Magnetics

1. The wire is laced in the homogenous stationary magnetic field normal to the direction of the induction lines. The active length of the wire is $l = 5cm$ and current is $I = 25A$. The magnetic field is acting with the force $F_m = 50mN$. Find the magnetic induction!

Solution

$l = 5cm,\ I = 25A,\ F_m = 50mN,\ \alpha = 90°$

$$F_m = I \cdot B \cdot l \cdot \sin\alpha \Rightarrow B = \frac{F_m}{I \cdot l \cdot \sin\alpha} \rightarrow B = \frac{50 \cdot 10^{-3} N}{25A \cdot 0.05m} = 4 \cdot 10^{-2} T = \underline{\underline{40mT}}.$$

2. The current in the wire is $I = 1A$. The area of the wire's cross-section is $S = 1mm^2$. The wire is moving in the homogenous magnetic field with constant acceleration $a = 2ms^{-2}$ in the direction normal to the induction lines. The density of the wire's material is $\rho = 2500 kg \cdot m^{-3}$. Find the magnetic induction!

Solution

$$F_m = I \cdot B \cdot l \cdot \sin\alpha \wedge F_m = m \cdot a \Rightarrow B = \frac{m \cdot a}{I \cdot l \cdot \sin\alpha} = \frac{\rho V \cdot a}{I \cdot l \cdot \sin\alpha} = \frac{\rho \cdot S \cdot l \cdot a}{I \cdot l \cdot \sin\alpha} = \frac{\rho \cdot S \cdot a}{I \cdot \sin\alpha} = \frac{2500 \cdot 10^{-6} \cdot 2}{1 \cdot \sin 90°} = 5mT$$

3. The circular wire is placed in the air. The current is $I = 2\,A$, the radius is 1cm. Find the magnetic induction in its center!

Solution

$\mu_0 = 4\pi \cdot 10^{-7}\ NA^{-2},\ \mu_r = 1,\ r = 0.01m$

$$B = \frac{\mu_r I}{2r} \approx \underline{\underline{0.13\,mT}}$$

4. Find the speed of the proton in the magnetic field with induction $B = 1T$ if its trajectory was circle with radius 60 cm. Find the frequency of proton's moving in the circles.

Solution

The charge and mass of the proton are $m = 1.673 \cdot 10^{-27} kg$, $Q = 1.602 \cdot 10^{-19} C$

$$BQr = mv \Rightarrow v = \frac{BQr}{m} = 5.75 \cdot 10^{7} ms^{-1}$$

$$v = 2\pi rf \Rightarrow f = \frac{v}{2\pi r} = 15.26 Mhz$$