Homework-6 chapter 9 [10, 16, 23, 35, 37, 45, 46]

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classical Physics 1 (210)

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Q10] A = represents the car

B = represents the load

+ve direction is the direction of the original motion of the car

$p_{initial} = p_{final} \rightarrow m_A v_A + m_B v_B = (m_A + m_B) v' \rightarrow$

$$v' = \frac{m_A v_A}{m_A + m_B} = \frac{(9150\ kg)(15.0\ m/s) + 0}{(9150\ kg) + (4350\ kg)} = \boxed{10.2\ m/s}$$

Q16] One dimension with the +ve direction. A = bullet, B = block

$v_B = 0$

$p_{initial} = p_{final} \rightarrow m_A v_A + m_B v_B$

$= m_A v'_A + m_B v'_B \rightarrow v'_B = \frac{m_A (v_A - v'_A)}{m_B}$

$$= \frac{(0.022\ kg)(210\ m/s - 150\ m/s)}{2.0\ kg}$$

$$= \boxed{0.66\ m/s}$$

Q23] a] Impulse will be the change in momentum.

$\Delta p = m \Delta v = (4.5 \times 10^{-2}\ kg)(45\ m/s - 0) = \boxed{2.0\ kg \cdot m/s}$

and it will be in forward direction.

b] Average force = $\frac{\text{impulse}}{\text{interaction time}}$

$\bar{F} = \frac{\Delta P}{\Delta t} = \frac{2.0 kg \cdot m/s}{3.5 \times 10^{-3} s} = \boxed{580 N}$ in forward direction

35] $A = 0.450$-kg puck   in +ve direction
$B = 0.900$-kg puck
$v_A = 4.80$ m/s
$v_B = 0$
$v_A - v_B = -(v'_A - v'_B) \rightarrow v'_B = v_A + v'_A$
By substituting into momentum conservation eq.
$m_A v_A + m_B v_B = m_A v'_A + m_B v'_B \rightarrow m_A v_A = m_A v'_A + m_B (v_A + v'_A) \rightarrow$

$v'_A = \frac{(m_A - m_B)}{(m_A + m_B)} v_A = \frac{-0.450 kg}{1.350 kg} (4.80 m/s)$
$= -1.60 m/s = \boxed{1.60 m/s} \boxed{west}$
$v'_B = v_A + v'_A = 4.80 m/s - 1.60 m/s = \boxed{3.20 m/s \text{ east}}$

37] A = moving ball
B = initially at rest   +ve direction
$v_A = 7.5 m/s$ $v_B = 0$ $v'_A = -3.8 m/s$
a] $v_A - v_B = -(v'_A - v'_B) \rightarrow v'_B = v_A - v_B + v'_A$
$= 7.5 m/s - 0 - 3.8 m/s = \boxed{3.7 m/s}$
b] $m_A v_A + m_B v_B = m_A v'_B + m_B v'_B \rightarrow$
$m_B = m_A \frac{(v_A - v'_A)}{(v'_B - v_B)} = (0.220 kg) \frac{(7.5 m/s - 3.8 m/s)}{3.7 m/s}$
$= \boxed{0.67 kg}$

45] Conservation of momentum in one direction, as particles will separate and travel in opposite direction.

A = heavier particle $m_A = 1.5 m_B$ and

B = lighter particle $v_A = v_B = 0$

$P_{initial} = P_{final} \rightarrow 0 = m_A v'_A + m_B v'_B \rightarrow v'_A = -\frac{m_B v'_B}{m_A}$

$= -\frac{2}{3} v'_B$, in this case -ve sign will be the direction.

So, $E_{added} = K'_A + K'_B = \frac{1}{2} m_A v'_A{}^2 + \frac{1}{2} m_B v'_B{}^2$

$= \frac{1}{2}(1.5 m_B)(\frac{2}{3} v'_B) + \frac{1}{2} m_B v'_B{}^2$

$= \frac{5}{3}(\frac{1}{2} m_B v'_B{}^2) = \frac{5}{3} K'_B$

$K'_B = \frac{3}{5} E_{added} = \frac{3}{5}(7500 J) = 4500 J$

$K'_A = E_{added} - K'_B = 7500 J - 4500 J = 3000 J$

Thus $\boxed{\begin{array}{l} K'_A = 3.0 \times 10^3 J \\ K'_B = 4.5 \times 10^3 J \end{array}}$

46] A = sports car $v_B = 0$ and $v'_A = v'_B$ Solve for v_A

B = SUV car

$P_{initial} = P_{final} \rightarrow m_A v_A + 0 = (m_A + m_B) v'_A \rightarrow v_A = \frac{m_A + m_B}{m_A} v'_A$

Kinetic energy of the car is lost due to negative work done by friction. The distance the cars slide forward is Δx. Solve for v'_A and use that to find v_A.

$W_{ft} (K_{final} - K_{initial})_{\text{after collision}} = 0 - \frac{1}{2}(m_A + m_B) v'^2_A$

$W_{ft} = F_{ft} \Delta x \cos 180° = -\mu_k (m_A + m_B) g \Delta x$

$-\frac{1}{2}(m_A + m_B) v'^2_A = -\mu_k (m_A + m_B) g \Delta x \rightarrow v'_A = \sqrt{2 \mu_k g \Delta x}$

$$v_A = \frac{m_A + m_B}{m_A} v'_A = \frac{m_A + m_B}{m_A} \sqrt{2 \mu_k g \Delta x}$$

$$= \frac{920\,kg + 2300\,kg}{920\,kg} \sqrt{2(0.80)(9.8\,m/s^2)(2.8\,m)}$$

$$= 23.191\,m/s \approx \boxed{23\,m/s}$$