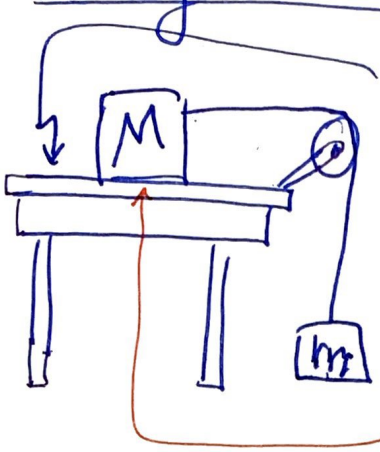
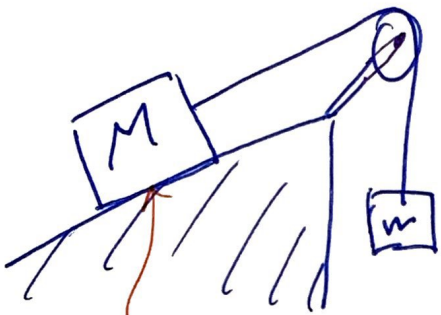
⊗ Pulley Problems 4d {Advanced Topics}



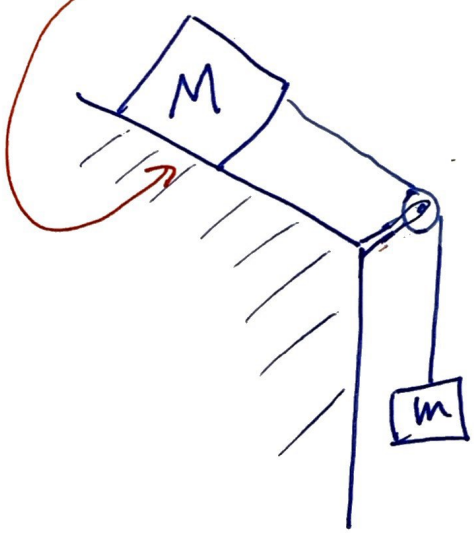
Friction: μ_s or μ_k or 0 depending...

← Chpt 4 used massless pulleys

F_N full weight F_W



partial F_N



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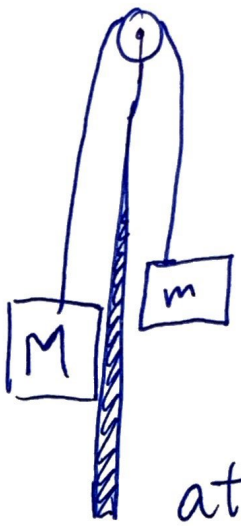


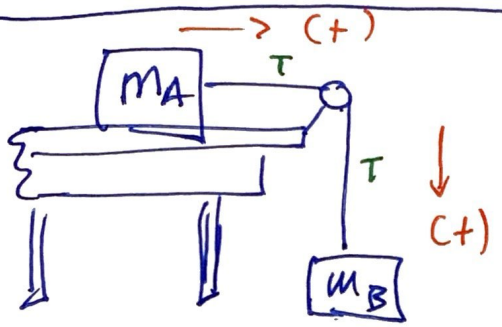
$F_N = 0$

atwood machine

{"table" dissapears}

Ex Consider a block A on a horizontal table with $\mu_k = 0.2$. Let $M_A = 5\,kg$ let there be a mass hanging over the edge of the table, passing thru a massless pulley that we call mass B, $M_B = 2\,kg$

(i)



DATA
$m_A = 5\,kg$
$m_B = 2\,kg$
$\mu_k = 0.2$
a = Find this value.

(ii)

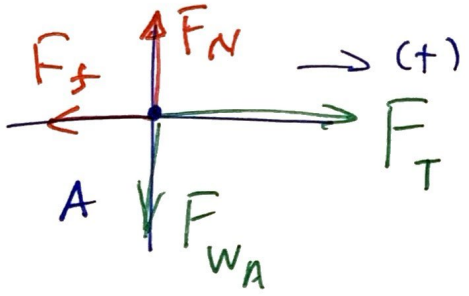
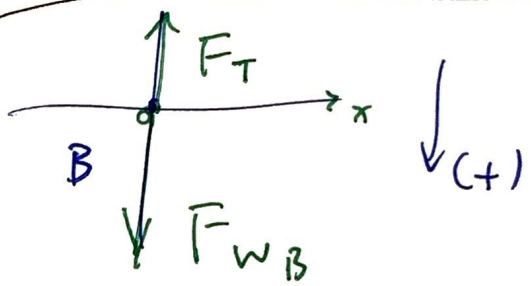


Table mass



Hanging mass

(iii) eqns.

x: $F_T - F_f = m_A a$ ← want $\quad -F_T + F_{W_B} = m_B a$ ← want

y: $F_N - F_{W_A} = 0$

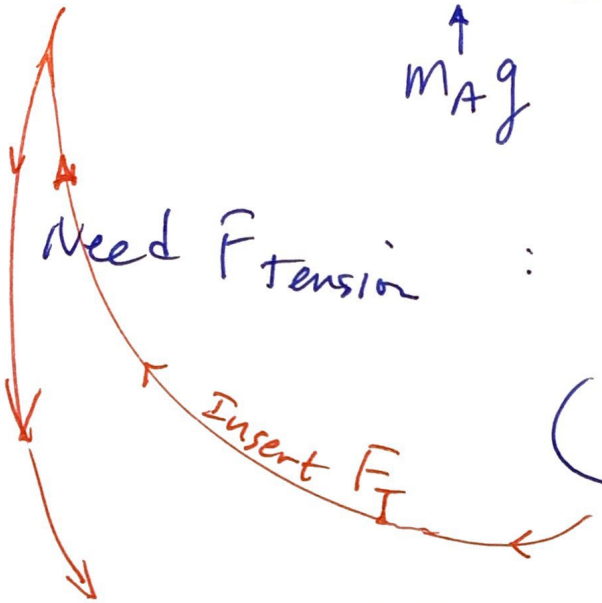
f: $F_f = \mu_k F_N$

(iv) Do the math y into f into x

$$F_T - [\mu_k (F_{W_A})] = m_A \underline{\underline{a}}$$

$$\uparrow$$

$$m_A g$$



Need $F_{tension}$: look at block B:

$$-F_T + F_{W_B} = m_B a$$

$$\Rightarrow F_T = F_{W_B} - m_B a$$

$$\Rightarrow \left[F_{W_B} - m_B \underline{\underline{a}}\right] - \mu_k m_A g = m_A \underline{\underline{a}}$$

$$\Rightarrow F_{W_B} - \mu_k m_A g = m_A a + m_B a$$

$$\Rightarrow m_B g - \mu_k m_A g = (m_A + m_B)\underline{\underline{a}}$$

$$\div \quad a = \frac{m_B g - \mu_k m_A g}{m_A + m_B}$$

$$\boxed{a = \left(\frac{m_B - \mu_k m_A}{m_B + m_A}\right) g}$$

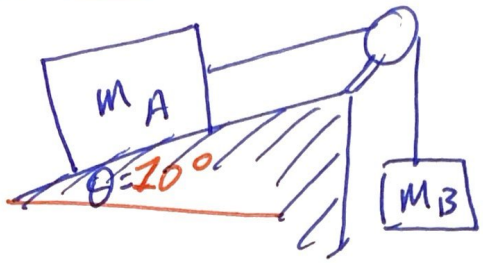
if $\mu_k = 0$ $\left(a = \frac{m_B}{m_{TOT}} \cdot g\right)$

if $m_A = 0$ $(a = g)$

$$= \left(\frac{2 - (0.2)5}{2+5}\right) g = \frac{2-1}{7} g = \boxed{\frac{1}{7} g} \quad \frac{1}{7}^{th} \text{ of free fall} = 1.4 \frac{m}{s^2}$$

Ex

(i)



$\theta = 10°$

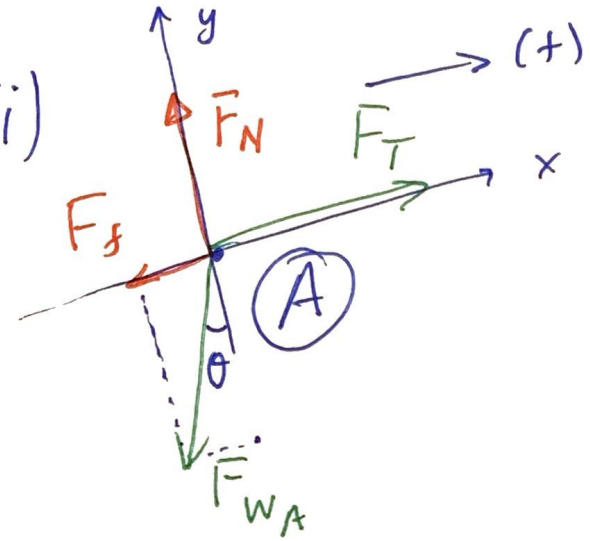
$m_A = 5\,kg$

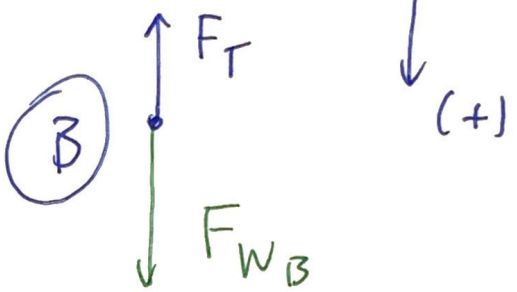
$m_B = 2\,kg$

$\mu_k = 0.2$

$a = ?$

(ii)





(iii) $x: F_T - F_f - F_{W_A}\sin\theta = M_A a$

$y: F_N - F_{W_A}\cos\theta = 0$

$f: F_f = \mu_{12} F_N$

$y: -F_T + F_{W_B} = m_B a$

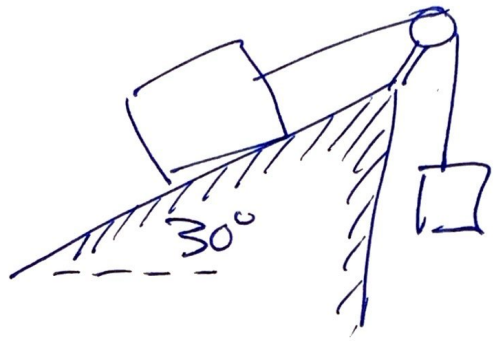
(iv) $x: (F_{W_B} - m_B a) - \mu_{12}\left[F_{W_A}\cos\theta\right] - F_{W_A}\sin\theta = m_A a$

$\Rightarrow m_B g - \mu_k m_A g\cos\theta - m_A g\sin\theta = m_A a + m_B a$

$\Rightarrow \boxed{a = \left[\frac{m_B - \mu_k m_A\cos\theta - m_A\sin\theta}{m_B + m_A}\right] g}$

$a = \left(\frac{2\,kg - (0.2)(5\,kg)\cos 10° - 5\,kg\sin 10°}{(2+5)\,kg}\right) g = 0.021\,g$

• let $\theta = 30°$



$$a = \left[\frac{2\,kg - (0.2)(5\,kg)\cos 30° - 5 \sin 30°}{2+5} \right] g$$

$$= \frac{-1.366}{7} g$$

$$= -0.195\, g \approx \underline{-0.2g}$$