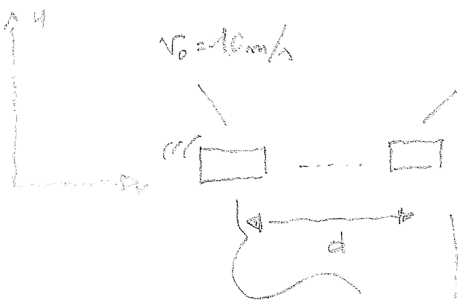
18



ETAPE 1

$m\vec{g} = \begin{bmatrix} 0 \\ -mg \end{bmatrix}$

$\vec{f} = \begin{bmatrix} -\mu mg \\ 0 \end{bmatrix}$

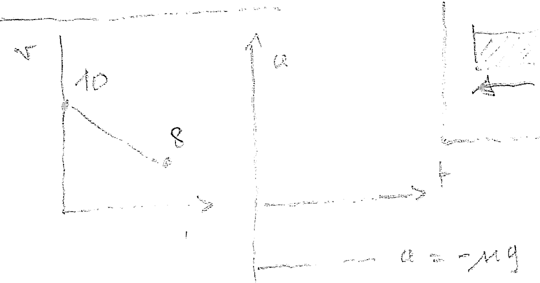
$\vec{N} = \begin{bmatrix} 0 \\ mg \end{bmatrix}$

DYNAMIQUE

$$\boxed{\sum \vec{F} = m\vec{a}}$$

$-\mu g = a$

$$\vec{a} = \begin{bmatrix} -\mu g \\ 0 \end{bmatrix} = \begin{bmatrix} -a \\ 0 \end{bmatrix}$$



ON DECELERE !
L'ACCELERATION EST NEGATIVE

ETAPE 2

CINEMATIQUE

$$\boxed{\begin{matrix} x(0) = 0 \\ v(0) = v_0 \end{matrix}}$$

$$\boxed{\begin{matrix} x(t) = d \\ v(t) = v_f \end{matrix}}$$

$x(t) = v_0 t - at^2/2 \quad (1)$

$v(t) = v_0 - at \quad (2)$

$$\boxed{t = \frac{v_0 - v_f}{a}}$$

EN INJECTANT DANS (1)

$$d = v_0\left(\frac{v_0 - v_f}{a}\right) - \frac{a}{2}\left(\frac{v_0 - v_f}{a}\right)^2$$

$$= \frac{1}{2a}\left[2v_0^2 - \cancel{2v_0 v_f} - v_0^2 - v_f^2 + \cancel{2v_0 v_f}\right]$$

$$\boxed{a = \frac{v_0^2 - v_f^2}{2d}}$$

VALEURS NUMERIQUES

$a = \frac{100-64}{2 \times 12} = \frac{36}{24} = 1,5\ m/s^2$

$f = 0,09 \times 1,5 = 0,135\ N$

$\mu = \frac{0,135}{0,09 \times 9,81} = 0,15$ ASSEZ COHERENT

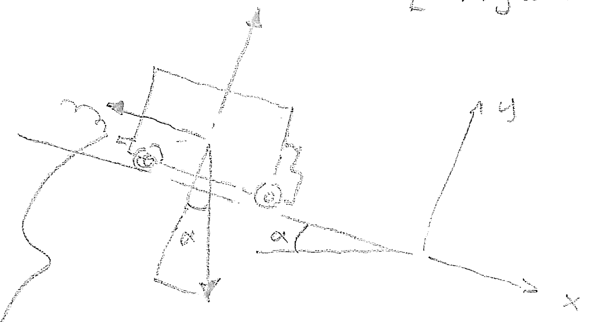
$$\vec{a} = \begin{bmatrix} -1,5 \\ 0 \end{bmatrix}$$

DECELERATION

CELA NE SERT A RIEN D'ETUDIER CETTE RELATION ! IL VAUT MIEUX S'ENTRAINER A LA DEDUIRE CHAQUE FOIS (si, si !)

19

$\vec{N} = \begin{bmatrix} 0 \\ mg\cos\alpha \end{bmatrix}$



$m\vec{g} = \begin{bmatrix} mg\sin\alpha \\ -mg\cos\alpha \end{bmatrix}$

$\vec{f} = \begin{bmatrix} -f \\ 0 \end{bmatrix}$

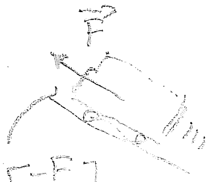
EN DESCENTE

$\underbrace{ma}_{=0} = -f + mg\sin\alpha$

$\boxed{f = mg\sin\alpha}$

EN MONTEE

$\underbrace{ma}_{=0} = -F + \underbrace{f}_{= mg\sin\alpha \ :-)} + mg\sin\alpha$



$\vec{F} = \begin{bmatrix} -F \\ 0 \end{bmatrix}$:-)

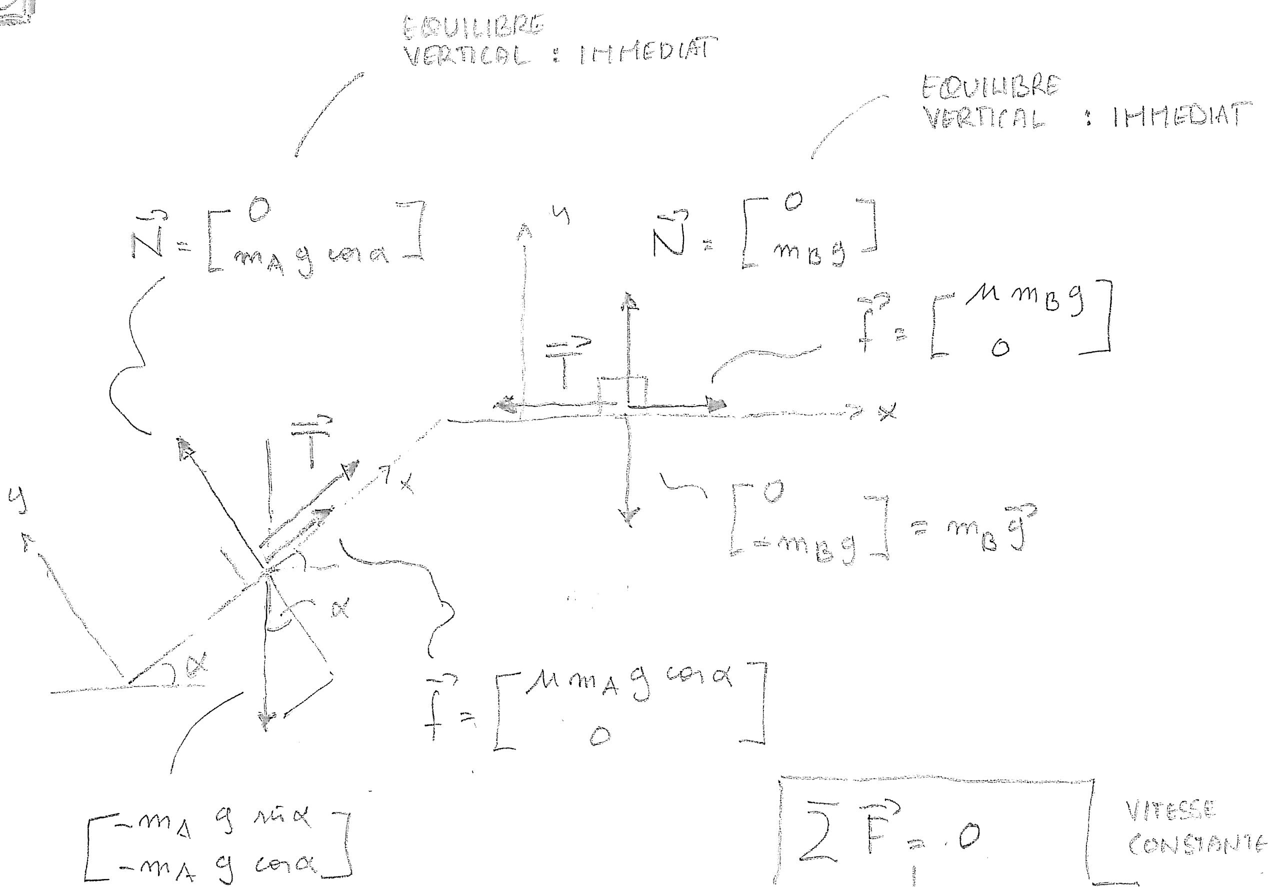
LA FORCE EST NEGATIVE POUR QUE LE CAMION REMONTE

$\boxed{F = 2mg\sin\alpha}$

VALEUR NUMERIQUE

$F = \underbrace{2 * 3000 * 9{,}81 * \sin(5°)}_{5130\ [N]}$

$\boxed{20}$



$\boxed{\sum \vec{F} = 0}$ VITESSE CONSTANTE

CORPS B

$\boxed{-T + \mu m_B g = 0}$

$\boxed{\sum \vec{F} = 0}$ VITESSE CONSTANTE

CORPS A

$\boxed{T - m_A g \sin\alpha + \mu m_A g \cos\alpha = 0}$

$$\mu \cancel{g} (m_B + m_A \cos\alpha) = m_A \cancel{g} \sin\alpha$$

$$\boxed{\mu = \frac{m_A \sin\alpha}{(m_B + m_A \cos\alpha)}}$$

$$\boxed{T = \mu m_B g}$$

VALEURS NUMERIQUES

$\sin(30°) = 1/2$
$\cos(30°) = \sqrt{3}/2$ } À CONNAÎTRE

$$\mu = \frac{1/2}{(2/5 + \sqrt{3}/2)} = \frac{1}{(4/5 + \sqrt{3})} = 0{,}395$$

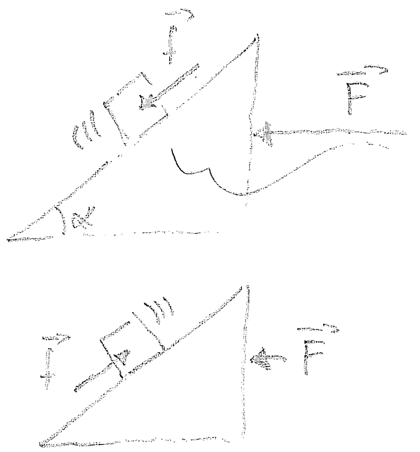
$$T = 0{,}395 * 9{,}81 * 2 = 7{,}75 \text{ [N]}$$

21

$\vec{F} = \begin{bmatrix} -F \\ 0 \end{bmatrix}$

$$\boxed{a = \frac{F}{(M+m)}} \qquad \vec{a} = \begin{bmatrix} -a \\ 0 \end{bmatrix}$$

$\vec{F}$ EST MAXIMAL
LE BLOC DU DESSUS VOUDRAIT MONTER !



$\vec{F}$ MINIMAL
LE BLOC VOUDRAIT DESCENDRE

$\vec{N} = \begin{bmatrix} -N \sin\alpha \\ N \cos\alpha \end{bmatrix}$

$\begin{bmatrix} \pm \mu_S N \cos\alpha \\ \pm \mu_S N \sin\alpha \end{bmatrix} = \vec{f}$

INCONNU!

$\begin{bmatrix} 0 \\ -mg \end{bmatrix}$

$$\boxed{\sum \vec{F} = m\vec{a}}$$ BLOC DU DESSUS !

$$\begin{cases} -ma = \mu_S N \cos\alpha - N \sin\alpha \\ 0 = -mg + \mu_S N \sin\alpha + N \cos\alpha \end{cases}$$

$$\boxed{N = \frac{mg}{(\cos\alpha + \mu_S \sin\alpha)}}$$

EN INJECTANT

$$\boxed{a = \frac{F}{(M+m)}}$$

ET

DANS L'EQUATION HORIZONTALE ...

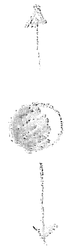
$$-\cancel{m}\frac{F}{(M+m)} = \cancel{m}g\,\frac{(\mu_S \cos\alpha - \sin\alpha)}{(\cos\alpha + \mu_S \sin\alpha)}$$

$$\boxed{\begin{aligned} F &= (M+m)\frac{(\sin\alpha - \mu_S \cos\alpha)}{(\cos\alpha + \mu_S \sin\alpha)}\, g = 3{,}9 \text{ [N]} \\ F &= (M+m)\frac{(\sin\alpha + \mu_S \cos\alpha)}{(\cos\alpha - \mu_S \sin\alpha)}\, g = 71{,}0 \text{ [N]} \end{aligned}}$$

CONCLUSION

$$\boxed{3{,}9 \leq F \leq 71{,}0 \text{ [N]}}$$

22



$F_D = k v^2$

mg

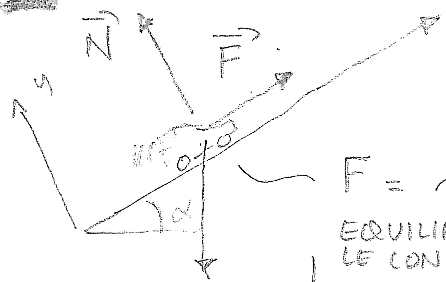
$$\boxed{\underbrace{m a}_{=0} = m g - k v_L^2 \quad \Rightarrow \quad v_L = \sqrt{\frac{mg}{k}}}$$

LORSQUE $v = v_L/2$

$$F = k \left(\frac{v_L}{2}\right)^2 = k \frac{mg}{4k} = \frac{mg}{4} = 49 \,[N]$$

($m = 20$, $g = 9{,}8$)

23

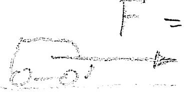


$F = m g \sin \alpha$

EQUILIBRE LE LONG DE x

OBSERVONS QU'ON PEUT OUBLIER LE FROTTEMENT CAR IL EST IDENTIQUE DANS LES DEUX CAS (*)

si ! si !



$F = m g \sin \alpha$

ACCELERATION SUR ROUTE HORIZONTALE

$$a = g \sin \alpha = 1{,}7 \,[m/s^2]$$

$g = 9{,}81$ $\qquad$ $\alpha = 10°$ PAR EXEMPLE

(*) DANS LA MONTEE

$F = m g \sin \alpha + f$

SUR ROUTE HORIZONTALE

$m a = F - f$

$= m g \sin \alpha + \cancel{f} - \cancel{f}$

$a = g \sin \alpha$

AVEC LE FROTTEMENT !