STAEDTLER® No. 937 811E Engineer's Computation Pad

••60 Figure 5-56 shows a man sitting in a bosun's chair that dangles from a massless rope, which runs over a massless, frictionless pulley and back down to the man's hand. The combined mass of man and chair is 95.0 kg. With what force magnitude must the man pull on the rope if he is to rise (a) with a constant velocity and (b) with an upward acceleration of 1.30 m/s²? (*Hint:* A free-body diagram can really help.)

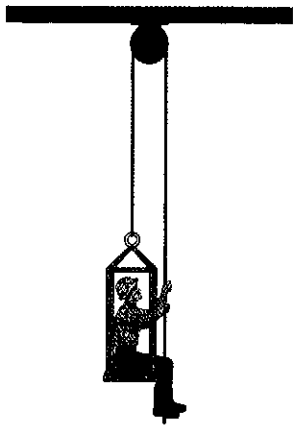
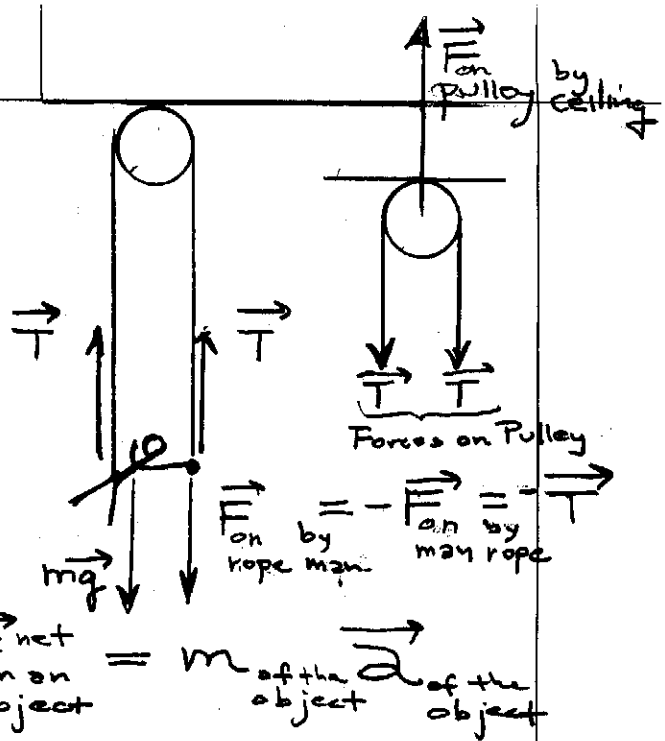


FIG. 5-56 Problem 60.

If the rope on the right extends to the ground and is pulled by a co-worker, with what force magnitude must the co-worker pull for the man to rise (c) with a constant velocity and (d) with an upward acceleration of 1.30 m/s²? What is the magnitude of the force on the ceiling from the pulley system in (e) part a, (f) part b, (g) part c, and (h) part d?



$\vec{F}^{\text{net on}}_{\text{man}} = \vec{T} + \vec{T} + m\vec{g} = m\vec{a}$ TAKE POSITIVE DIRECTION UPWARDS

$\Rightarrow 2T - mg = ma \Rightarrow T = m(g+a)/2$

a) $\vec{v} = \text{constant} \Rightarrow \vec{a} \equiv 0 \Rightarrow T = mg/2$

b) $\vec{a} \neq 0 \Rightarrow T = mg/2 + ma/2$

$\vec{F}^{\text{net}}_{\text{on pulley}} = \vec{T} + \vec{T} + \vec{F}_{pc} = m_p \vec{a}_c \equiv 0 \Rightarrow -2T + F_{pc} = 0$

$\Rightarrow \vec{F}_{\text{on pulley by ceiling}} = \vec{F}_{pc} = -\vec{F}_{cp} = +2T \quad (+\Rightarrow \text{up})$

e) $\vec{F}_{cp} = -2T = -2\,mg/2 = -mg$ if $a = 0$

f) $\vec{F}_{cp} = -2T = -2\left[mg/2 + ma/2\right] = -mg - ma$ if $a \neq 0$

$\vec{F}^{\text{net}}_{\text{on man}} = \vec{T} + m\vec{g} = m\vec{a}$

$\Rightarrow T - mg = ma \Rightarrow T = m(g+a)$

c) $T = mg$ if $a = 0$

d) $T = mg + ma$ if $a \neq 0$

g) $-2T = -2mg$

h) $-2T = -2mg + -2ma$

