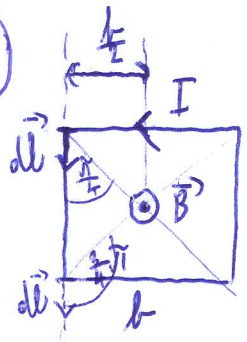
1.

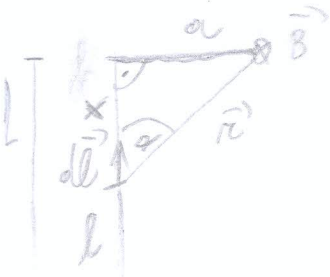


1b – používam Biot-Savartov zákon:

$$\vec{B} = \frac{\mu_0 I}{4\pi} \int \frac{d\vec{l} \times \vec{r}}{|\vec{r}|^3}$$

– dostávam príspevky od strán štvorca: $|\vec{B}| = 4|\vec{B}'|$

$$B' = \frac{\mu_0 I}{4\pi} \int \frac{dl\, r \sin\alpha}{r^3} = \frac{\mu_0 I}{4\pi} \int \frac{dl \sin\alpha}{r^2} \quad 1b$$



$$\operatorname{tg}\alpha = \frac{a}{x} = \frac{a}{L-l} \Rightarrow L - l = \frac{a}{\operatorname{tg}\alpha}$$

$$l = L - \frac{a}{\operatorname{tg}\alpha} = L - a\frac{\cos\alpha}{\sin\alpha}$$

$$dl = -a\,\frac{(-\sin\alpha)\cdot\sin\alpha - \cos\alpha\cdot\cos\alpha}{\sin^2\alpha}\,d\alpha$$

1b $$dl = a\,\frac{\sin^2\alpha + \cos^2\alpha}{\sin^2\alpha}\,d\alpha = \frac{a}{\sin^2\alpha}\,d\alpha$$

1b $$\sin\alpha = \frac{a}{r} \Rightarrow r = \frac{a}{\sin\alpha}$$

$$B' = \frac{\mu_0 I}{4\pi} \int \frac{\alpha}{\sin^2\alpha}\,d\alpha \cdot \sin\alpha\,\frac{\sin^2\alpha}{a^2} = \frac{\mu_0 I}{4\pi a} \int \sin\alpha\, d\alpha$$

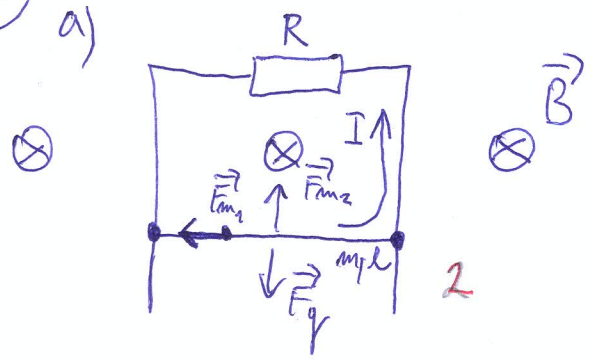
$$B' = \frac{\mu_0 I}{2\cdot 4\pi \frac{b}{2}} \int_{\frac{\pi}{4}}^{\frac{3}{4}\pi} \sin\alpha\, d\alpha = \frac{\mu_0 I}{2\pi b}\left[-\cos\alpha\right]_{\frac{\pi}{4}}^{\frac{3}{4}\pi} = \frac{\mu_0 I}{2\pi b}\left[\frac{\sqrt{2}}{2} + \frac{\sqrt{2}}{2}\right] = \frac{\mu_0 I}{\pi b}\frac{\sqrt{2}}{2} \quad 1b$$

$$B = 4B' = 2\sqrt{2}\,\frac{\mu_0 I}{\pi b} \quad 1b$$

65

2.

a)



2

$\vec{F}_{m_1}$ – magnetická sila na pohybujúci sa náboj

$\vec{F}_{m_2}$ – mag. sila na vodič s prúdom

b) $|u_i| = \frac{dQ}{dt} = \frac{B\,dS}{dt} = \frac{B \cdot l \cdot dx}{dt} = \frac{B l v \cdot dt}{dt} = \boxed{B l v}$ 1

c) $|\vec{F}_{m_2}| = |\vec{F}_g|$ 1 , $\vec{F}_{m_2} = I\,\vec{l} \times \vec{B}$ 1

$IlB = mg$, $I = \frac{u}{R} = \frac{Blv}{R}$ 0,5

$\frac{Blv}{R} lB = mg$

$\boxed{v = \frac{mgR}{(Bl)^2}}$ 0,5

6b