

Chapter 7 LINEAR MOMENTUM

9. Assume the mass of alpha particle is m , then the mass of nucleus is $57m$.

Momentum conservation, $m_1v_1 + m_2v_2 = m_1v_1' + m_2v_2'$,
 $0 + 0 = m(3.8 \times 10^5 \text{ m/s}) + 57mv_2' \Rightarrow v_2' = \boxed{-6.7 \times 10^3 \text{ m/s}}$.

The $-$ sign means it is opposite to alpha particle's velocity.

12. (a) Assume one section has $v_1' = V$, then the other section has $v_2' = V + 2.20 \times 10^3 \text{ m/s}$, relative to earth.

Momentum conservation, $m_1v_1 + m_2v_2 = m_1v_1' + m_2v_2'$,
 $(900 \text{ kg})(5.80 \times 10^3 \text{ m/s}) = (450 \text{ kg})V + (450 \text{ kg})(V + 2.20 \times 10^3 \text{ m/s})$,
 Therefore, $v_1' = V = \boxed{4.70 \times 10^3 \text{ m/s}}$, and $v_2' = \boxed{6.90 \times 10^3 \text{ m/s}}$.

(b) Energy supplied = ΔKE
 $= \frac{1}{2}(450 \text{ kg})(4.70 \times 10^3 \text{ m/s})^2 + \frac{1}{2}(450 \text{ kg})(6.90 \times 10^3 \text{ m/s})^2 - \frac{1}{2}(900 \text{ kg})(5.80 \times 10^3 \text{ m/s})^2 = \boxed{5.45 \times 10^8 \text{ J}}$.

16. (a) Impulse = $\Delta p = (0.045 \text{ kg})(50 \text{ m/s}) - 0 = \boxed{2.3 \text{ kgm/s}}$.

(b) $F = \frac{\Delta p}{\Delta t} = \frac{2.25 \text{ kgm/s}}{5.0 \times 10^{-3} \text{ s}} = \boxed{4.5 \times 10^2 \text{ N}}$.

17. (a) $p = mv = (115 \text{ kg})(4.0 \text{ m/s}) = \boxed{4.6 \times 10^2 \text{ kgm/s East}}$.

(b) Impulse = $\Delta p = 0 - 460 \text{ kgm/s} = \boxed{-4.6 \times 10^2 \text{ kgm/s (West)}}$.

(c) Impulse = $\boxed{4.6 \times 10^2 \text{ kgm/s east}}$.

(d) $F = \frac{\Delta p}{\Delta t} = \frac{460 \text{ kgm/s}}{0.75 \text{ s}} = \boxed{6.1 \times 10^2 \text{ N east}}$.

22. Energy conservation, $\frac{1}{2} m_1 v_1^2 + \frac{1}{2} m_2 v_2^2 = \frac{1}{2} m_1 v_1'^2 + \frac{1}{2} m_2 v_2'^2$,

$$\frac{1}{2} (0.450 \text{ kg})(3.00 \text{ m/s})^2 + 0 = \frac{1}{2} (0.450 \text{ kg})v_1'^2 + \frac{1}{2} (0.900 \text{ kg})v_2'^2,$$

or, $9.00 \text{ m}^2/\text{s}^2 = v_1'^2 + 2v_2'^2$,

Momentum conservation, $m_1v_1 + m_2v_2 = m_1v_1' + m_2v_2'$,

$$(0.450 \text{ kg})(3.00 \text{ m/s}) + 0 = (0.450 \text{ kg})v_1' + (0.900 \text{ kg})v_2', \quad \text{or} \quad 3.00 \text{ m/s} = v_1' + 2v_2'$$

Solve for $v_1' = \boxed{-1.00 \text{ m/s (backwards)}}$, and $v_2' = \boxed{2.00 \text{ m/s}}$.

39. Momentum conservation: $mv = (m + M)V \Rightarrow V = \frac{(0.018 \text{ kg})(200 \text{ m/s})}{0.018 \text{ kg} + 3.6 \text{ kg}} = 0.995 \text{ m/s}$,

Energy conservation: $\frac{1}{2} (m + M)V^2 = (m + M)gh \Rightarrow h = \frac{(0.995 \text{ m/s})^2}{2(9.80 \text{ m/s}^2)} = 0.0505 \text{ m}$,

66. $\boxed{4.00 \text{ m}}$ from energy conservation.

71. (a) When mass m is at the bottom, its velocity is calculated from energy conservation.

$$mgh = \frac{1}{2}mv^2, \quad \Rightarrow \quad (9.80 \text{ m/s}^2)(3.60 \text{ m}) = \frac{1}{2}v_1^2, \quad v_1 = 8.40 \text{ m/s},$$

Momentum conservation. $(1.20 \text{ kg})(8.40 \text{ m/s}) + 0 = (1.20 \text{ kg})v_1' + (7.00 \text{ kg})v_2'$,

Energy conservation. $\frac{1}{2}(1.20 \text{ kg})(8.40 \text{ m/s})^2 + 0 = \frac{1}{2}(1.20 \text{ kg})v_1'^2 + \frac{1}{2}(7.00 \text{ kg})v_2'^2$,

Solve for $v_1' = \boxed{-5.94 \text{ m/s}}$, and $v_2' = \boxed{2.46 \text{ m/s}}$.

(b) Energy conservation. $\frac{1}{2}mv_2'^2 = mgh', \Rightarrow \frac{1}{2}(-5.94 \text{ m/s})^2 = (9.80 \text{ m/s}^2)h'$,

So, $h' = 1.80 \text{ m}$, Therefore, $d = \frac{h'}{\sin 30.0^\circ} = \frac{1.80 \text{ m}}{0.50} = \boxed{3.60 \text{ m}}$.