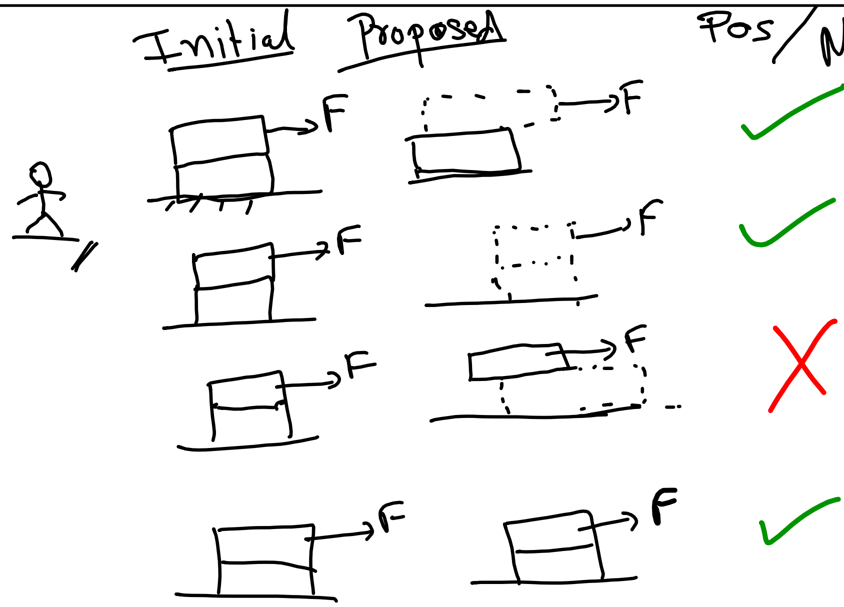
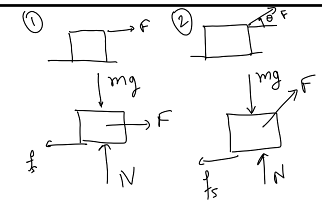
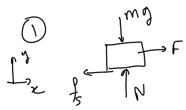



$f \le \mu_s N$

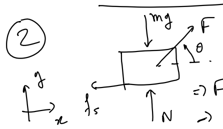
if No-s...

$f = \mu_k N$




$$\Sigma F_x = ma_x = m(0) = 0$$
$$F - f_s = 0 \quad \text{— (i)}$$
$$\Sigma F_y = ma_y = m(0) = 0$$
$$N - mg = 0 \quad \text{— (ii)}$$
$$f_s \le \mu_s N$$
$$\underline{F \le \mu_s mg} \quad ①$$




$$\Sigma F_x = ma_x = 0$$
$$\Rightarrow F\cos\theta - f_s = 0 \quad \text{—(i)}$$
$$\Rightarrow f_s = F\cos\theta$$
$$\Sigma F_y = ma_y = 0$$
$$N + F\sin\theta - mg = 0$$
$$\Rightarrow N = mg - F\sin\theta \quad \text{—(ii)}$$

$$f_s \le \mu_s N$$
$$F\cos\theta \le \mu_s(mg - F\sin\theta)$$
$$F(\cos\theta + \mu_s\sin\theta) \le \mu_s mg$$
$$F \le \frac{\mu_s mg}{\cos\theta + \mu_s\sin\theta} = \frac{\cancel{\mu_s mg}}{\sqrt{1+\mu_s^2}\left(\frac{\cos\theta}{\sqrt{1+\mu_s^2}} \ldots\right)}$$

$$\sin(A+B) = \sin A\cos B + \cos A\sin B$$
$$\sin(\alpha+\theta) = \frac{\cos\theta}{\sqrt{1+\mu_s^2}} + \frac{\mu_s}{\sqrt{1+\mu_s^2}}\sin\theta$$
$$\tan\alpha = \frac{1}{\mu_s}, \quad \sin\alpha = \frac{1}{\sqrt{1+\mu_s^2}}, \quad \cos\alpha = \frac{\mu_s}{\sqrt{1+\mu_s^2}}$$

$$F \le \frac{\mu_s mg}{\sqrt{1+\mu_s^2}\left(\frac{\cos\theta}{\sqrt{1+\mu_s^2}} + \frac{\mu_s}{\sqrt{1+\mu_s^2}}\sin\theta\right)}$$
$$F \le \frac{\mu_s mg}{\sqrt{1+\mu_s^2}\,\sin(\alpha+\theta)}$$

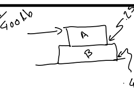
$$\boxed{F_{min} = \frac{\mu_s mg}{\sqrt{1+\mu_s^2}}}$$


$$\Sigma F_x = f_s - mg\sin\theta = 0$$
$$\Sigma F_y = N - mg\cos\theta$$

$$f_s = mg\sin\theta$$
$$N = mg\cos\theta$$

if $f_s \le \mu_s N$,
$$\cancel{mg}\sin\theta \le \mu_s \cancel{mg}\cos\theta$$
$$\Rightarrow \underline{\tan\theta \le \mu_s}$$

3.114



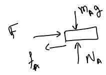

$w_A = 55$ lbs.

$w_B = 73$ lbs

Assm 1) A & B stay together & B slides on ground

$a_A = a_B$

A)



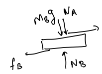

$\Sigma F_x = m_A a_A$

$F - f_A = m_A a_A \quad -(i)$

$\Sigma F_y = m_A a_y = 0$

$\Rightarrow N_A - m_A g = 0 \quad -(ii)$

B)




$\Sigma F_x = m_B a_x = m_B a_B$

$f_A - f_B = m_B a_B \quad -(iii)$

$\Sigma F_y = m_B a_y = 0$

$N_B - N_A - m_B g = 0$

$\Rightarrow N_B = N_A + m_B g$

$= (m_A + m_B) g \quad -(iv)$

As 'B' is sliding,

$f_B = \mu_k N_B$

$= .45 \times (55 + 73)$

$= 57.6$ lbs

Adding (i) & (iii)

$F - f_B = m_A a_A + m_B a_B$

$400 - 57.6 = \left(\frac{55}{32.2} + \frac{73}{32.2}\right) a$

$\Rightarrow a = 86.135 \text{ ft/s}^2$

(iii)

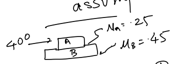
$f_A - f_B = m_B a_B$

$f_A - 57.6 = \frac{73}{32.2} \times 86.135$

$f_A = 252.875$ lb

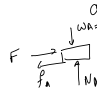
$\mu_A N_A = .25 \times 55 = 14$ lb

As $f_A \nleq \mu_A N_A$, our assumption was wrong




A moves & B does not.

$a_B = 0$




$\Sigma F_x = m_A a_A$

$\Rightarrow F - f_A = m_A a_A \quad -(i)$

$\Sigma F_y = m a_y = 0$

$\Rightarrow N_A - m_A g = 0$

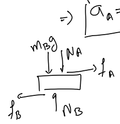
$f_A = \mu_A N_A = .25 \times 55$

$f_A = 13.725$ lbs

$F - f_A = m_A a_A$

$\Rightarrow 400 - 13.725 = \frac{55}{32.2} \times a_A$

$\Rightarrow \boxed{a_A = 226.13 \text{ ft/s}^2}$




$\Sigma F_x = 0$

$f_A = f_B = 13.725$ lb

$\Sigma F_y = 0 \Rightarrow N_B - N_A - m_B g = 0$

$\Rightarrow N_B = (m_A + m_B) g$

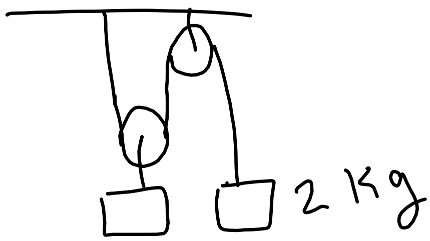
$= 128$ lb

check $f_A = 13.725$ lbs

$\mu_B N_B = .45 \times 128$

$= 57.6$ lbs

as $f_B \leq \mu_B N_B$, our assumption was true.




1) 2 Kg

2) 4 Kg

3) 8 Kg

4) 16 Kg