

Energy Worksheet # 3 γ

① $M_1 = 0.44 \text{ kg}$ $M_1 v_1 + M_2 v_2 = M_1 v_1' + M_2 v_2'$
 $v_1 = 4.5 \text{ m/s}$ $0.44(4.5) = 0.44 v_1' + 0.22 v_2'$
 $M_2 = 0.22 \text{ kg}$ $1.98 = 0.44 v_1' + 0.22 v_2'$
 $v_2 = ?$ $v_1' = \frac{1.98 - 0.22 v_2'}{0.44}$
 $v_1' = 4.5 - 0.5 v_2'$

$$\frac{1}{2} M_1 v_1^2 + \frac{1}{2} M_2 v_2^2 = \frac{1}{2} M_1 (v_1')^2 + \frac{1}{2} M_2 (v_2')^2$$

$$\frac{1}{2}(0.44)(4.5)^2 = \frac{1}{2}(0.44)(v_1')^2 + \frac{1}{2}(0.22)(v_2')^2$$

$$4.455 = 0.22(v_1')^2 + 0.11(v_2')^2$$

$$4.455 = 0.22(4.5 - 0.5 v_2')^2 + 0.11(v_2')^2$$

$$4.455 = 0.22(20.25 - 4.5 v_2' + 0.25(v_2')^2) + 0.11(v_2')^2$$

$$4.455 = 4.455 - 0.99 v_2' + 0.055(v_2')^2 + 0.11(v_2')^2$$

$$0.165(v_2')^2 - 0.99 v_2' = 0$$

$$v_2' = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$= \frac{0.99 \pm \sqrt{0.99^2 - 4(0.165)(0)}}{2(0.165)}$$

$$= \boxed{6 \text{ m/s}} \text{ OR } 0$$

$$v_1' = 4.5 - 0.5(6)$$

$$v_1' = \boxed{1.5 \text{ m/s}}$$

$$\textcircled{2} M_1 = 0.300 \text{ kg}$$

$$v_1 = 2.50 \text{ m/s}$$

$$M_2 = 0.6 \text{ kg}$$

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

$$M_1 v_1 + M_2 v_2 = M_1 v_1' + M_2 v_2'$$

$$0.3(2.5) = 0.3(v_1') + 0.6(v_2')$$

$$0.75 - 0.3v_1' = 0.6v_2'$$

$$v_1' = 2.5 - 2v_2'$$

$$\begin{aligned} \frac{1}{2} M_1 v_1^2 + \frac{1}{2} M_2 v_2^2 &= \frac{1}{2} M_1 (v_1')^2 + \frac{1}{2} M_2 (v_2')^2 \\ 0.5(0.3)(2.5)^2 &= \frac{1}{2}(0.3)(v_1')^2 + 0.5(0.6)(v_2')^2 \\ 0.9375 &= 0.15(v_1')^2 + 0.3(v_2')^2 \end{aligned}$$

$$0.9375 = 0.15(2.5 - 2v_2')^2 + 0.3(v_2')^2$$

$$0.9375 = 0.15(6.25 - v_2' + 4(v_2')^2) + 0.3(v_2')^2$$

$$0.9375 = 0.9375 - 0.15v_2' + 0.6(v_2')^2 + 0.3(v_2')^2$$

$$0.9(v_2')^2 - 0.15v_2' = 0$$

$$v_2' = \frac{0.15 \pm \sqrt{0.15^2}}{2(0.9)} = 0.16$$

$$v_1' = 2.18 \text{ m/s}$$

$$(2.5 - 2v_2')(2.5 - 2v_2')$$

$$\begin{aligned}
 (3) \quad m_1 &= m_2 & m_1 v_1 + m_2 v_2 &= m_1 v_1' + m_2 v_2' \\
 v_1 &= 2 \text{ m/s} & m_2(2) + m_2(-3) &= m_2 v_1' + m_2 v_2' \\
 v_2 &= -3 \text{ m/s} & -m_2 &= m_2(v_1' + v_2') \\
 & & -1 &= v_1' + v_2' \\
 & & v_2' &= -1 - v_1'
 \end{aligned}$$

$$\frac{1}{2} m_1 v_1^2 + \frac{1}{2} m_2 v_2^2 = \frac{1}{2} m_1 (v_1')^2 + \frac{1}{2} m_2 (v_2')^2$$

$$0.5 m_2 (2)^2 + 0.5 (m_2) (3)^2 = 0.5 m_2 (v_1')^2 + 0.5 m_2 (v_2')^2$$

$$2m_2 + 4.5m_2 = 0.5m_2 [(v_1')^2 + (v_2')^2]$$

$$\frac{6.5}{0.5} = (v_1')^2 + (v_2')^2$$

$$13 = (v_1')^2 + (-1 - v_1')^2$$

$$13 = (v_1')^2 + (1 + 2v_1' + (v_1')^2)$$

$$2(v_1')^2 + 2v_1' - 12 = 0$$

$$v_1' = \frac{-2 \pm \sqrt{2^2 - 4(2)(-12)}}{4}$$

$$= 0.5 \text{ OR } \boxed{-3 \text{ m/s}}$$

$$v_2' = -1 + 3 = \boxed{2 \text{ m/s}}$$

(4)

$$\boxed{2 \text{ m/s}}$$

$$\textcircled{4} \quad M_A = 2.4 \text{ kg} \quad M_A V_A + M_B V_B = M_A V_A' + M_B V_B'$$

$$V_A = 10 \text{ m/s} \quad 2.4(10) = 2.4 V_A' + 3.6 V_B'$$

$$M_B = 3.6 \text{ kg}$$

$$V_B = 0 \text{ m/s} \quad \frac{24 - 3.6 V_B'}{2.4} = V_A'$$

$$V_A' = 10 - 1.5 V_B'$$

$$\frac{1}{2} M_A V_A^2 + \frac{1}{2} M_B V_B^2 = \frac{1}{2} M_A (V_A')^2 + \frac{1}{2} M_B (V_B')^2$$

$$0.5(2.4)(10)^2 = 0.5(2.4)(V_A')^2 + 0.5(3.6)(V_B')^2$$

$$120 = 1.2(V_A')^2 + 1.8(V_B')^2$$

$$120 = 1.2(10 - 1.5 V_B')^2 + 1.8(V_B')^2$$

$$120 = 1.2(100 - 30 V_B' + 2.25(V_B')^2) + 1.8(V_B')^2$$

$$120 = 120 - 36 V_B' + 4.5(V_B')^2$$

$$4.5(V_B')^2 - 36 V_B' = 0$$

$$V_B' = \frac{36 \pm \sqrt{36^2}}{2(4.5)} = \boxed{8 \text{ m/s}} \text{ OR } 0 \text{ m/s}$$

$$V_A' = 10 - 1.5 V_B' = 10 - 1.5(8) = \boxed{-2 \text{ m/s}}$$

$$\textcircled{6} \quad \begin{array}{l} M_1 = 6 \text{ kg} \\ V_1 = 6 \text{ m/s} \\ M_2 = 2 \text{ kg} \\ V_2 = 2 \text{ m/s} \end{array} \quad \begin{array}{l} M_1 V_1 + M_2 V_2 = M_1 V_1' + M_2 V_2' \\ 6(6) + 2(2) = 6V_1' + 2V_2' \\ V_1' = \frac{40 - 2V_2'}{6} \\ V_1' = 6.67 - 0.33V_2' \end{array}$$

$$\frac{1}{2} M_1 V_1^2 + \frac{1}{2} M_2 V_2^2 = \frac{1}{2} M_1 (V_1')^2 + \frac{1}{2} M_2 (V_2')^2$$

$$\frac{1}{2}(6)(6)^2 + \frac{1}{2}(2)(2)^2 = \frac{1}{2}(6)(V_1')^2 + 0.5(2)(V_2')^2$$

$$112 = 3(V_1')^2 + (V_2')^2$$

$$112 = 3(6.67 - 0.33V_2')^2 + (V_2')^2$$

$$112 = 3(44.49 - 4.4V_2' + 0.109(V_2')^2) + (V_2')^2$$

$$112 = 133.47 - 13.2V_2' + 1.327(V_2')^2$$

$$1.327(V_2')^2 - 13.2V_2' + 21.47$$

$$V_2' = \frac{13.2 \pm \sqrt{13.2^2 - 4(1.327)(21.47)}}{2(1.327)}$$

$$= \boxed{7.9} \text{ OR } -38.6 \text{ m/s}$$

$$V_1' = 6.67 - 0.33(7.9) = 4.1$$

$$\therefore \boxed{V_1' = 4.1 \text{ m/s} \quad V_2' = 7.9 \text{ m/s}}$$