Ft = \Delta p$

$F(.02) = (.035)(-10) - (.035)(15)$

$\boxed{F = -43.75\ \text{N}}$

4. A 1500 kg car traveling at 10 m/s somehow experiences a net force as shown in the diagram. (The force is in the direction that the car was moving.) What is the final speed of the car?



$J = \text{Area} \rightarrow = \Delta p = \frac{1}{2}(2+8)(3000) = 15{,}000$

$J = \text{trapezoid} = \frac{1}{2}(8)(3000)(2) = 24{,}000$ ~~N·s~~

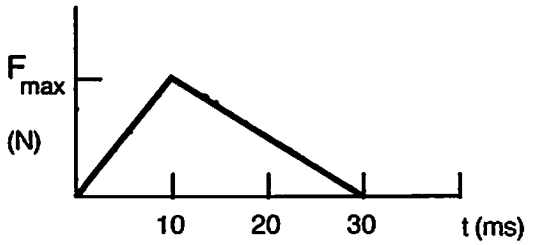
$\therefore 15{,}000 = mv_f - mv_i = 1500v_f - 1500(10)$

$30{,}000 = 1500\,v_f$

$\boxed{v_f = 20\ \text{m/s}}$

should read "magnitude"

5. A tennis ball of mass 0.1 kg bounces off a wall. It had an original speed of 30 m/s and bounces straight backwards with a speed of 20 m/s. The force verses time graph showing the impulse of the wall on the tennis ball is shown. What was the maximum force on the tennis ball?



$\Delta p = mv_f - mv_i = (0.1)(-20) + (0.1)(30)$

$\Delta p = -5$ kg·m/s

$J = \text{Area} = \Delta p$

$\therefore \frac{1}{2}(F)(.03) = -5$

$\boxed{F = -333\ \text{N}}$

Answers: *1) 212 kg·m/s, ⊥ and away from surface* *2) 8.3i + 10j m/s* *3) (-) 43.75 N* *4) 20 m/s* *5) (-) 333 N*