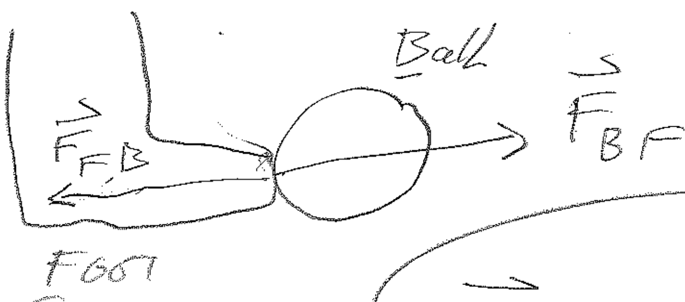
3RD LAW
CH 4

Review: Between 2 Bodies

FOR EVERY ACTION THERE IS A REACTION

FIG 4.25

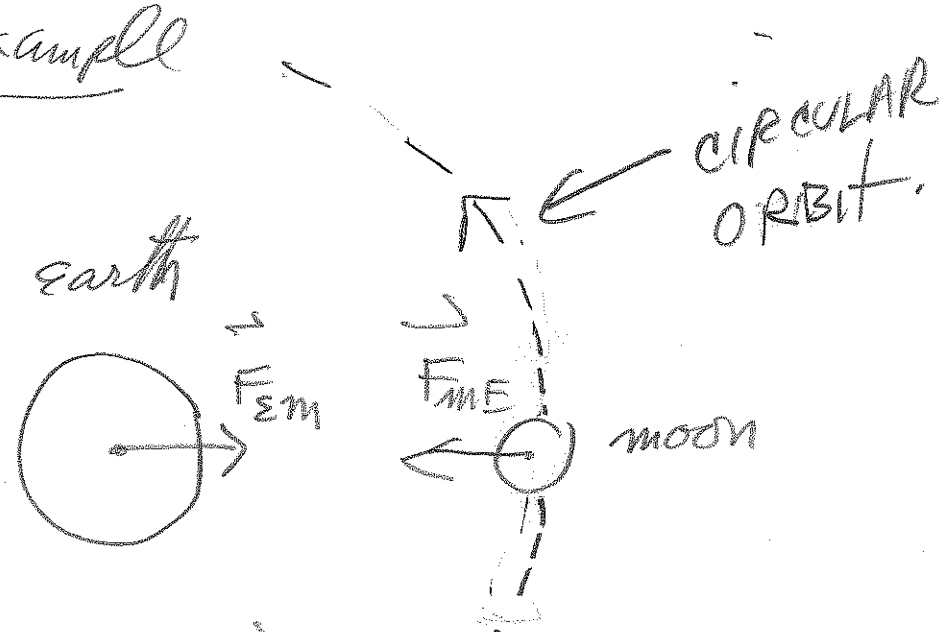


$$\vec{F}_{FB} = -\vec{F}_{BF}$$

NOTE: USE 2ND LAW TO GET $\vec{a}$ OF BALL:

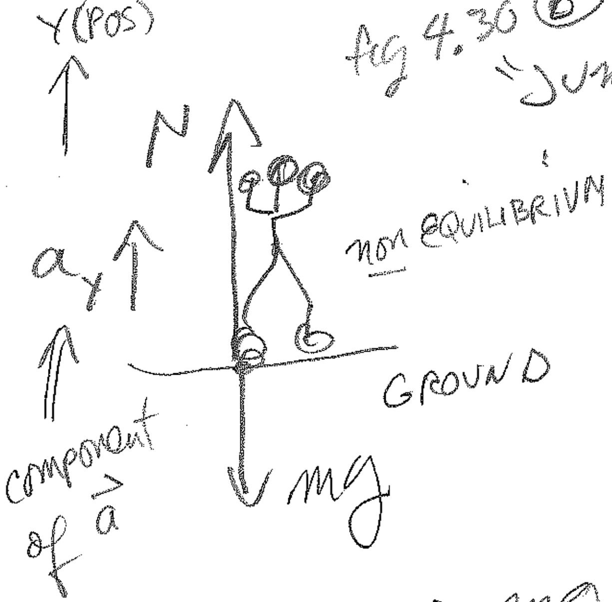
$$m_B \vec{a} = \vec{F}_{BF}$$

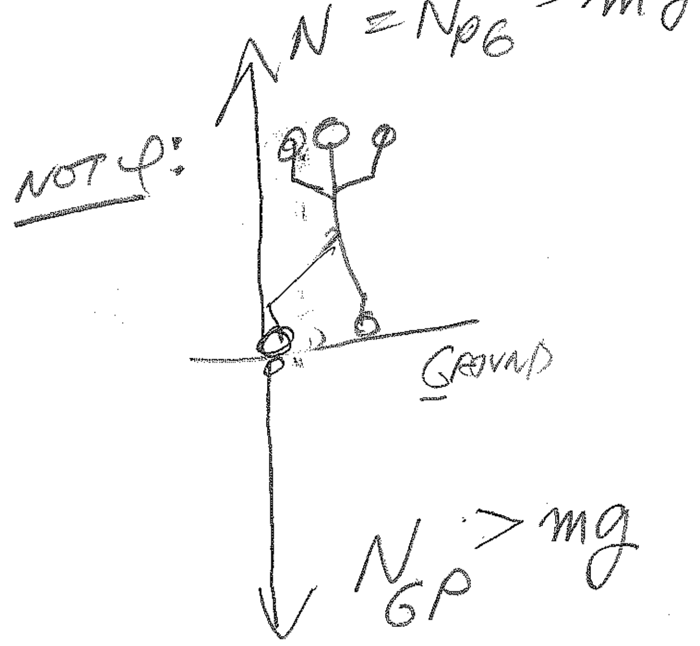
MY EXAMPLE



$$\vec{F}_{ME} = -\vec{F}_{EM}$$

fig 4.30 (b) "Jump up"





$N = N_{PG} > mg$

net force

Y(POS) ↑

$\sum F_y = pos - neg$

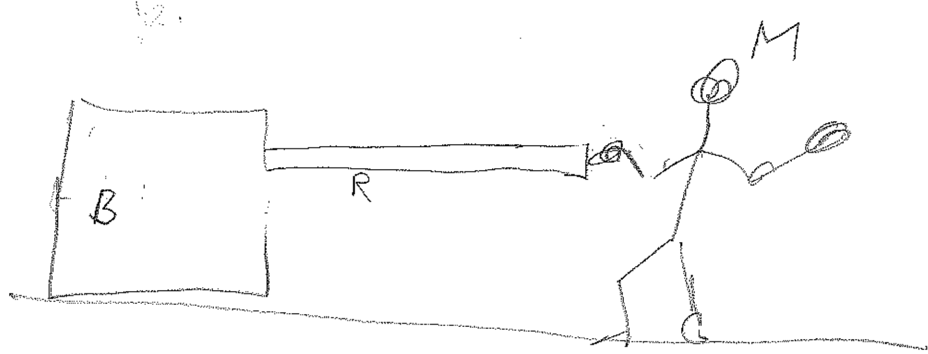
$ma_y = N_{PG} - mg$

$\vec{N}_{PG} = -\vec{N}_{GP}$

Ch4-5 as a unit of Thought

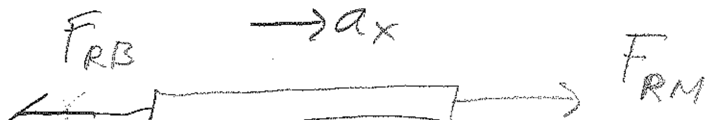
Newton's 3RD LAW

Example 4.10



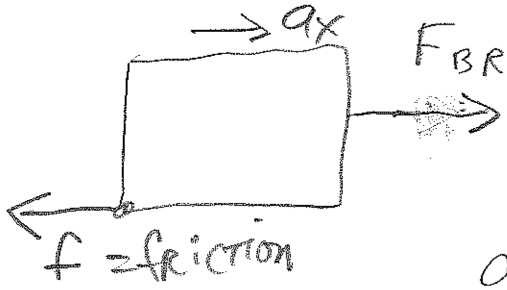
Isolate

Rope:



IF $F_{RB} = F_{RM}$, $a_x = 0$

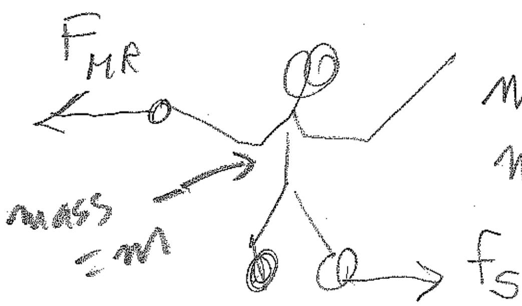
BOX:



IF $F_{BR} = f$, $a_x = 0$

$a_x = 0$ since $F_{MR} = f_s$

MAN:



$ma_x = pos - neg$

$ma_x = f_s - F_{MR} = 0$ IF EQUILIBRIUM

Example 4.10

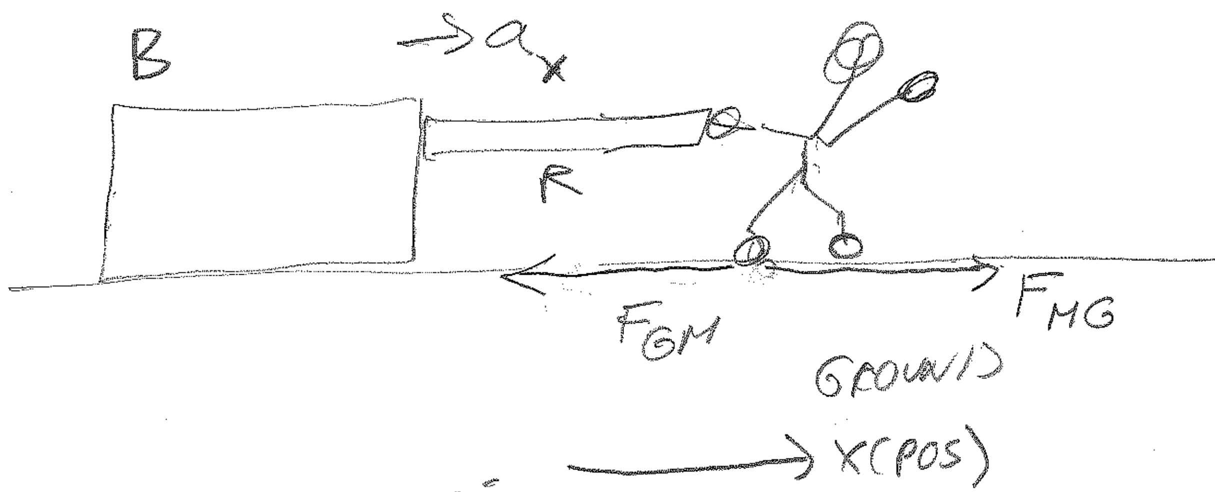
$$F_{RM} = F_{MR}$$

$$F_{BR} = F_{RB}$$

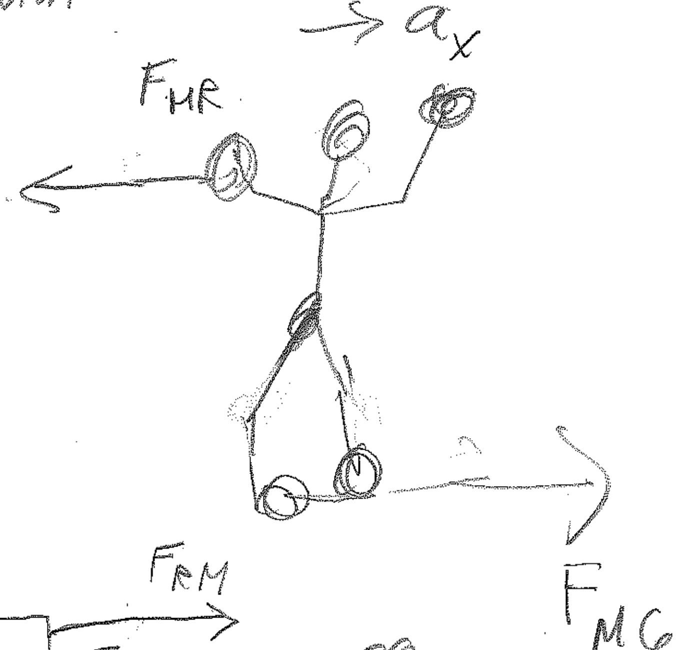
Equal magnitudes (3RD LAW)

Note: walking and pulling

rope + box



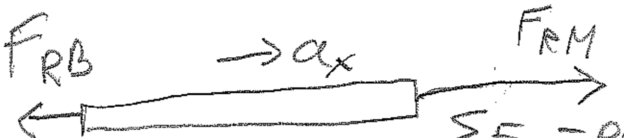
Now revisit



$\sum F_x = pos - neg$

$m_M a_x = F_{MG} - F_{MR}$

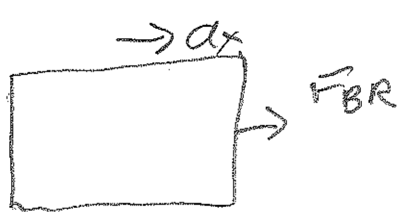
Rope



$\sum F_x = pos - neg$

$m_R a_x = F_{RM} - F_{RB}$

Box



$\sum F_x = pos - neg$

$m_B a_x = F_{BR} - 0$

3 EQUATIONS

(I) $m_M a_x = F_{MG} - F_{MR}$

(II) $m_R a_x = F_{RM} - F_{RB}$

(III) $m_B a_x = F_{BR}$

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note $F_{MR} = F_{RM}$ and $F_{RB} = F_{BR}$
from 3RD LAW Newton

ADD 3 EQUATIONS TO cancel F_{MR} and F_{RB}
where $F_{MR} = F_{RM}$ and $F_{RB} = F_{BR}$

ADD: $m_M a_x + m_R a_x + m_B a_x = F_{MG}$

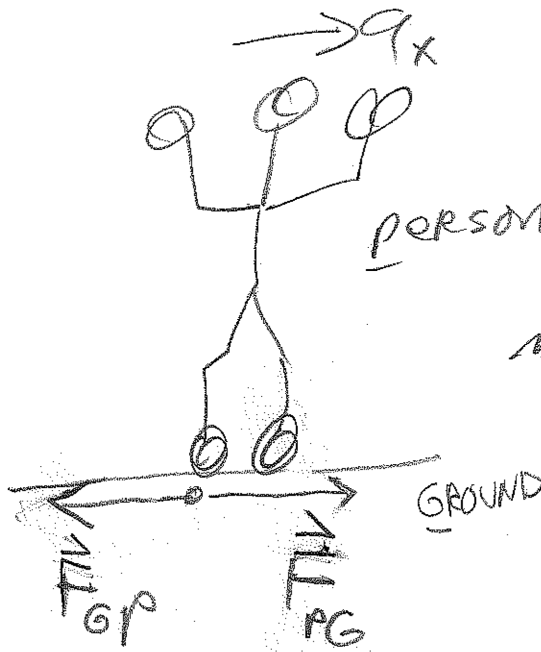
$$\Longrightarrow \quad a_x = \frac{F_{MG}}{m_M + m_R + m_B}$$

where $\vec{F}_{MG}$ = reaction force of GROUND ON M

Example 4.9

See page 125 review

fig 4.30(a) explains walking



note $\vec{F}_{PG} = -\vec{F}_{GP}$

and

$m a_x = F_{PGx}$

CH 5 All examples

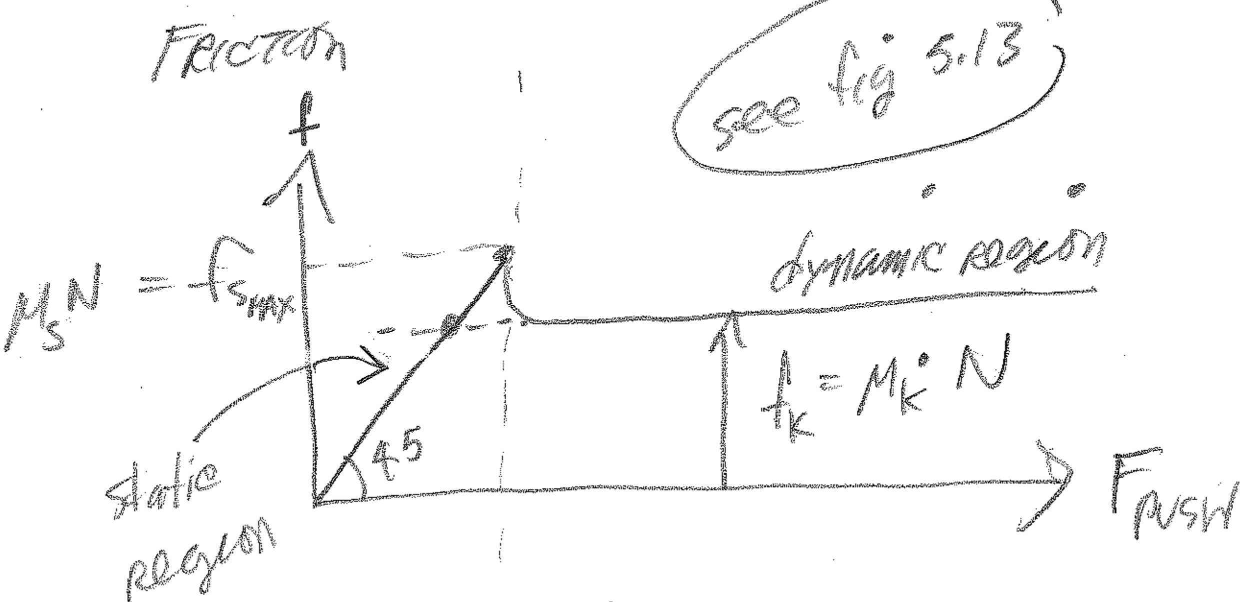
* at REST

** MOVING

$\vec{a}=0$ { Example 5.4 ✓ *Static EQUILIBRIUM
Example 5.5 **Dynamic EQUILIBRIUM

Example 5.6 non-EQUILIBRIUM
5.7 " "
5.8 " "
5.9 " "
(T=0) 5.10 ✓ " "
5.11 " "
5.12 " "

} $\vec{a} \neq 0$

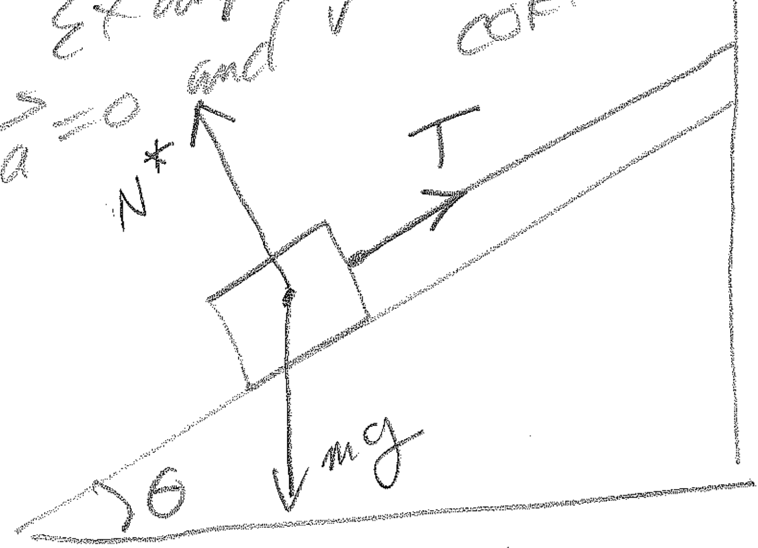


Example 5.16

Example 5.17 ✓

Example: 5.4

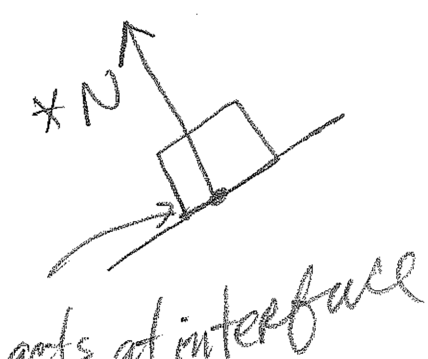
$\vec{a} = 0$ and $\vec{v} = 0$

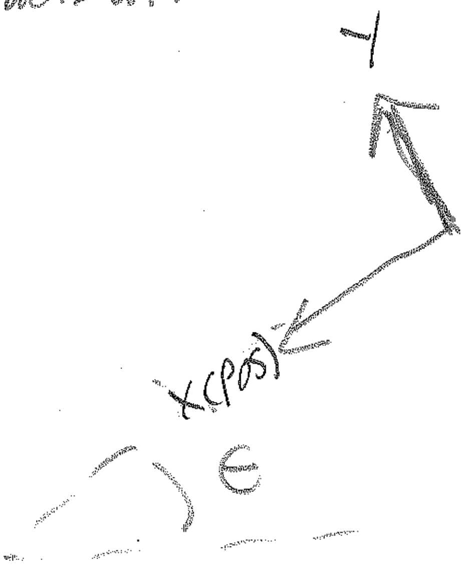


$T = |\vec{T}|$

$N = |\vec{N}|$

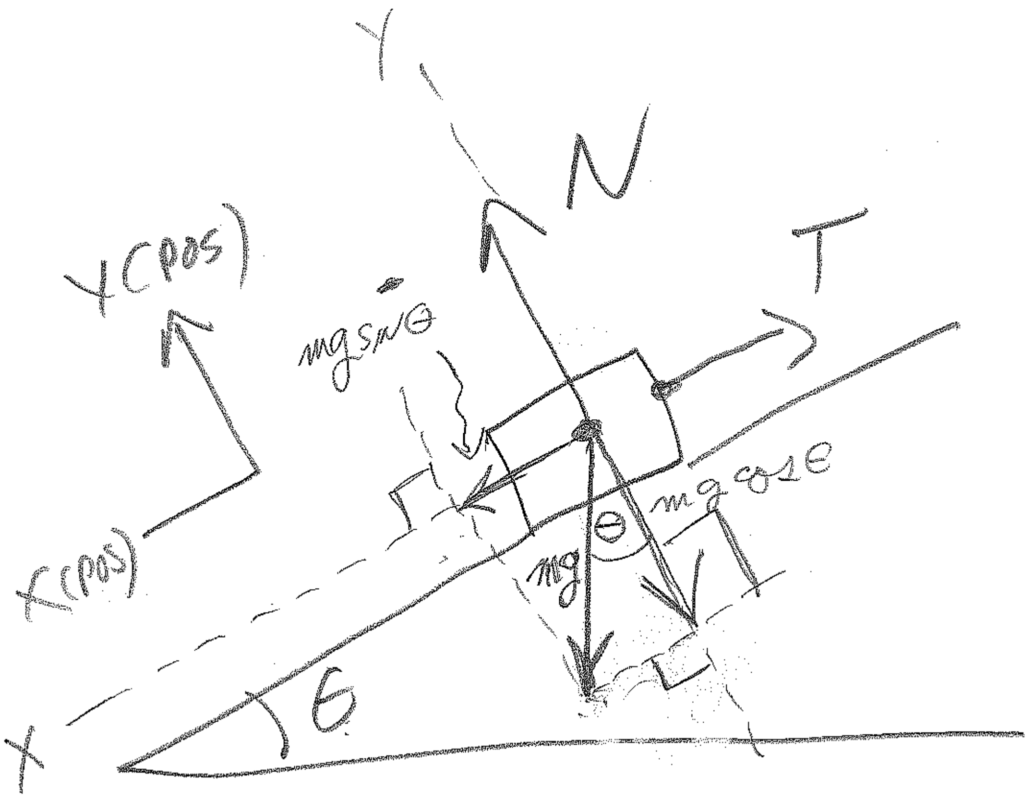
$mg = |m\vec{g}|$





(A) Choose X along incline (see test #1, #5)

(B) Decompose each vector along x and y



$$\Sigma F_x = pos - neg$$

$$ma_x = mg\sin\theta - T$$

EQUILIBRIUM $a_x = 0$

$$0 = mg\sin\theta - T$$

$$\boxed{T = mg\sin\theta}$$ SPECIAL CASE

$$\Sigma F_y = pos - neg$$

$$ma_y = N - mg\cos\theta$$

SINCE $a_y = 0$ (EQUILIBRIUM)

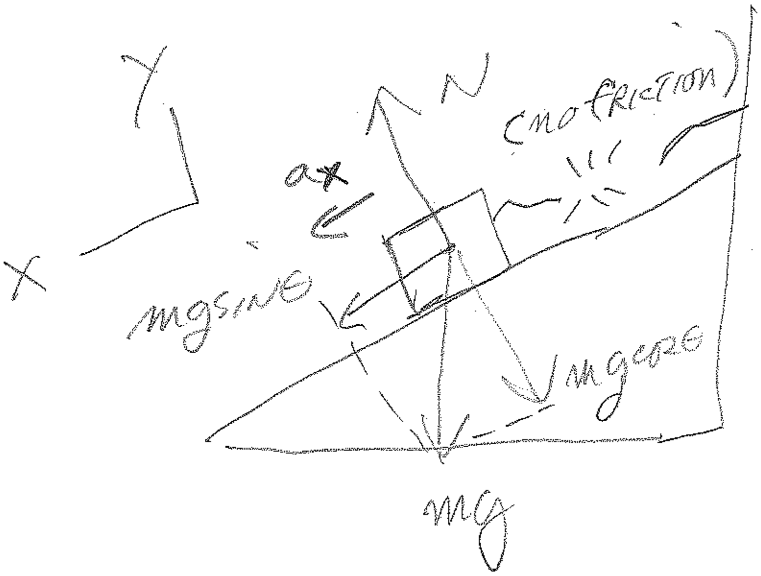
$$0 = N - mg\cos\theta$$

$$N = mg\cos\theta$$

GENERALLY TRUE

cut the cable $(T=0)$

$\Rightarrow$ cut to Example 5.10



$$\sum F_x = \text{pos} - \text{neg}$$

$$ma_x = mg\sin\theta - 0$$

$$\boxed{a_x = g\sin\theta} \leq g$$

since $\sin\theta \leq 1$

Galileo lab
$(5^\circ < \theta < 10^\circ)$

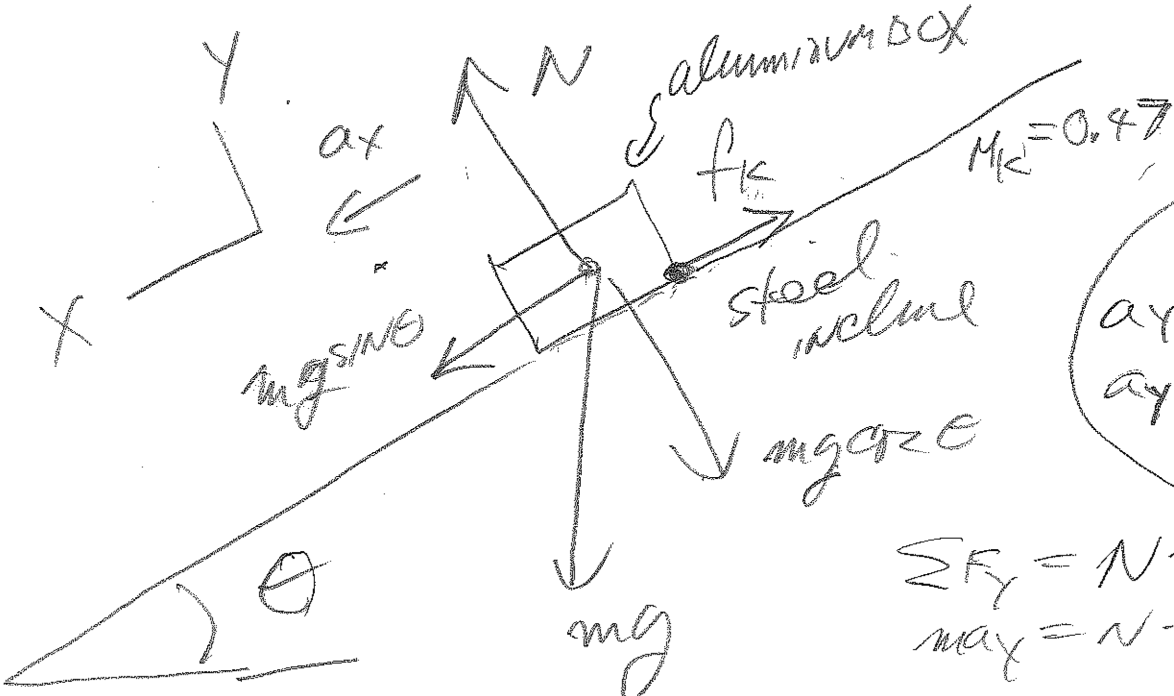
Example 5.17 (μ_K is given)

Use $f_K = \mu_K \cdot N$

Table of coefficients (pg 147 table 5.1)

Examples al on steel ($\mu_K = 0.47$)

Rubber on concrete ($\mu_K = 0.8$)



$a_Y = \frac{dv_Y}{dt} = 0$

$a_Y = 0$ since $v_Y = 0$ = constant

$\Sigma F_Y = N - mg\cos\theta$

$ma_Y = N - mg\cos\theta$

$0 = N - mg\cos\theta$

$N = mg\cos\theta$

$f_K = \mu_K \cdot N$

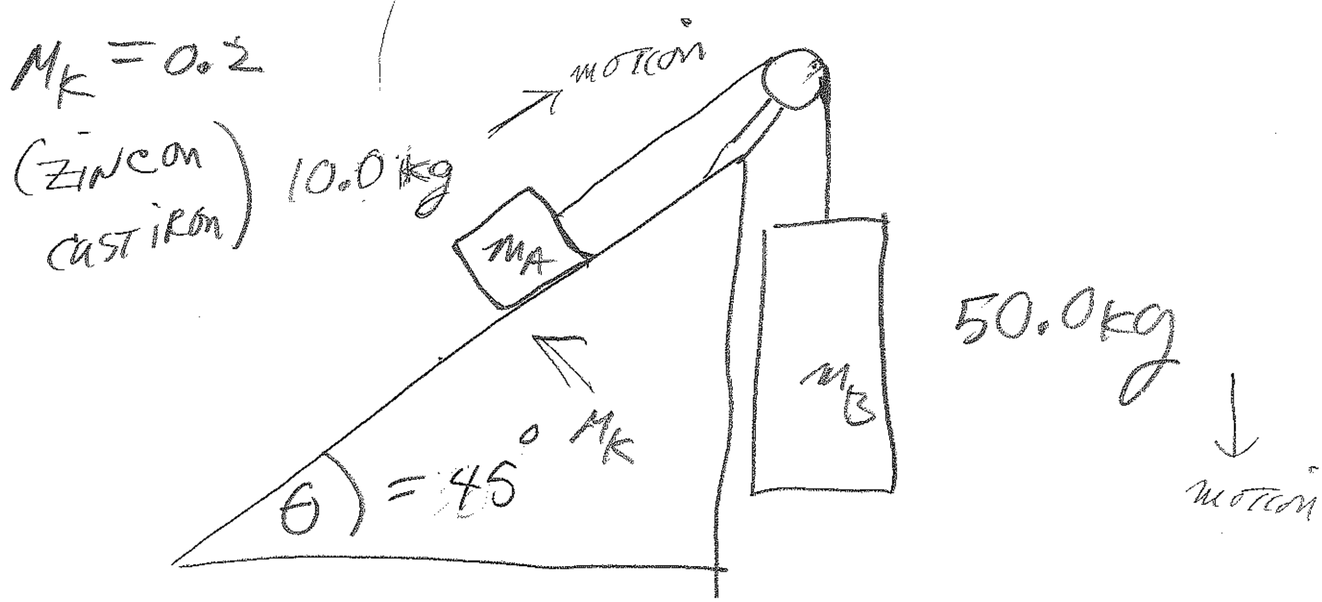
$\Sigma F_X =$ pos − neg.

$ma_X = mg\sin\theta - f_K$

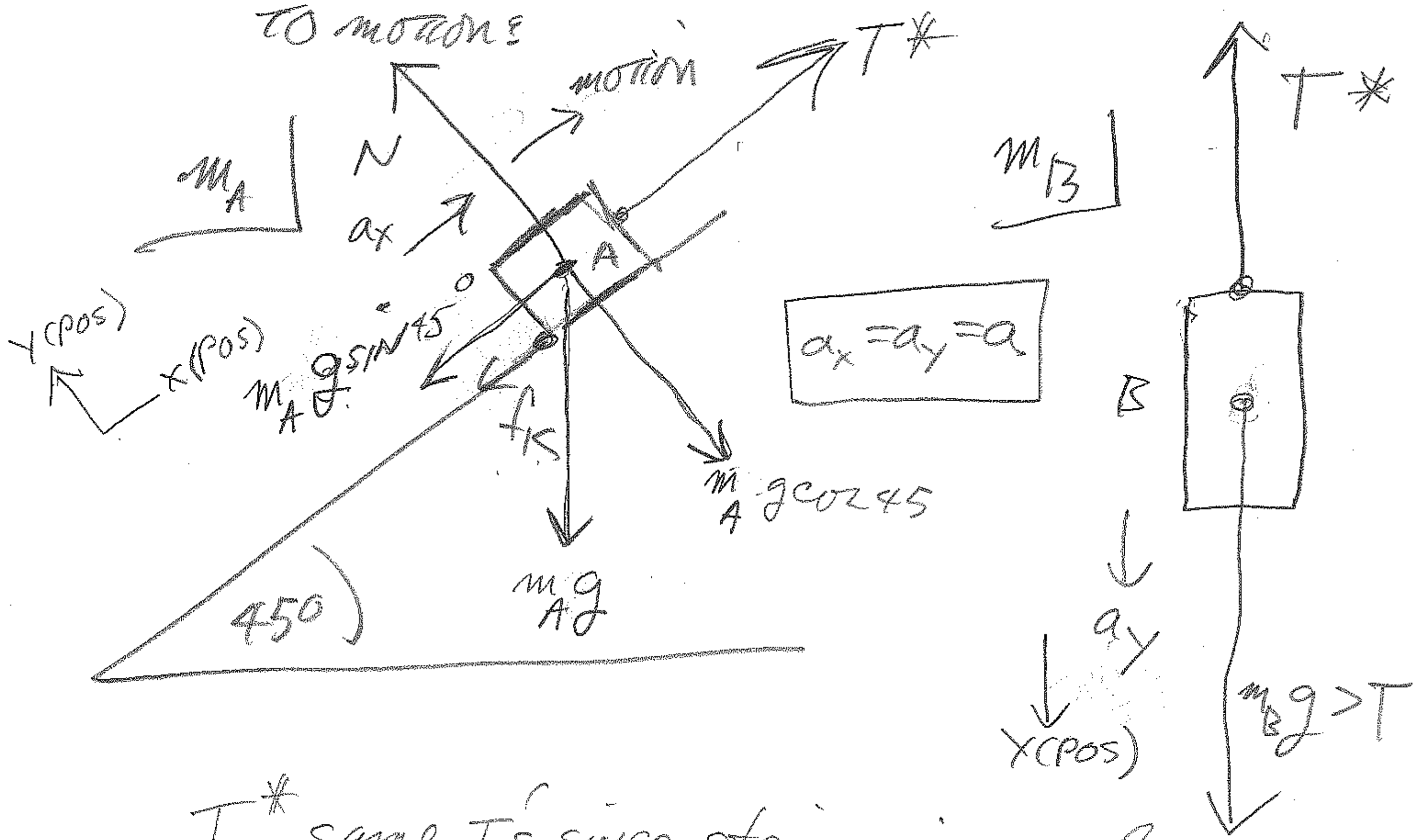
$m a_X = mg\sin\theta - \mu_K \cdot N$

$m a_X = mg\sin\theta - \mu_K \cdot mg\cos\theta \Rightarrow \boxed{a_X = g\sin\theta - \mu_K g\cos\theta}$

SUMMARY problem

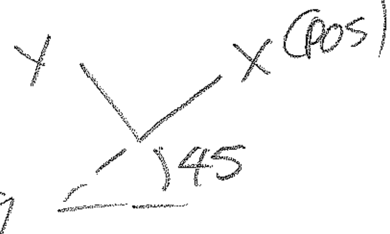


Isolate objects; pick axes according to motion!



T* same T's since string is massless and pulley is also massless.

m_A



$$m_A a_x = pos - neg$$

$$m_A a_x = T - m_A g \sin 45 - f_K$$

note: $\sum F_Y = m_A a_Y = 0 = N_A - m_A g \cos\theta$

$$N_A = m_A g \cos\theta$$

$$m_A a_x = T - m_A g \sin 45 - \mu_K m_A g \cos 45$$

m_B

$$m_B a_Y = pos - neg$$

$$m_B a_Y = m_B g - T$$

↓ Y (POS)

$$a_Y = a_x = a$$

UNKNOWNS: a and T

(I) $m_A a = T - m_A g \sin 45 - \mu_K m_A g \cos 45$

(II) $m_B a = m_B g - T$

ADD $m_A a + m_B a = m_B g - m_A g \sin 45 - \mu_K m_A g \cos 45$

$$a = \frac{m_B g - m_A g \sin 45 - \mu_K m_A g \cos 45}{(m_A + m_B)}$$

$$a \approx \frac{416\,(N)}{60\,kg}$$

$$a = \boxed{6.93\ m/s^2}$$

$$a = 7\ \frac{m}{s^2}$$