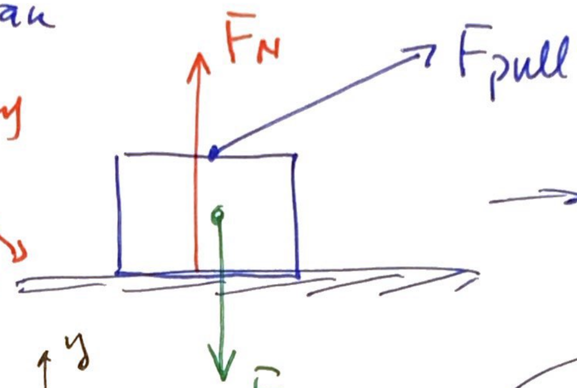
4B **Newton's Law in 2-Dimensions**

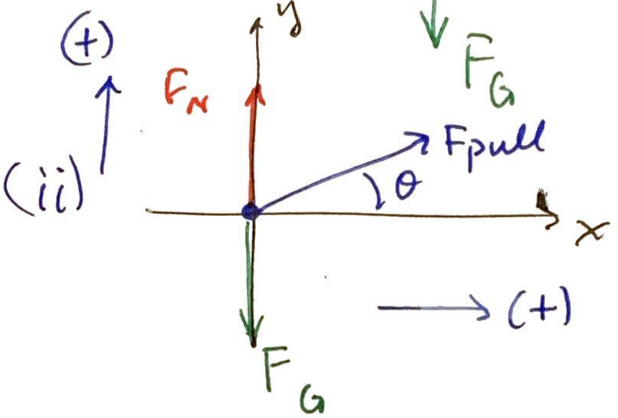
Ex Find the horizontal acc'ln

(i) Diagram



The block starts to slide sideway.

(ii)



DATA

let $m = 10\,kg$

$F_{pull} = 40\,N$

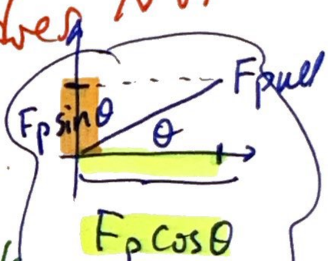
$\theta = 30°$ N of E

Q: ask what is the blocks acc'ln? $a_x = ?$

(iii) $\boxed{\sum \vec{F} = m\vec{a}}$ vectors:

x: $\sum F_x = m a_x$ → seek this

y: $\sum F_y = m a_y$ → "0" since the block does NOT leave the table



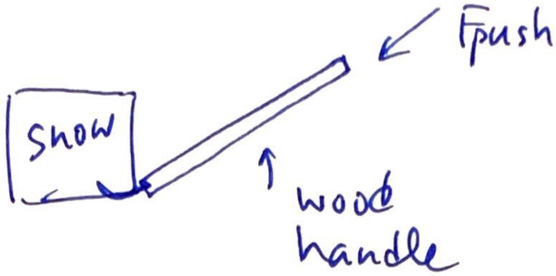
x: $(F_N)_x - (F_G)_x + (F_{pull})_x = m a_x$ ($(F_N)_x \to 0$, $(F_G)_x \to 0$; we seek a_x)

y: $(F_N)_y - (F_G)_y + (F_{pull})_y = m a_y$ ($a_y \to 0$) ← This eqn not needed.

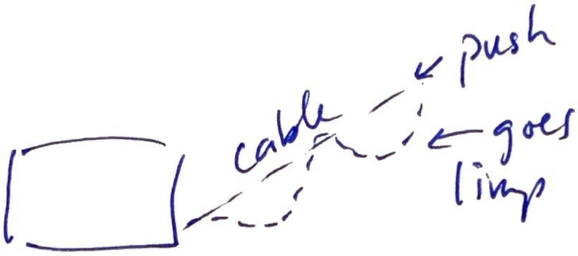
$F_p \cos 30° = m a_x$

$$a_x = \frac{40\,N \cos 30°}{10\,kg} = \underline{3.46\,m/s^2}$$

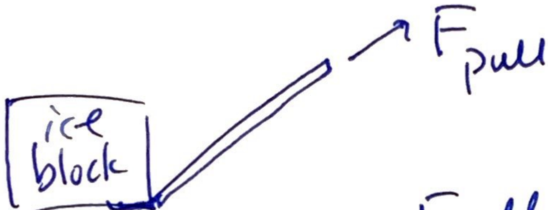
(*) Compression vs. Tension Forces



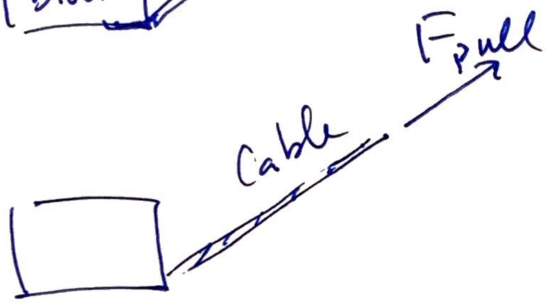
The handle experience **Compression**



Cable experiences **No Compression.**

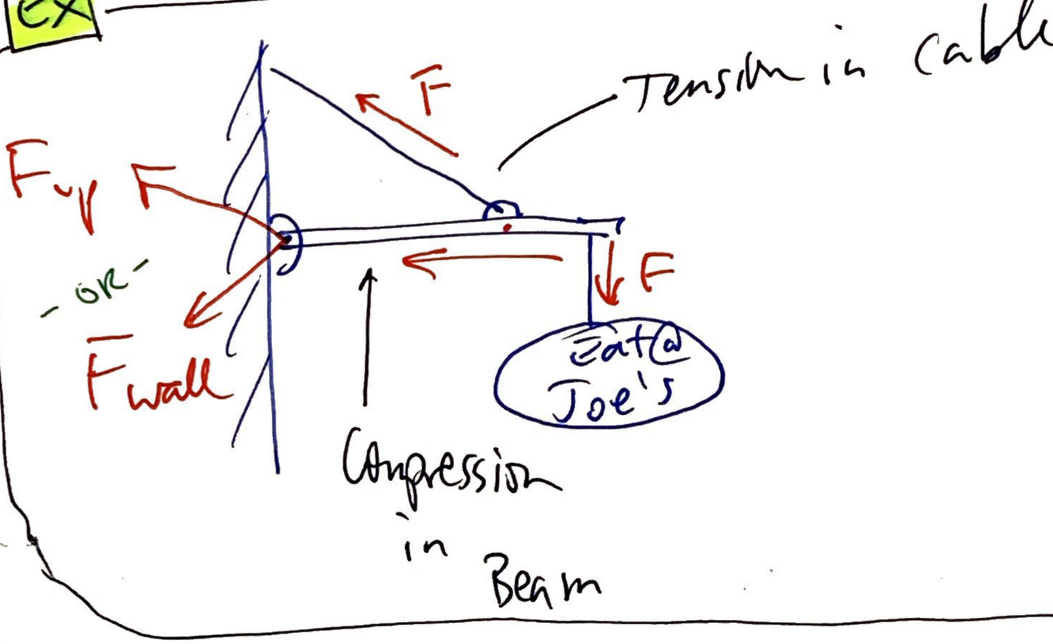


the handle experience **Tension**



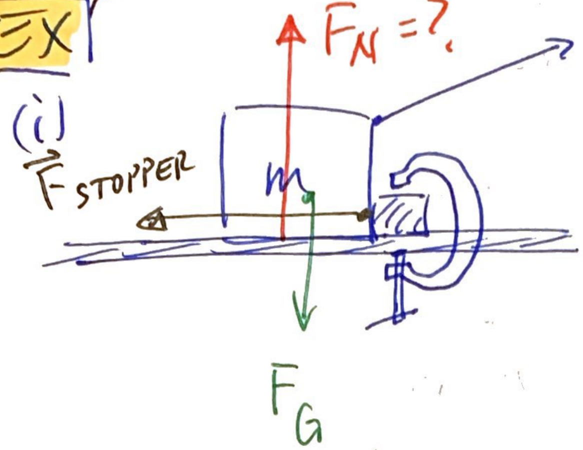
The cable experiences **Tension** also

Ex

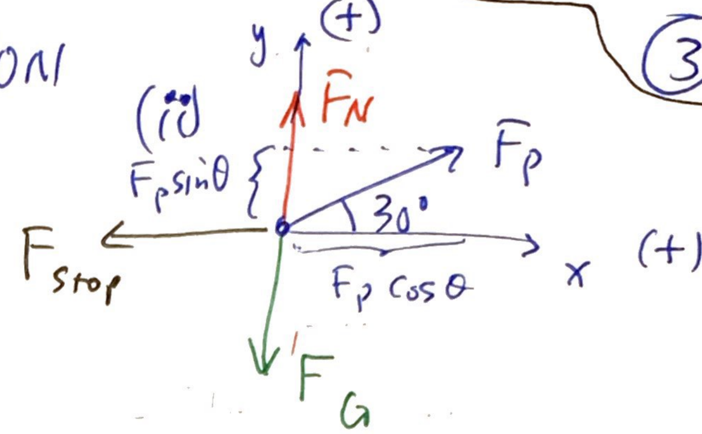


EX

(i)



(ii)



(iii) $\sum F_x = m a_x$ (→ 0) $\longrightarrow (F_N)_x + (F_{pull})_x - (F_G)_x - F_{STOP} = 0$

$$F_p \cos\theta = F_{stop}$$

$\sum F_y = m a_y$ (→ 0)

$$(F_N)_y + (F_{pull})_y - (F_G)_y - (F_{stop})_y = 0$$

$$F_N + F_p \sin\theta - mg - 0 = 0$$

$$\boxed{F_N = mg - F_p \sin\theta}$$

$$= (10\,kg)(9.8\,m/s^2) - (40N)\sin 30^\circ \quad (\sin 30^\circ = 1/2)$$

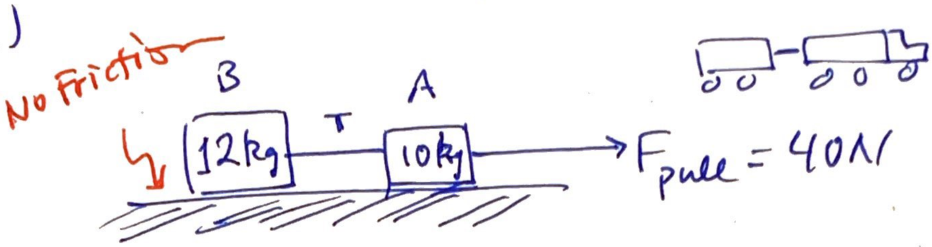
$$= 98N - 20N$$

$$\boxed{F_N = 78N}$$

- Our pulling force causes the Normal force {Bathroom Scale} to be 20N less i.e. the table does not need to support as much weight!! {since the F_{pull} alviates the weight of the box}

EX Two boxes, one in tow of the other

(i)

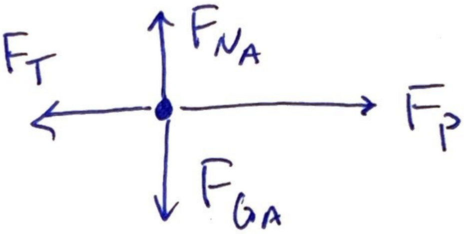


(1-Dim)

(a) Find the acc'ln of the system of blocks.

(ii) Freebody

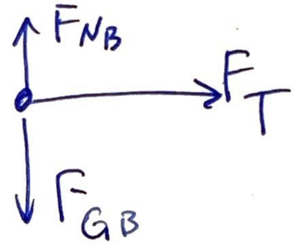
A :



(iii) eqns

$$\begin{cases} F_p - F_T = m_A a_A & : x \\ y: \text{not needed} \end{cases}$$

B :



$$\begin{cases} F_T = m_B a_B & : x \\ y: \text{Not needed} \end{cases}$$

(iv) do the math ...

let insert $F_T = m_B a_B$ into $F_p - T_T = m_A a_A$

$$\Rightarrow \quad F_p - (m_B a_B) = m_A a_A$$

$$F_p = m_A a_A + m_B a_B$$

Here we recognize that $a_A = a_B$, call these "a"

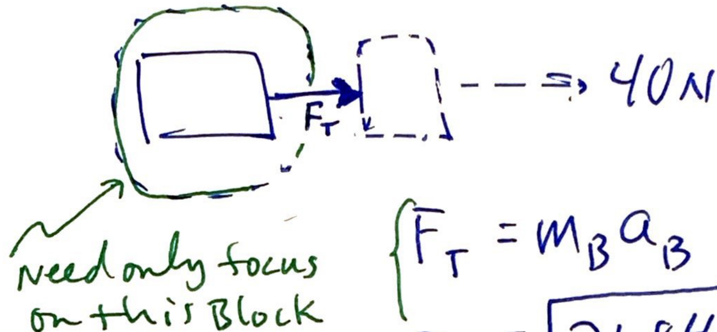
$$F_p = (m_A + m_B) a$$

$$\Rightarrow \quad a = \frac{F_p}{m_A + m_B}$$

← Hey, we could a just added the masses together!

$$a = \frac{40N}{(10 + 12)\,kg} = \boxed{1.82\ m/s^2}$$

(b) what is the tension between the blocks? (5)



$F_T = m_B a_B = (12\,kg)(1.82\,m/s^2)$

$= \boxed{21.84\,N}$

(c) why is F_T Not 40N?

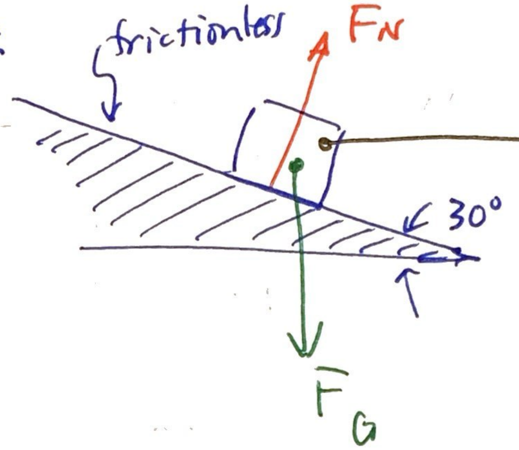
about $\frac{1}{2} F_{Pull}$ is used to acc'lt A and

one $\frac{1}{2} F_{Pull}$ used to acc'lt B.

Frictionless Incline Problem EX

(a) Find acc'ln

(i)

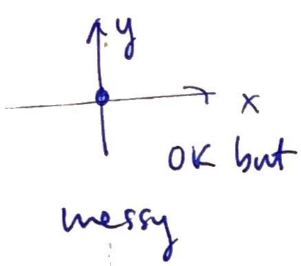


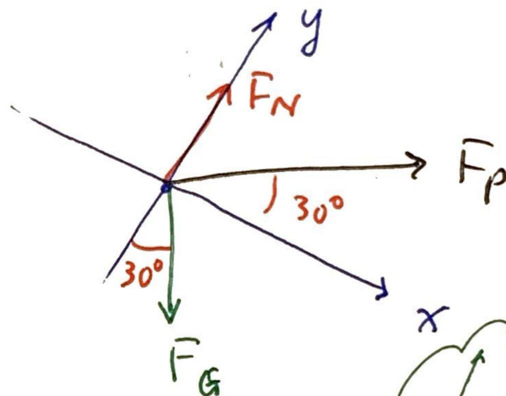
If $\theta = 30°$, $m = 10kg$

$F_p = 40N$

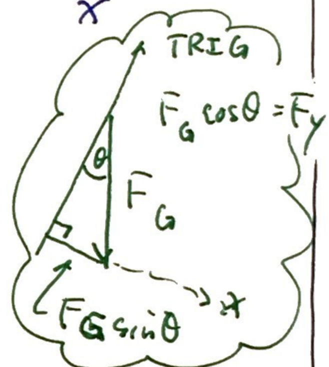
then find acc'ln down the ramp.

(ii)





(iii) Eqns: $\sum \vec{F} = m\vec{a}$



x: $(F_N)_x + (F_p)_x + (F_G)_x = ma_x$ ($(F_N)_x \to 0$, $a_x \to a$)

y: $(F_N)_y + (F_p)_y - (F_G)_y = ma_y$ ($a_y \to 0$ does not leave surface)

x: $F_p \cos\theta + F_G \sin\theta = m\underline{\underline{a}}$

y: $\underline{F_N} + F_p \sin\theta - F_G \cos\theta = 0$

Two-Eqns with two unknowns: a & F_N

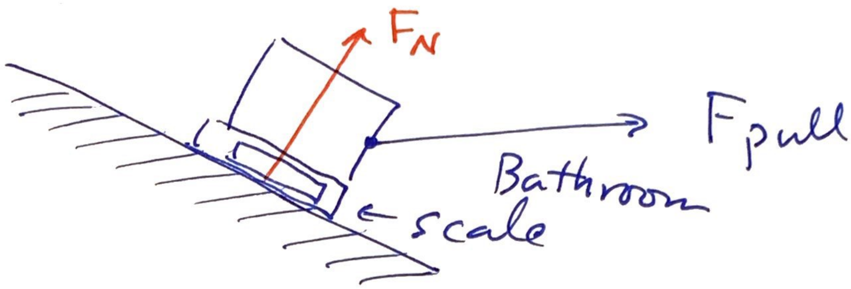
(iv) Solve: These eqns are not coupled so we only need one at a time:

Top: $a = \dfrac{F_p \cos\theta + F_G \sin\theta}{m} = \dfrac{40\cos 30° + 98N \sin 30°}{10kg}$ ($F_G \to mg$)

$a = \dfrac{34.64 + 49.00}{10} = \boxed{8.36\ m/s^2}$

Note if $F_p = 0$ then $\boxed{a = \dfrac{F_G \sin\theta}{m}} = \dfrac{98 \sin 30}{10} = \underline{\underline{4.9\ m/s^2}}$

(b) what is the Normal Force ?



y: $F_N + F_p \sin\theta - F_G \cos\theta = 0$

$$F_N = F_G \cos\theta - F_p \sin\theta$$

$$= 98N \cos 30^\circ - 40N \sin 30^\circ$$

$$F_N = 64.9N$$ vs 98N if the table was horizontal

If $F_p = 0$

$$F_N = F_G \cos\theta$$

$$= 98 \cos 30^\circ$$

$$F_N = 84N$$ vs 64.9 N when pulled

If $F_p = 0$ and $\theta = 0^\circ$ then $F_N = F_G \underbrace{\cos 0^\circ}_{1}$

- Horiz. $F_N = F_G$

- Vertical: $F_N = F_G \underbrace{\cos 90^\circ}_{0}$

$$F_N = 0N$$ Free fall