Momentum + Impulse Problems

#1-25 odd

$p = m\vec{v}$

(1) $m = 3\,Kg$, $\vec{v} = 5\,\frac{m}{s}$

$p = m\vec{v} = 3Kg \cdot 5\frac{m}{s} = 15\,Kg\frac{m}{s}$

(3) $m = 12\,Kg$, $\vec{v} = 5.5\,\frac{m}{s}$

$p = m\vec{v} = 12Kg \cdot 5.5\frac{m}{s} = 66\,Kg\frac{m}{s}$

(5) $m = 18\,Kg$, $\vec{v} = 0.5\,\frac{m}{s}$

$p = m\vec{v} = 18\,Kg \cdot 0.5\frac{m}{s} = 9\,Kg\frac{m}{s}$

Change in Momentum $= m(\vec{v}_2 - \vec{v}_1)$

(7) $m = 4\,Kg$, $\vec{v}_2 = 12\,\frac{m}{s}$, $\vec{v}_1 = 10\,\frac{m}{s}$

$\Delta p = m\Delta\vec{v} = m(\vec{v}_2 - \vec{v}_1)$

$= 4\,Kg\left(12\frac{m}{s} - 10\frac{m}{s}\right)$

$= 4\,Kg\left(2\frac{m}{s}\right) =$

$= 8\,Kg\frac{m}{s}$

(9) $m = 33\,Kg$, $\vec{v}_2 = 12\,\frac{m}{s}$, $\vec{v}_1 = 30\,\frac{m}{s}$

$\Delta p = m\Delta\vec{v} = m(\vec{v}_2 - \vec{v}_1)$

$= 33\,Kg\left(12\frac{m}{s} - 30\frac{m}{s}\right)$

$= 33\,Kg\left(-18\frac{m}{s}\right)$

$= -594\,Kg\frac{m}{s}$

Momentum + Impulse Problems

Impulse = $Ft = m\Delta\vec{v} = I$

(11) $m = 3\ Kg$
$\vec{v}_2 = 12\ \frac{m}{s}$
$\vec{v}_1 = 0\ \frac{m}{s}$

$I = m\Delta\vec{v} = 3Kg(12\frac{m}{s} - 0\frac{m}{s})$
$= 3Kg(12\frac{m}{s}) = 36\ Kg\frac{m}{s}$

(13) $m = 13\ Kg$
$\vec{v}_2 = 12\ \frac{m}{s}$
$\vec{v}_1 = 20\ \frac{m}{s}$

$I = m\Delta\vec{v} = 13Kg(12\frac{m}{s} - 20\frac{m}{s})$
$= 13Kg(-8\frac{m}{s})$
$= -104\ Kg\frac{m}{s}$

(15) $m = 3\ Kg$
$\vec{v}_2 = 0$
$\vec{v}_1 = 12\ \frac{m}{s}$

$I = m\Delta\vec{v} = 3Kg(0\frac{m}{s} - 12\frac{m}{s})$
$= 3Kg(-12\frac{m}{s})$
$= -36\ Kg\frac{m}{s}$

$Ft = m\Delta v$

(17) Force on a 4 Kg object acc. from $10\frac{m}{s}$ to $12\frac{m}{s}$ in 2.5 s?

Use $\vec{F}\cdot t = m\Delta\vec{v}$, so $\vec{F} = \frac{m\Delta\vec{v}}{t} = \frac{4Kg(12\frac{m}{s} - 10\frac{m}{s})}{2.5s}$

$\vec{F} = 3.2\ N$

(19) $m = 33\,Kg$ $\quad \vec{F} = ?$ $\quad$ Use $\vec{F} \cdot t = m\Delta\vec{v}$

$\vec{v}_2 = 12\,\frac{m}{s}$

$\vec{v}_1 = 30\,\frac{m}{s}$

$t = 4.5\,s$

$$\vec{F} = \frac{m\Delta\vec{v}}{t} = \frac{33\,Kg\left(12\,\frac{m}{s} - 30\,\frac{m}{s}\right)}{4.5\,s} =$$

$$\vec{F} = -132\,N$$

(21) $t = ?$ $\quad$ Use $\vec{F} \cdot t = m\Delta\vec{v}$, so $t = \frac{m\Delta\vec{v}}{F}$

$m = 3\,Kg$

$\vec{v}_2 = 12\,\frac{m}{s}$

$\vec{v}_1 = 0\,\frac{m}{s}$

$\vec{F} = 2.5\,N$

$$t = \frac{3\,Kg\left(12\,\frac{m}{s} - 0\,\frac{m}{s}\right)}{2.5\,\frac{Kgm}{s^2}} = 14.4\,s$$

(23) $t = ?$ $\quad$ Use $\vec{F} \cdot t = m\Delta\vec{v}$, so $t = \frac{m\Delta\vec{v}}{F}$

$m = 13\,Kg$

$\vec{v}_2 = 12\,\frac{m}{s}$

$\vec{v}_1 = 20\,\frac{m}{s}$

$F = -2.5\,N$

$$t = \frac{13\,Kg\left(12\,\frac{m}{s} - 20\,\frac{m}{s}\right)}{-2.5\,\frac{Kgm}{s^2}} = 41.6\,s$$

(25) $t = ?$ $\quad$ Use $\vec{F} \cdot t = m\Delta v$, so $t = \frac{m\Delta\vec{v}}{F}$

$m = 3\,Kg$

$\vec{v}_2 = 0\,\frac{m}{s}$

$\vec{v}_1 = 12\,\frac{m}{s}$

$F = -2.5\,N$

$$t = \frac{3\,Kg\left(0\,\frac{m}{s} - 12\,\frac{m}{s}\right)}{-2.5\,\frac{Kgm}{s^2}} = 14.4\,s$$

Collisions Problems Elastic 1,3,5 and Inelastic 1,3,5.

Elastic

(1)

Cue Ball	8-Ball
$m_1 = 0.25\ Kg$	$m_2 = 0.25\ Kg$
$V_1 = 22 \frac{m}{s}$	$V_2 = 0$
$V_1' = 0 \frac{m}{s}$	$V_2' = ?$

$$m_1 V_1 + m_2 V_2 = m_1 V_1' + m_2 V_2'$$

$$\frac{m_1 V_1 + m_2 V_2 - m_1 V_1'}{m_2} = V_2'$$

$$V_2' = \frac{(0.25\ Kg \cdot 22 \frac{m}{s}) + (0.25\ Kg \cdot 0 \frac{m}{s}) - (0.25\ Kg \cdot 0 \frac{m}{s})}{0.25\ Kg}$$

$$\boxed{V_2' = 22 \frac{m}{s}}$$

(3)

Bullet	Target
$m_1 = 0.1\ Kg$	$m_2 = 1.5\ Kg$
$V_1 = 420 \frac{m}{s}$	$V_2 = 0 \frac{m}{s}$
$V_1' = 300 \frac{m}{s}$	$V_2' = ?$

$$V_2' = \frac{m_1 V_1 + m_2 V_2 - m_1 V_1'}{m_2} = \frac{(0.1\ Kg \cdot 420 \frac{m}{s}) + (1.5\ Kg \cdot 0 \frac{m}{s}) - (0.1\ Kg \cdot 300 \frac{m}{s})}{1.5\ Kg}$$

$$V_2' = \frac{12\ Kg \frac{m}{s}}{1.5\ Kg} = \boxed{8 \frac{m}{s}}$$

Elastic

(5)

Cart 1

$m_1 = 8.5\ kg$

$V_1 = 9.54\ \frac{m}{s}$

$V_1' = 3.57\ \frac{m}{s}$

Cart 2

$m_2 = 36.8\ kg$

$V_2 = 0\ \frac{m}{s}$

$V_2' = ?$

$$V_2' = \frac{m_1 V_1 + m_2 V_2 - m_1 V_1'}{m_2} = \frac{(8.5\ kg \cdot 9.54\ \frac{m}{s}) + (36.8\ kg \cdot 0\ \frac{m}{s}) - (8.5\ kg \cdot 3.57\ \frac{m}{s})}{36.8\ kg}$$

$$\boxed{V_2' = 1.4\ \frac{m}{s}}$$

Inelastic

(1)

Boy

$m_1 = 70.0\ kg$

$V_{1+2} = 3.0\ \frac{m}{s}$

$V_1' = 3.1\ \frac{m}{s}$

Skateboard

$m_2 = 2.0\ kg$

$V_{1+2} = 3.0\ \frac{m}{s}$

$V_2' = ?$

$$(m_1 + m_2)(V_{1+2}) = m_1 V_1' + m_2 V_2'$$

$$V_2' = \frac{(m_1 + m_2) V_{1+2} - m_1 V_1'}{m_2}$$

$$V_2' = \frac{((70.0\ kg + 2.0\ kg)(3.0\ \frac{m}{s})) - (70.0\ kg \cdot 3.1\ \frac{m}{s})}{2.0\ kg}$$

$$\boxed{V_2' = -0.5\ \frac{m}{s}}$$

(3) Inelastic

10th graders $m_1 = 60\ kg$

$V_{1+2} = 0$

$V_1 = ?$

Ladder $m_2 = 7\ kg$

$V_2' = 15\ \frac{m}{s}$

$$(m_1 + m_2)(V_{1+2}) = m_1 V_1' + m_2 V_2'$$

$$\frac{((m_1+m_2)(V_{1+2})) - m_2 V_2'}{m_1} = V_1'$$

$$V_1' = \frac{(60\ kg + 7\ kg)(0) - (7\ kg \cdot 15\ \frac{m}{s})}{60\ kg} = \boxed{-1.8\ \frac{m}{s}}$$

Now, for a projectile motion problem from cliff.

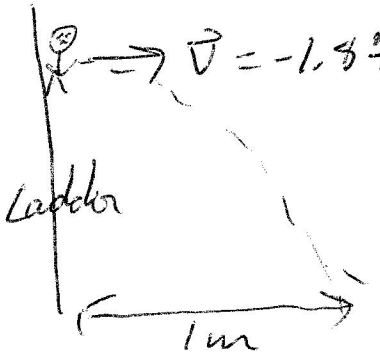
5 m high, so $d = \frac{1}{2} g t^2$

$$t = \sqrt{\frac{2d}{g}} = \sqrt{\frac{2 \cdot 5\ m}{9.8\ \frac{m}{s^2}}} = 0.5\ s$$

Now, find horiz. distance traveled in 0.5s to fall

$X = V \cdot t$, so $X = -1.8\ \frac{m}{s} \cdot .5\ s = -.9\ m$

If he made it to the pool, he hit the side of the pool just before going in the pool.



Inelastic

(5)

~~child~~ Package

$m_1 = 6.4\ Kg$

$V_1 = 0\ \frac{m}{s}$

$V_{1+2} = 0\ \frac{m}{s}$

$V_1' = 10\ \frac{m}{s}$

Boat + Child

$m_2 = 26\ Kg + 45\ Kg = 71\ Kg$

$V_2' = ?$

$$(m_1 + m_2)(V_{1+2}) = m_1 V_1' + m_2 V_2'$$

$$\frac{\left((m_1 + m_2)(V_{1+2})\right) - m_1 V_1'}{m_2} = V_2'$$

$$\frac{\left((6.4\ Kg + 71\ Kg)\left(0\ \frac{m}{s}\right)\right) - \left(6.4\ Kg \cdot 10\ \frac{m}{s}\right)}{71\ Kg} = V_2'$$

$$V_2' = -0.9\ \frac{m}{s}$$