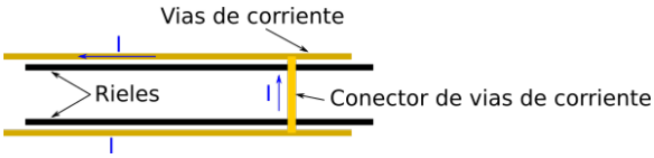
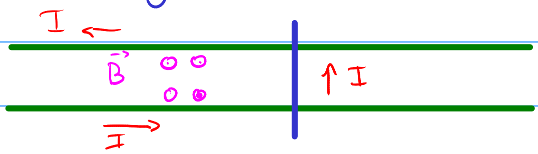
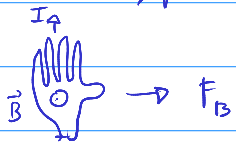
Problema 1



a) El campo magnetico debe ir saliente, por la regla de mano derecha





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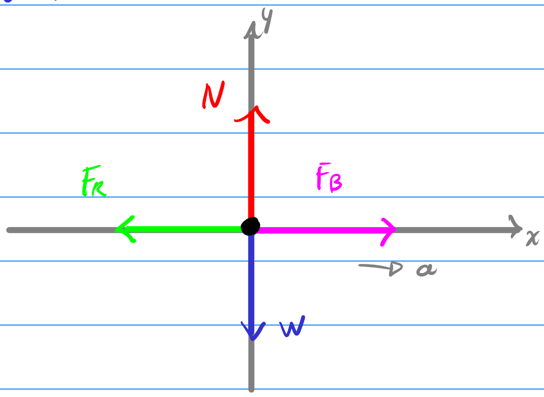
b) Diagrama de cuerpo libre.



$I \rightarrow -\hat{k}$

$B \rightarrow \hat{j}$

$\sum F_y = 0$

$N - W = 0$

$N = W$

$N = mg$

$\sum F_x = ma$

$F_B - F_R = ma$

$F_B = F_R + ma$ como V es constante $a = 0$

$F_B = F_R$

$F_B = \mu N$

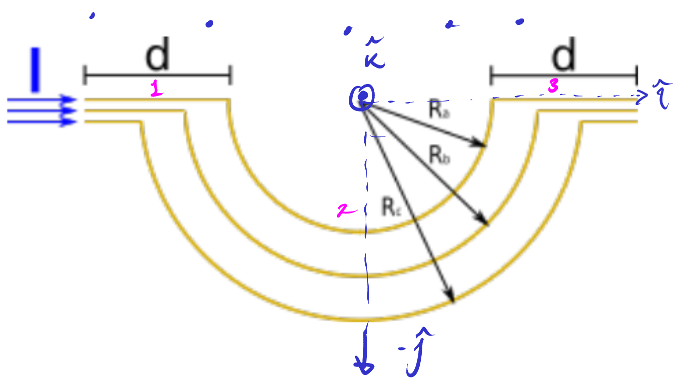
$F_B = \mu mg$

$\vec{F}_B = \mu mg \ \hat{\imath}$

$\vec{F}_B = 0{,}001 \cdot 500\,000\ kg \cdot 9{,}8\ m/s^2$

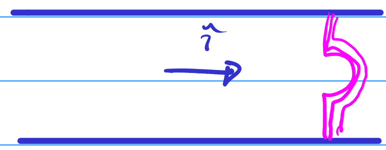
$\vec{F}_B = \underline{4900\ N}$

Tenemos el cable.

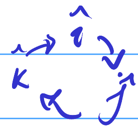


$B \rightarrow \hat{k}$

Tienen 3 segmentos cada alambre



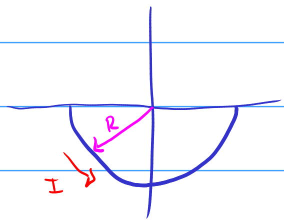
Para segmentos rectos 1, 3



$$\vec{F}_{B_{1,3}} = I L \hat{i} \times B \hat{k}$$

$$\vec{F}_{B_{1,3}} = I L B (-\hat{j})$$

Para segmento circular 2



$$dl = R\,d\theta\,\hat{\theta}$$

$$dl = R\,d\theta\,(-\operatorname{sen}\theta\,\hat{i} + \cos\theta\,\hat{j})$$

$$\Rightarrow d\vec{F}_2 = I\,d\vec{l} \times \vec{B}$$

$$= I R\,d\theta\,[-\operatorname{sen}\theta\,\hat{i} + \cos\theta\,\hat{j}] \times B\hat{k}$$

$$= IR\,d\theta[-\operatorname{sen}\theta\,(\hat{i}\times\hat{k}) + \cos\theta\,(\hat{j}\times\hat{k})]$$

$$= IR\,d\theta[-\operatorname{sen}\theta(-\hat{j}) + \cos\theta\,(\hat{i})]$$

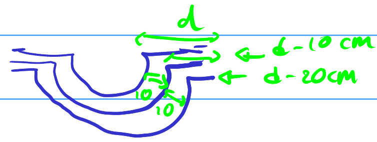
$$\Rightarrow d\vec{F}_2 = -IRB\operatorname{sen}\theta\,d\theta\,(-\hat{j}) + IRB\cos\theta\,d\theta\,(\hat{i})$$

$$F_2 = -IRB\int_{\pi}^{2\pi} \operatorname{sen}\theta\,d\theta\,(-\hat{j}) + IRB\int_{\pi}^{2\pi} \cos\theta\,d\theta\,(\hat{i})$$

$$\vec{F}_2 = 2IRB(-\hat{j}) + 0\,(\hat{i})$$

∴ La fuerza magnetica generada total es de

$$\vec{F}_B = \vec{F}_{B_1} + \vec{F}_{B_2} + \vec{F}_{B_3}$$



$$\vec{F}_B = (ILB + 2IRB + ILB)(-\hat{j})$$ cada alambre

$$\vec{F}_B = 2IB(L+R)(-\hat{j})$$

⇒ Para $R_a = 0{,}3m$ Para $R_b = 0{,}4m$

$$\vec{F}_{Ba} = 2I \cdot 25T(0{,}25m + 0{,}3m) = 27{,}5\,I$$

$$\vec{F}_{B_b} = 2 \cdot I \cdot 25T(0{,}15 + 0{,}4)$$

$$\vec{F}_{B_b} = 27{,}5\,I$$

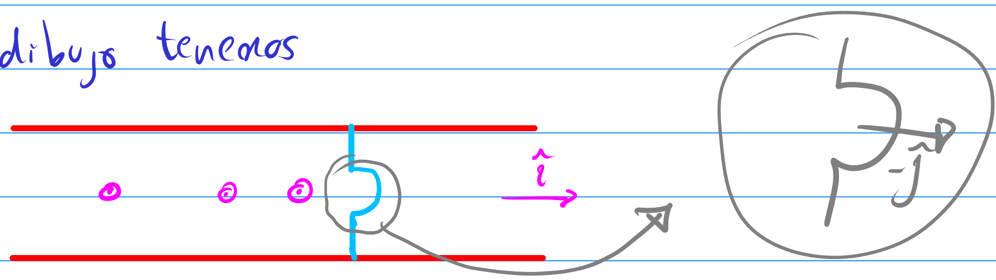
Para $R_c = 0{,}5\,m$

$$\vec{F}_{Bc} = 2I \cdot 25T(0{,}05 + 0{,}5) = 27{,}5\,I$$

$$\Rightarrow \vec{F}_B = 27{,}5\,I \cdot 3 \quad (-\hat{j})$$

$$\vec{F}_B = 82{,}5\,I \quad (-\hat{j}) \Leftarrow$$

⇒ Como en el dibujo tenemos



$\hat{i}$ es equivalente a $\underline{\underline{-\hat{j}}}$

Anteriormente tenemos que $\vec{F}_B = 4900\ N\ (\hat{i})$ y calculemos que $\vec{F}_B = 82{,}5\,I\ (\hat{i})$

$$\Rightarrow 4900 = 82{,}5\,I$$

$$\frac{4900}{82{,}5} = I \rightarrow \boxed{I = 59{,}39\ A}$$

R/b

c) $\vec{F}_B = 82{,}5\, I\ \hat{\imath}$ $\qquad V_i = 0\ m/s \qquad t = 1{,}5\,s$

$V_f = 55{,}55\ m/s$

$$\Sigma F = ma$$

$$F_B - F_R = ma$$

$$\frac{82{,}5\, I - \mu m g}{m} = a = \frac{82{,}5\, I - 500}{500000} = a$$

$$a = 1{,}7\times10^{-4} I - 1{,}0\times10^{-3}$$

$$\frac{dv}{dt} = 1{,}7\times10^{-4} I - 1{,}0\times10^{-3}$$

$$dv = 1{,}7\times10^{-4} I\,dt + 9{,}8\times10^{-3}\,dt$$

$$V_f = \int_0^{1{,}5} 1{,}7\times10^{-4} I\,dt + \int_0^{1{,}5} 9{,}8\times10^{-3}\,dt$$

$$\Rightarrow \quad V_f = \int_0^{1{,}5} \left[1{,}7\times10^{-4} k \ln(t+1) + 1{,}7\times10^{-4}\cdot I_0\right] dt + \int_0^{1{,}5} 9{,}8\times10^{-3}\,dt$$

$$V_f = \int_0^{1{,}5} \left[1{,}7\times10^{-4} k \ln(t+1) + 1{,}7\times10^{-4}\cdot I_0\right] dt + \int_0^{1{,}5} 9{,}8\times10^{-3}\,dt$$

$$V_f = \int_0^{1{,}5} 1{,}7\times10^{-4} k \ln(t+1)\,dt + \int_0^{1{,}5} 1{,}7\times10^{-4}\cdot 59{,}39\,dt + \int_0^{1{,}5} 9{,}8\times10^{-3}\,dt$$

$$V_f = 0{,}00013\,K + 0{,}0298$$

$$\frac{55{,}55 - 0{,}0298}{0{,}00013} = K \quad \rightarrow \quad \boxed{\therefore\ K = 4{,}3\times10^{5}}$$

d)

$$dV = \left[1{,}7\times10^{-4}\cdot\left(4{,}3\times10^{5}\ln(t+1) + 59{,}39\right) + 9{,}8\times10^{-3}\right]dt$$

$$V = \int_0^t \left(72{,}6\ln(t+1) + 0{,}01 + 9{,}8\times10^{-3}\right)dt$$

$$V(t) = 73{,}11\ln(t+1) - 73{,}08t + 73{,}11\ln(t+1) \quad [m/s]$$

$$I(t) = 4{,}3\times10^{5}\ln(t+1) + 59{,}39 \quad [A]$$