

④ Area = $F \cdot \Delta t = \text{impulse}$

area = $\frac{1}{2}bh + l \cdot w$

$\frac{1}{2}(3s)(6N) + (2s)(-4N)$

$= 9N \cdot s - 8N \cdot s = 1N \cdot s$

⑤ $F \Delta t = m \Delta v$

$1N \cdot s = (.50kg)(\Delta v)$

$\Delta v = 2m/s$

⑥ $m_1 = .15kg$

$v_1 = 35m/s$

$v_1' = 25m/s$

$v_2 = 0m/s$

$v_2' = 3.0m/s$

$m_2 = ?$

$m_1 v_1 + m_2 v_2 = m_1 v_1' + m_2 v_2'$

$m_1 v_1' = m_1 v_1 + m_2 v_2'$

$m_1 v_1 - m_1 v_1' = m_2 v_2'$

$\frac{m_1 v_1 - m_1 v_1'}{v_2'} = m_2$

$m_2 = \frac{(.15kg)(35m/s) - (.15kg)(25m/s)}{(3.0m/s)}$

$m_2 = .50kg$

⑦ $m = .125kg$

$\Delta t = .030s$

$v_i = 14.5m/s$

$v_f = -16.5m/s$

$F = ?$

$F \Delta t = m \Delta v$

$F \Delta t = m(v_f - v_i)$

$F = \frac{m(v_f - v_i)}{\Delta t}$

$= \frac{(.125kg)(-16.5m/s - 14.5m/s)}{.030s}$

$= -130N$

⑧ $m_1 = 50kg$

$m_2 = 2kg$

$v_2' = 20m/s$

$v_1' = ?$

$v_i = 0$

$(m_1 + m_2) v_i = m_1 v_1' + m_2 v_2'$

$0 = m_1 v_1' + m_2 v_2'$

$-m_1 v_1' = m_2 v_2'$

$v_1' = \frac{-m_2 v_2'}{m_1}$

$= \frac{-(2kg)(20m/s)}{50kg} = -.8m/s$

9) $F = 540 \text{ N}$
 $m = 65 \text{ kg}$
 $v_i = 175 \text{ m/s}$
 $v_f = 0 \text{ m/s}$
 $\Delta t = ?$

$F \Delta t = m \Delta v$
 $F \Delta t = m (v_f - v_i)$
 $\Delta t = \frac{m (v_f - v_i)}{F}$
 $= \frac{(65 \text{ kg})(0 - 175 \text{ m/s})}{540 \text{ N}}$
 $= 21 \text{ s}$

10) $m_1 = 12 \text{ kg}$
 $v_1 = 15 \text{ m/s}$
 $m_2 = 36 \text{ kg}$
 $v_2 = 5.0 \text{ m/s}$
 $v_1' = 6.0 \text{ m/s}$
 $v_2' = ?$

$m_1 v_1 + m_2 v_2 = m_1 v_1' + m_2 v_2'$
 $m_1 v_1 + m_2 v_2 - m_1 v_1' = m_2 v_2'$
 $\frac{m_1 v_1 + m_2 v_2 - m_1 v_1'}{m_2} = v_2'$
 $\frac{(12)(15) + (36)(5.0) - (12)(6.0)}{36}$
 $= 8.0 \text{ m/s}$

11) $m_1 = .50 \text{ kg}$
 $v_1 = 4.0 \text{ m/s}$
 $m_2 = .30 \text{ kg}$
 $v_2 = -2.0 \text{ m/s}$
 $v_1' = ?$
 $v_2' = ?$

P $m_1 v_1 + m_2 v_2 = m_1 v_1' + m_2 v_2'$
 $m_1 v_1' = m_1 v_1 + m_2 v_2 - m_2 v_2'$
 $(.5) v_1' = (.5)(4.0) + (.30)(-2.0) - (.30)(v_2')$
 $.5 v_1' = 2.0 - .6 - .30 v_2'$
 $.5 v_1' = 1.4 - .3 v_2'$
 $v_1' = 2.8 - .6 v_2'$

$KE \frac{1}{2} m_1 v_1^2 + \frac{1}{2} m_2 v_2^2 = \frac{1}{2} m_1 v_1'^2 + \frac{1}{2} m_2 v_2'^2$
 $m_1 v_1^2 + m_2 v_2^2 = m_1 v_1'^2 + m_2 v_2'^2$
 $(.50)(4.0)^2 + (.30)(-2.0)^2 = (.50)(v_1')^2 + (.30)(v_2')^2$
 $8 + 1.2 = .50(v_1')^2 + .30(v_2')^2$
 $9.2 = .50(2.8 - .6 v_2')^2 + .30(v_2')^2$
 $9.2 = .50(7.8 - 3.4 v_2' + .36(v_2')^2) + .30(v_2')^2$
 $9.2 = 3.9 - 1.7 v_2' + .18(v_2')^2 + .30(v_2')^2$
 $0 = -5.3 - 1.7 v_2' + .48(v_2')^2$

$v_1' = 2.8 - .6 v_2'$
 $v_1' = 2.8 - .6(5.5)$
 $= -.5 \text{ m/s}$

$v_1' = -.5 \text{ m/s}$
 $v_2' = 5.5 \text{ m/s}$

$v_2' = -1.9, 5.5 \text{ m/s}$

$$\begin{array}{lll} \textcircled{12} & m_1 = 180 \text{ kg} & v_1 = 0 & v_1' = ? \\ & m_2 = 51 \text{ kg} & v_2 = 0 & v_2' = 3.0 \text{ m/s} \end{array}$$

$$(m_1 + m_2)v = m_1 v_1' + m_2 v_2'$$

$$0 = m_1 v_1' + m_2 v_2'$$

$$-m_1 v_1' = m_2 v_2'$$

$$v_1' = \frac{-m_2 v_2'}{m_1}$$

$$= \frac{-(51 \text{ kg})(3.0 \text{ m/s})}{180 \text{ kg}} = -0.85 \text{ m/s}$$

opp direction
from swimmer

$$\textcircled{13} \quad v = -0.85 \text{ m/s}$$

$$\Delta x = 13 \text{ m}$$

$$t = ?$$

$$\Delta x = v t$$

$$t = \frac{\Delta x}{v} = \frac{13 \text{ m}}{0.85 \text{ m/s}} = \boxed{15 \text{ s}}$$

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$$m_1 = .058 \text{ kg}$$

$$v_1 = 9.3 \text{ m/s}$$

$$m_2 = 1.4 \text{ kg}$$

$$v_2 = 0 \text{ m/s}$$

Divide problem into 2 parts

① momentum

② KE to PE

① momentum

$$m_1 v_1 + m_2 v_2 = (m_1 + m_2) v_f$$

$$m_1 v_1 = (m_1 + m_2) v_f$$

$$v_f = \frac{m_1 v_1}{m_1 + m_2}$$

$$= \frac{(.058 \text{ kg})(9.3 \text{ m/s})}{(.058 \text{ kg} + 1.4 \text{ kg})} = \frac{(.058)(9.3)}{1.5 \text{ kg}}$$
$$= \boxed{.36 \text{ m/s}}$$

② KE \rightarrow PE

$$KE = \frac{1}{2} m v^2$$

$$= \frac{1}{2} (.058 \text{ kg} + 1.4 \text{ kg})(.36 \text{ m/s})^2$$

$$= \frac{1}{2} (1.5 \text{ kg})(.36 \text{ m/s})^2$$

$$= \boxed{.097 \text{ J}}$$

KE = PE

$$.097 \text{ J} = mgh$$

$$h = \frac{.097 \text{ J}}{mg}$$

$$= \frac{.097 \text{ J}}{(1.5 \text{ kg})(9.80 \text{ m/s}^2)}$$

$$= \boxed{.0066 \text{ m}}$$

$$= .66 \text{ cm}$$