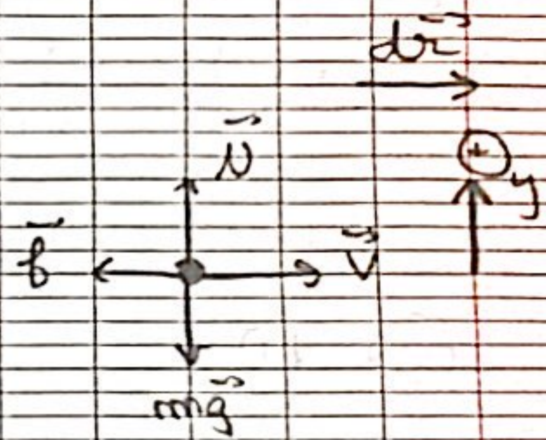
Ex 9:

$v_{i_1} = 40\ Km/h$; $v_{f_1} = 0$; $x_1 = 3\ m$

$v_{i_2} = 80\ Km/h$; $v_{f_2} = 0$; $x_2 = ?$



non conservat' of the mechanical energy.

$W_{\vec{f}} = \Delta ME = ME_f - ME_i$

$$= \cancel{\frac{1}{2} m v_f^2} + \cancel{mgh_f} - \frac{1}{2} m v_i^2 - \cancel{mgh_i}$$

$W_{\vec{f}} = -\frac{1}{2} m v_i^2$

$W_{\vec{f}} = \int \vec{f}\, \vec{dr} = -\int f\, dr\ ?$

FRD: $m\vec{g} + \vec{N} + \vec{f} = m\vec{a}$

proj on y: $-mg + N = 0$

$N = mg \quad ; \quad f = \mu mg = cst$

$W_{\vec{f}} = -\int f\, dr = -f.x = -\frac{1}{2} m v_i^2$

case 1: $f.x_1 = \frac{1}{2} m v_{i_1}^2$ (1)

case 2: $f.x_2 = \frac{1}{2} m v_{i_2}^2$ (2)

$\frac{(1)}{(2)} : \frac{x_1}{x_2} = \left(\frac{v_{i1}}{v_{i2}}\right)^2 \Rightarrow x_2 = x_1 \left(\frac{v_{i2}}{v_{i1}}\right)^2$

$= 3\left(\frac{80}{40}\right)^2 = 12\,m.$

Ex 5:

AB $\begin{cases} V_A = 12\,m/s \\ d = 10\,m \\ f_{sand} = 4 \times 800\,N \end{cases}$ BC $\begin{cases} V_f = 0 = V_D \\ x = ? \\ f_{water\ tank} = 1,25 \times 10^6\, x^3 \end{cases}$

Work Kinetic energy theorem: $\sum \vec{ext} = \Delta KE$

$\underbrace{W_{m\vec{g}}}_{0} + \underbrace{W_{\vec{N}}}_{0} + W_{\vec{f}sand} + W_{f\,water\,tank} = \underbrace{KE_D}_{0} - KE_A$

$W_{\vec{f}sand} = \int \vec{f}_{sand}\, \vec{dr} = -\int f_{sand}\, dr = -f d$

$W_{\vec f w} = \int \vec f \, d\vec r = \int f \, dx = -1{,}25 \cdot 10^6 \int x^3 \, dx$

$= -1{,}25 \times 10^6 \cdot \frac{x^4}{4}$

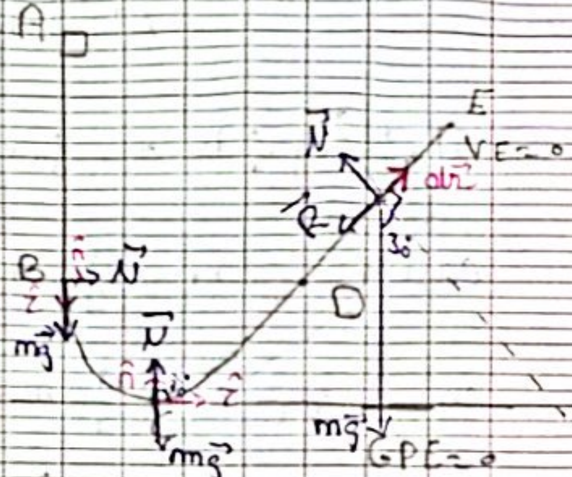
$\Rightarrow$

$-fd - 1{,}25 \times 10^6 \cdot \frac{x^4}{4} = -\frac{1}{2} m v_A^2$

smooth surface: no friction

Ex 6:

$v_A = 0$



a) FRD at B:

$m\vec g + \vec N = m\vec a$

proj on $\hat n$: $0 + N_B = m \cdot \frac{v_B^2}{R}$

$ME_A = ME_B$

$\frac{1}{2} \cancel{m} v_A^2 + \cancel{m} g h_A = \frac{1}{2} \cancel{m} v_B^2 + \cancel{m} g h_B$

$3gR = \frac{1}{2} v_B^2 + gR \Rightarrow v_B^2 = 2 \cdot 2gR = 4gR$

$N_B = m \frac{v_B^2}{R} = m \frac{4gR}{R} = 4gm$

b) N_C? $m\vec g + \vec N = m\vec a$

proj on $\hat n$ at C: $-mg + N_C = m \frac{v_C^2}{R} \Rightarrow N_C = m\left(\frac{v_C^2}{R} + g\right)$

$ME_B = ME_C$

$\frac{1}{2} \cancel{m} v_B^2 + \cancel{m} g h_B = \frac{1}{2} \cancel{m} v_C^2 + \cancel{m} g h_C$

$v_C^2 = v_B^2 + 2gR = 6Rg$

$N_C = m(6g + g) = 7mg$

c) $\sum W_{\vec{F}ext} = \Delta KE = \cancel{KE_E} - KE_D$

$= W_{m\vec{g}} + W_{\vec{N}} + W_{\vec{f}}$

$W_{m\vec{g}} = \int m\vec{g} \cdot d\vec{r} = \int mg\cos(120)\, dr = -\frac{mg}{2} s$

$W_{\vec{f}} = \int \vec{f}\, d\vec{r} = -\int f\, dx$

FBD: $m\vec{g} + \vec{N} + \vec{f} = m\vec{a}$

proj on y: $-mg\cos 30 + N = 0$

$f = \mu mg\cos 30 = \frac{\sqrt{3}}{2}\mu mg.$

$W_{\vec{f}} = -\frac{\sqrt{3}}{2}\mu mg s.$

$\sum W_{\vec{F}ext} = -\frac{1}{2} m v_D^2$

$-\frac{\cancel{m}g}{\cancel{2}} s - \frac{\sqrt{3}}{\cancel{2}}\mu \cancel{m} g s = -\frac{1}{\cancel{2}}\cancel{m} v_D^2$

$sg(1 + \sqrt{3}\mu) = v_D^2$

let's find v_D : $ME_B = ME_D$

$\frac{1}{2} m v_B^2 + \cancel{mgR} = \frac{1}{2} m v_D^2 + \cancel{mgR}.$

$v_D = v_B = \sqrt{4gR}$

$s = \frac{4gR}{g(1+\sqrt{3}\mu)} = \frac{4R}{1+\sqrt{3}\mu}$