PROB. 13-136

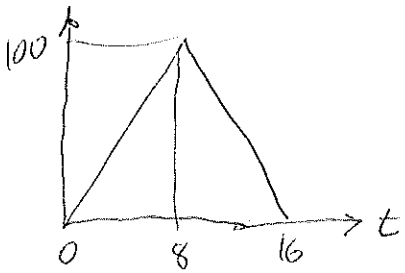
$W = 125^{LB}$, $\mu_s = 0.50$, $\mu_K = 0.40$, $v_1 = 0$

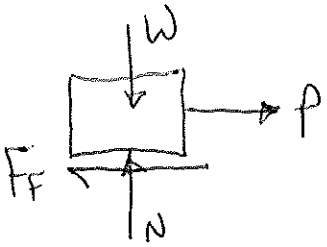
a) FIND TIME WHEN BLOCK STARTS TO MOVE.

FROM $0 \le t \le 8^s$, $P = \frac{100}{8} t = 12.5t$

FROM $8 \le t \le 16^s$, $P = -12.5t + b$, $0 = -12.5(16) + b$

$b = 200 \Rightarrow P = -12.5t + 200$



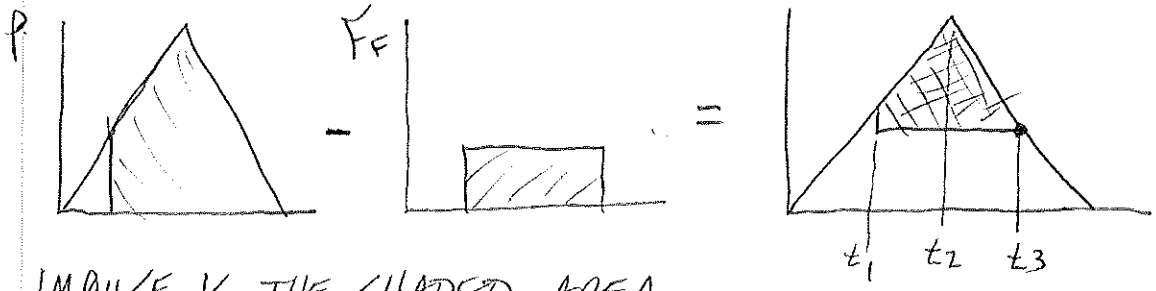


$F_F = \mu_s W$: BLOCK MOVES WHEN

$P = \mu_s W = (0.5)(125^{LB}) = 62.5^{LB}$

$t = \frac{P}{12.5} = \frac{62.5}{12.5} = 5.0^s$

b) FIND v_{max} : OCCURS WHEN THE IMPULSE IS MAXIMUM



IMPULSE IS THE SHADED AREA

FIND t_3 : $\mu_K W = (0.4)(125^{LB}) = 50^{LB}$

$-12.5t_3 + 200 = 50 \Rightarrow t_3 = 12^s$

PROB. 13-136 CONT.

$$m\cancel{v_1}^{\,0} + \Sigma Imp_{1-2} = mv_2, \quad \Sigma Imp = \frac{W}{g}v_2, \quad v_2 = \frac{(\Sigma Imp)g}{W}$$

$$\Sigma Imp = \int_{t_1}^{t_2} F\,dt + \int_{t_2}^{t_3} F\,dt$$

$$= \int_{t_1}^{t_2} P\,dt + \int_{t_2}^{t_3} P\,dt - \int_{t_1}^{t_3} \mu_k W\,dt$$

$$= \int_5^8 (12.5t)\,dt + \int_8^{12} (-12.5t + 200)\,dt - \int_5^{12} (50)\,dt$$

$$= \left[\frac{12.5}{2}t^2\right]_5^8 + \left[-\frac{12.5}{2}t^2 + 200t\right]_8^{12} - \left[50t\right]_5^{12}$$

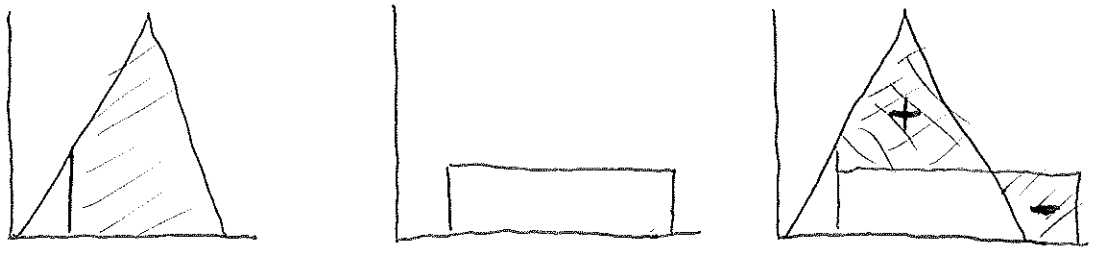
$$= \frac{12.5}{2}(8^2 - 5^2) - \frac{12.5}{2}(12^2 - 8^2) + 200(12-8) - 50(12-5)$$

$$\Sigma Imp = 193.75 \text{ lb}\cdot\text{s}$$

$$v_2 = \frac{(193.75 \text{ lb}\cdot\text{s})(32.2 \frac{\text{ft}}{\text{s}^2})}{(125 \text{ lb})} = 49.91 \frac{\text{ft}}{\text{s}}$$

c) FIND TIME WHEN BLOCK STOPS MOVING

$$m\cancel{v_1}^{\,0} + \Sigma Imp_{1-2} = m\cancel{v_2}^{\,0} \Rightarrow \Sigma Imp_{1-2} = 0$$



$$\Sigma Imp_{1-2} = \int_{t_1}^{t_2} P\,dt + \int_{t_2}^{t_3} P\,dt - \int_{t_1}^{t_3} W\,dt = 0$$

FIRST SEE IF BLOCK IS STILL MOVING AT $t = 16$ s

PROB. 13-136 CONT.

AT $t = 16^s$,

$$\Sigma IMP_{1-2} = \int_5^8 (12.5t)\,dt + \int_8^{16} (-12.5t + 200)\,dt - \int_5^{16} (50)\,dt$$

$$= \left[\frac{12.5}{2}t^2\right]_5^8 - \left[\frac{12.5}{2}t^2\right]_8^{16} + \left[200t\right]_8^{16} - \left[50t\right]_5^{16}$$

$$= \frac{12.5}{2}(8^2 - 5^2) - \frac{12.5}{2}(16^2 - 8^2) + 200(16-8) - 50(16-5)$$

$$= (243.75 - 1200 + 1600) - (550) = 643.75 - 550$$

$$\Sigma IMP_{1-2} = 93.75^{LB \cdot s}$$

$$V_{16} = \frac{(93.75^{LB \cdot s})(32.2\frac{ft}{s^2})}{(125^{LB})} = 24.15\frac{ft}{s} \quad \text{STILL MOVING}$$

$$\Sigma IMP_{1-2} = 0 = \int_5^8 P\,dt + \int_8^{16} P\,dt - \int_5^t \mu_k W\,dt$$

$$\int_5^t 50\,dt = 643.75$$

$$\left[50t\right]_5^t = 643.75$$

$$50(t-5) = 643.75$$

$$50t - 250 = 643.75$$

$$\boxed{t = 17.87^s}$$