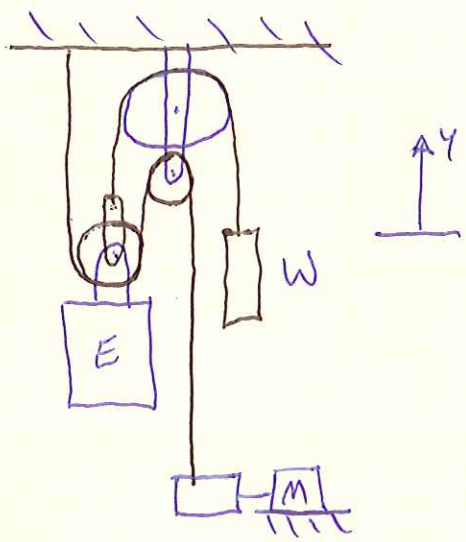
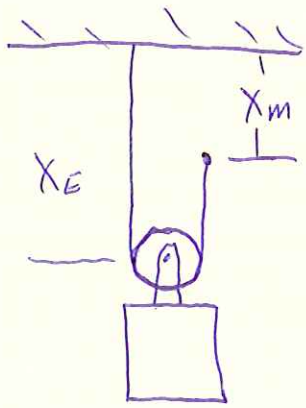
PROB. 13-54





$x_E + (x_E - x_m) = \text{CONST}$

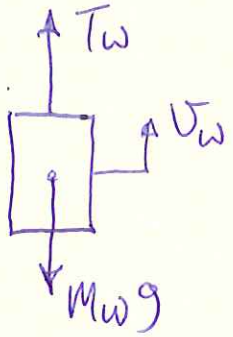
$2x_E - x_m = \text{CONST.}$

$2v_E = v_m$

$m_E = 3000\ kg$, $m_W = 1000\ kg$

a) FIND POWER WHEN $v_E = 3\ \frac{m}{s}$ DOWN (CONSTANT)

COUNTER WEIGHT:

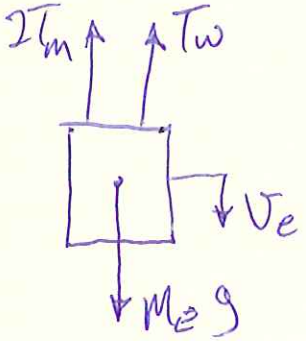


$\Sigma F = ma_y$

$T_W - m_W g = 0 \quad (a_W = 0)$

$T_W = m_W g$

ELEVATOR:

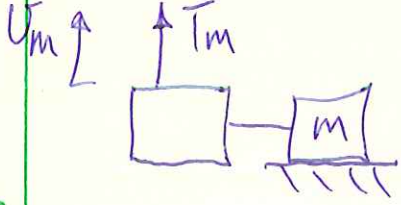


$\Sigma F = ma_y$

$2T_m + T_W - m_e g = 0 \quad (a_E = 0)$

$T_m = \frac{1}{2}(m_e g - T_W)$

MOTOR:



$P_m = \vec{F} \cdot \vec{v} = T_m \cdot v_m = \frac{1}{2}(m_e g - T_W) \cdot (2v_e)$

$P_m = (m_e g - m_W g)\, v_e$

$P_m = (m_e - m_W)\, g\, v_e$

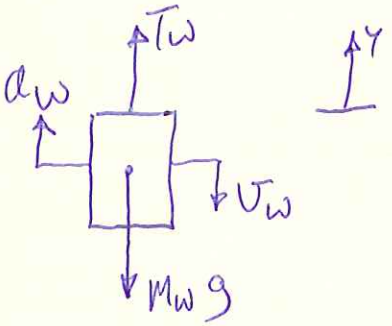
PROB. 13-54 CONT.

$$P_m = [3000 - 1000\ kg](9.81\ \tfrac{m}{s^2})(3\ \tfrac{m}{s})\left(\tfrac{N\cdot s^2}{kg\cdot m}\right)\left(\tfrac{J}{N\cdot m}\right)\left(\tfrac{kJ}{1000\ J}\right)\left(\tfrac{kW}{kJ/s}\right)$$

$$\boxed{P_m = 58.86\ kW}$$

b) FIND POWER FOR $v_e = 3\ \tfrac{m}{s}$ UPWARD, $a_E = 0.5\ \tfrac{m}{s^2}$ DECELERATING

COUNTERWEIGHT:

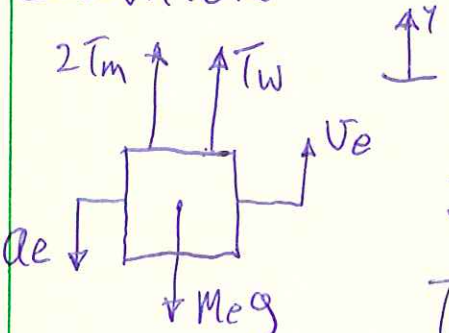


$$\Sigma F = ma_y$$

$$T_w - m_w g = m_w a_w$$

$$T_w = m_w(g + a_w) = m_w(g + a_E)$$

ELEVATOR:



$$\Sigma F = ma_y$$

$$2T_m + T_w - m_e g = -m_e a_e$$

$$2T_m + m_w(g + a_e) = m_e(g - a_e)$$

$$T_m = \tfrac{1}{2}[m_e(g - a_e) - m_w(g + a_e)]$$

$$P_m = \vec{F}\cdot\vec{v} = T_m \cdot v_m$$

$$= \tfrac{1}{2}[m_e(g - a_e) - m_w(g + a_e)]\cdot(2v_e)$$

$$= v_e[m_e(g - a_e) - m_w(g + a_e)]$$

$$= (3\ \tfrac{m}{s})[(3000\ kg)(9.81 - 0.5\ \tfrac{m}{s^2}) - (1000\ kg)(9.81 + 0.5\ \tfrac{m}{s^2})]$$

$$\cdot\left(\tfrac{N\cdot s^2}{kg\cdot m}\right)\left(\tfrac{J}{N\cdot m}\right)\left(\tfrac{kJ}{1000\ J}\right)\left(\tfrac{kW}{kJ/s}\right) = \boxed{52.86\ kW}$$