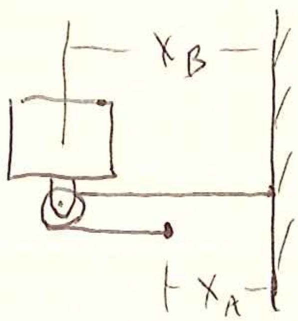
PROB. 13-21

$m_A = 3^{kg}, \quad m_B = 8^{kg}, \quad v_{B,1} = 0, \quad \Delta x_B = 0.6^m, \quad$ FIND $v_{B,2}$

BLOCK B:



$$x_B + (x_B - x_A) = \text{CONSTANT}$$

$$2x_B - x_A = \text{CONSTANT}$$

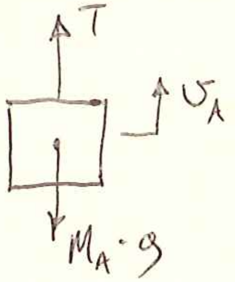
$$2x_B - x_A = 2x_{B,0} - x_{A,0}$$

$$2(x_B - x_{B,0}) = (x_A - x_{A,0})$$

$$\boxed{2\Delta x_B = \Delta x_A}$$

$$2v_B - v_A = 0 \; ; \quad \boxed{v_A = 2v_B}$$

BLOCK A:



$$T_1 + {}_1U_2 = T_2$$

$$T_1 = 0 \text{ SINCE } v_{A,1} = 0$$

$$T_2 = \frac{1}{2} m_A v_{A,2}^2 = \frac{1}{2} m_A (2v_{B,2})^2$$

$$T_2 = 2 m_A v_{B,2}^2$$

$${}_1U_2 = F\cos\alpha \cdot \Delta x = (T - m_A \cdot g) \cdot \Delta x_A = (T - m_A \cdot g)(2\Delta x_B)$$

$${}_1U_2 = 2(T - m_A \cdot g)\Delta x_B$$

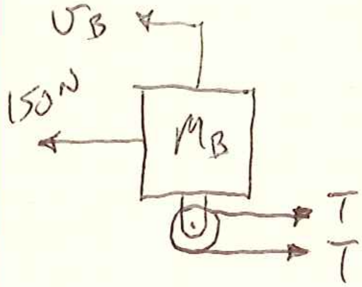
$$2(T - m_A \cdot g)\Delta x_B = 2 m_A \cdot v_{B,2}^2$$

$$T = m_A \cdot g + \frac{m_A v_{B,2}^2}{\Delta x_B} \; ; \quad \boxed{T = m_A\left(g + \frac{v_{B,2}^2}{\Delta x_B}\right)}$$

TOPS 35500

PROB. 13-21 CONT.

BLOCK B:



$$T_1 + {}_1U_2 = T_2$$

$T_1 = 0$ SINCE $v_{B,1} = 0$

$$T_2 = \frac{1}{2} m_B v_{B,2}^2$$

$${}_1U_2 = F\cos\alpha \cdot \Delta x$$

$${}_1U_2 = (150 - 2T)\cdot \Delta x_B$$

$$(150 - 2T)\cdot \Delta x_B = \frac{1}{2} m_B v_{B,2}^2$$

$$150\Delta x_B - 2\Delta x_B \cdot m_A\left(g + \frac{v_{B,2}^2}{\Delta x_B}\right) = \frac{1}{2} m_B v_{B,2}^2$$

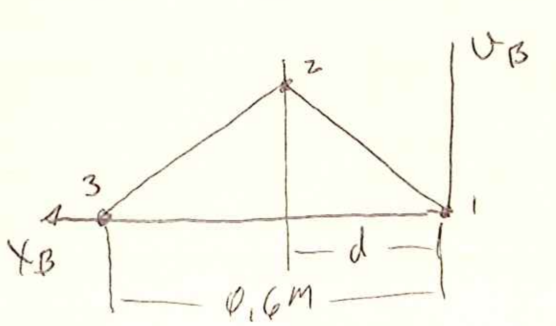
$$150\Delta x_B - 2m_A \cdot g\,\Delta x_B - 2m_A v_{B,2}^2 = \frac{1}{2} m_B v_{B,2}^2$$

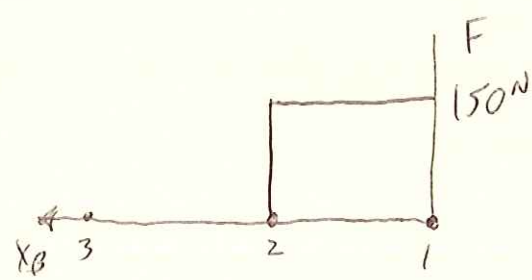
$$(4m_A + m_B)v_{B,2}^2 = (300 - 4m_A\cdot g)\Delta x_B$$

$$v_{B,2} = \sqrt{\frac{(300 - 4m_A\cdot g)\,\Delta x_B}{(4m_A + m_B)}}$$

$$v_{B,2} = \sqrt{\frac{[300 - 4(3^{kg})(9.81\,\frac{m}{s^2})](0.6^m)}{[4(3^{kg}) + (8^{kg})]}} \;\; \boxed{= 2.338\,\frac{m}{s}}$$

b) FIND d FOR $v_{B,3} = 0$





PROB. 13-21 CONT.

FROM BEFORE, $\Delta X_A = 2\Delta X_B$ AND $v_A = 2v_B$

PART 1: 150^N FORCE IS APPLIED UNTIL $\Delta X_B = d$

BLOCK A: $T_1 + {}_1U_2 = T_2$

$T_1 = 0$ SINCE $v_{A,1} = 0$; $T_2 = \frac{1}{2} m_A v_{A,2}^2$

$T_2 = \frac{1}{2} m_A (2v_{B,2})^2 = 2m_A v_{B,2}^2$

${}_1U_2 = (T - m_A \cdot g) \cdot \Delta X_A = 2(T - m_A \cdot g)\Delta X_B = 2(T - m_A \cdot g)d$

$2(T - m_A \cdot g)\cancel{\Delta X_B}\,d = 2m_A v_{B,2}^2$

$T = m_A \cdot g + \frac{m_A v_{B,2}^2}{\cancel{\Delta X_B}\,d} \boxed{= m_A\left(g + \frac{v_{B,2}^2}{d}\right)}$

BLOCK B: $T_1 + {}_1U_2 = T_2$, $T_1 = 0$, $T_2 = \frac{1}{2} m_B v_{B,2}^2$

${}_1U_2 = (150 - 2T)d$

$(150 - 2T)d = \frac{1}{2} m_B v_{B,2}^2$

$150d - 2d \cdot m_A\left(g + \frac{v_{B,2}^2}{d}\right) = \frac{1}{2} m_B v_{B,2}^2$

$150d - 2d m_A \cdot g - 2m_A v_{B,2}^2 = \frac{1}{2} m_B v_{B,2}^2$

$(4m_A + m_B)v_{B,2}^2 = 300d - 4m_A \cdot g \cdot d$

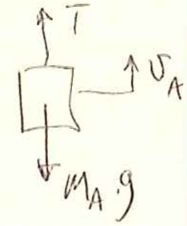
$$\boxed{v_{B,2}^2 = \left[\frac{(300 - 4m_A \cdot g)d}{(4m_A + m_B)}\right]}$$

PROB. 13-21 CONT.

PART 2: 150^N FORCE IS REMOVED.

BLOCK A: $T_2 + {}_2U_3 = T_3$, $T_3 = 0$ SINCE $v_{A,3} = 0$

$$T_2 = \frac{1}{2} m_A v_{A,2}^2 = \frac{1}{2} m_A (2v_{B,2})^2 = 2 m_A v_{B,2}^2$$



$${}_2U_3 = (T - m_A \cdot g) \cdot \Delta X_A = (T - m_A \cdot g)(2 \Delta X_B)$$

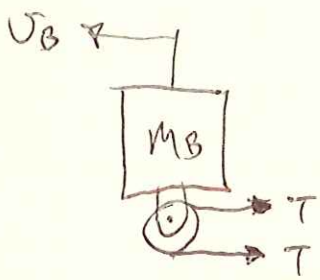
$${}_2U_3 = 2(T - m_A \cdot g)(0.6 - d)$$

$$2 m_A v_{B,2}^2 + 2(T - m_A \cdot g)(0.6 - d) = 0$$

$$(T - m_A \cdot g) = -\frac{m_A v_{B,2}^2}{(0.6 - d)}$$

$$T = m_A \cdot g - \frac{m_A v_{B,2}^2}{(0.6 - d)} = \boxed{m_A \left[g - \frac{v_{B,2}^2}{(0.6 - d)} \right]}$$

BLOCK B:



$T_2 + {}_2U_3 = T_3$, $T_3 = 0$ SINCE $v_{B,3} = 0$

$$T_2 = \frac{1}{2} m_B v_{B,2}^2$$

$${}_2U_3 = -2T(0.6 - d)$$

$$\frac{1}{2} m_B v_{B,2}^2 - 2T(0.6 - d) = 0$$

$$\frac{1}{2} m_B v_{B,2}^2 - 2(0.6 - d) \cdot m_A \left[g - \frac{v_{B,2}^2}{(0.6 - d)} \right] = 0$$

$$\frac{1}{2} m_B v_{B,2}^2 - 2(0.6 - d) m_A g + 2 m_A v_{B,2}^2 = 0$$

PROB. 13-21 CONT.

$$m_B v_{B,2}^2 - 4(0.6-d)m_A g + 4m_A v_{B,2}^2 = 0$$

$$(m_B + 4m_A)v_{B,2}^2 = 4(0.6-d)m_A g$$

$$(m_B + 4m_A)\left[\frac{(300-4m_A g)d}{(4m_A + m_B)}\right] = 4(0.6-d)m_A \cdot g$$

$$(300 - 4m_A g)d = 4(0.6-d)m_A \cdot g$$

$$(300 - 4m_A \cdot g + 4m_A \cdot g)d = 2.4\, m_A \cdot g$$

$$d = \frac{2.4\, m_A \cdot g}{300} = \frac{2.4(3^{kg})(9.81\,\frac{m}{s^2})}{300} \boxed{= 0.2354^{m}}$$