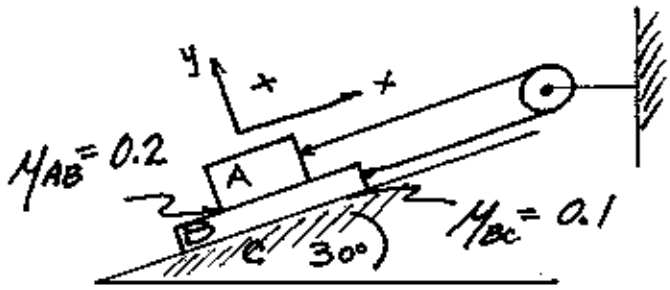
HIBBELER

Hc 13-34



$m_A = 10\,kg$

$W_A = 10\,kg\,(9.81\,\frac{m}{s^2}) = 98.1\,N.$

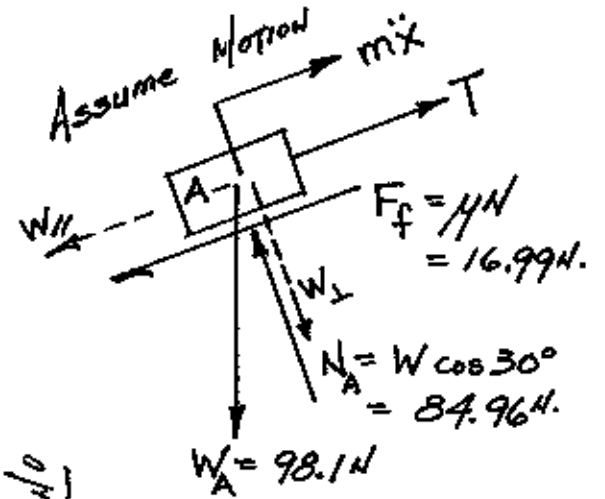
$m_B = 50\,kg$

$W_B = 50(9.81) = 490.5\,N.$

? t for Block A to slide 0.5 m on plate B ?

INITIALLY AT REST: $t = 0$, $x = \dot{x} = \ddot{x} = 0$

ISOLATE EACH MASS; DRAW F.B.D; APPLY NEWTON'S 2nd. LAW; SOLVE SIMULTANEOUSLY.



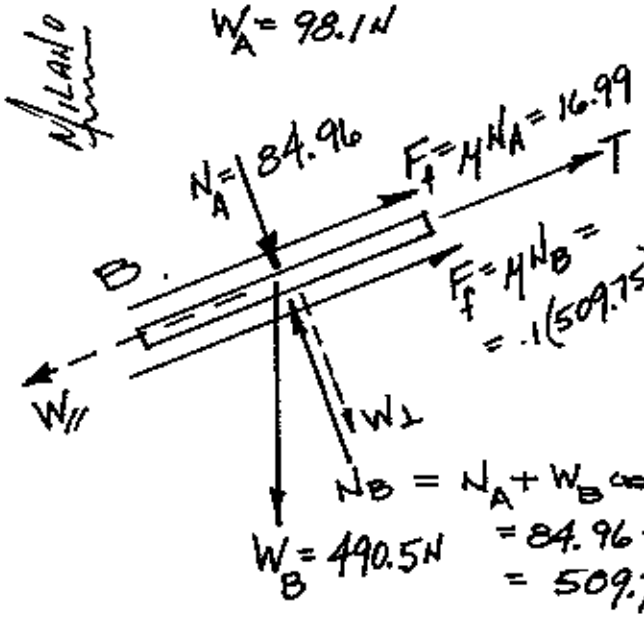
$\sum \vec{F}_{m_A} = m_A \vec{a}$

$T - W_A \sin 30° - \mu N = m_A \ddot{x}_A$

$T - 98.1\,(.5) - 16.99 = (10\,kg)\,\ddot{x}_A$

$T - 66.04 = 10\,\ddot{x}_A$ (1)

or $\boxed{T = 10\ddot{x}_A + 66.04}$



$\sum \vec{F}_{m_B} = m_B \vec{a}$

$T + F_{f_{AB}} + F_{f_{BC}} - W_B \sin 30° = m_B \ddot{x}_B$

$T + 16.99 + 50.98 - 245.25 = 50\,\ddot{x}_B$

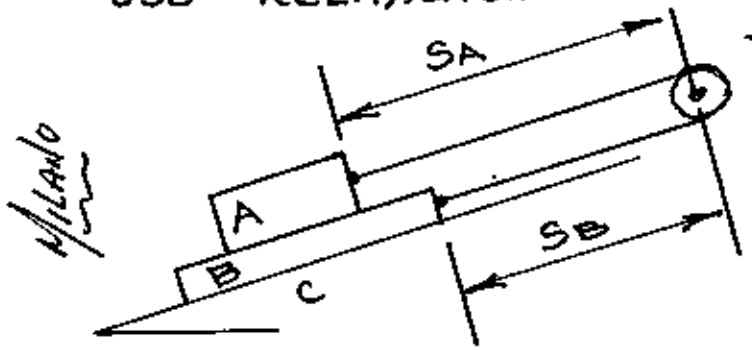
$T - 177.28 = 50\,\ddot{x}_B$ (2)

$\boxed{T = 50\ddot{x}_B + 177.28}$

SET EQ. (1) = EQ. (2)

$10\,\ddot{x}_A + 66.04 = 50\,\ddot{x}_B + 177.28$ (3)

for PULLEY SYSTEM,
USE RELATIONSHIP OF LENGTHS



You can ignore length around pulley since it is unchanged.

length of cable = $L = s_A + s_B + \frac{1}{2}\pi d$

Only s_A and s_B will vary. DIFFERENTIATE

$\frac{d}{dt} \Rightarrow 0 = \dot{s}_A + \dot{s}_B + 0$ VELOCITY

AGAIN, $\frac{d}{dt} \Rightarrow 0 = \ddot{s}_A + \ddot{s}_B$ ACCELERATION

$\therefore \boxed{\ddot{s}_A = -\ddot{s}_B}$ (4)

Substitute this relationship into Eq. (3)

$10\,\ddot{s}_A + 66.04 = 50(-\ddot{s}_A) + 177.28$

$60\,\ddot{s}_A = 111.24$

$\ddot{s}_A = 1.854 \frac{m}{s^2}$ ↗

$\therefore \ddot{s}_B = -1.854 \frac{m}{s^2}$ ↙ OPP. DIR.

BLOCK A slides on PLATE B 0.5m ; but B slides down as A slides up.

$\therefore$ RELAT. DIST. $s_{A/B} = 0.5m = {}^{\Delta}s_A - {}^{\Delta}s_B$

Where ${}^{\Delta}s_A = -{}^{\Delta}s_B$ for this pulley system

As ONE "SHORTENS", THE OTHER "LENGTHENS"

${}^{\Delta}s_A = .5 + {}^{\Delta}s_B = .5 + (-{}^{\Delta}s_A)$

${}^{\Delta}s_A = 0.25\,m$

$0.25 = s_0 + v_0 t + \frac{1}{2} a_A t^2$ where I.C. = 0

$0.25 = \frac{1}{2}(1.854)t^2$

$\boxed{t = 0.519\,s}$