ÇANKAYA UNIVERSITY

PHYS 132 – PHYSICS II

CHAPTER 28

MAGNETIC FIELDS

PROBLEMS SET

1) What is the force per meter of length on a straight wire carrying a 9.40-A current when perpendicular to a 0.90-T uniform magnetic field? (*b*) What if the angle between the wire and field is 35.0°? **[Answer: a) 8.5 N/m, b) 4,9 N/m]**

2) A circular loop of wire, of radius *r*, carries current *I*. It is placed in a magnetic field whose straight lines seem to diverge from a point a distance *d* below the loop on its axis. (That is, the field makes an angle $\boldsymbol{\theta}$ with the loop at all points, Fig. 27–41, where $\tan\boldsymbol{\theta} = \mathbf{r/d}$) Determine the force on the loop.

[Answer:

$$-2\pi IB\frac{r^2}{\sqrt{r^2+d^2}}\hat{\mathbf{k}}$$

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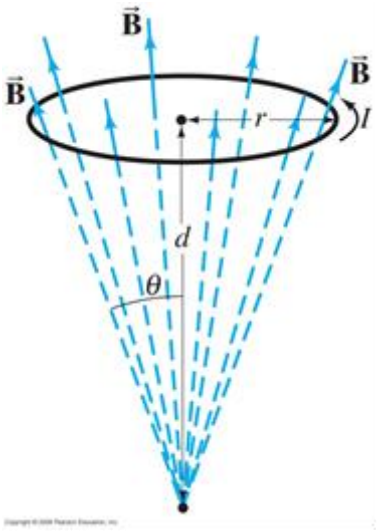


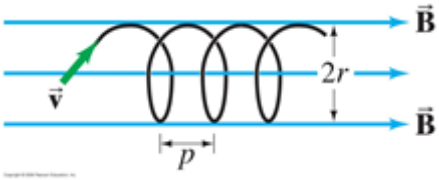
3) *** For a particle of mass *m* and charge *q* moving in a circular path in a magnetic field *B*, (*a*) show that its kinetic energy is proportional to r^2, the square of the radius of curvature of its path, and (*b*) show that its angular momentum is $L = qBr^2$, about the center of the circle.

[Answer: using $\boldsymbol{r = \frac{mv}{qB}}$, a) $\boldsymbol{K = \frac{1}{2}mv^2 \propto r^2}$, b) $\boldsymbol{L = mvr = qBr^2}$]

4) *** An electron moves with velocity $\vec{v} = (7.0\hat{\imath} - 6.0\hat{\jmath}) \times 10^4\ m/s$ in a magnetic field $\vec{B} = (-0.80\hat{\imath} + 0.60\hat{\jmath})T$. Determine the magnitude and direction of the force on the electron.**[Answer: $\mathbf{1 \times 10^{-15}}$ N $\hat{\mathbf{k}}$]**

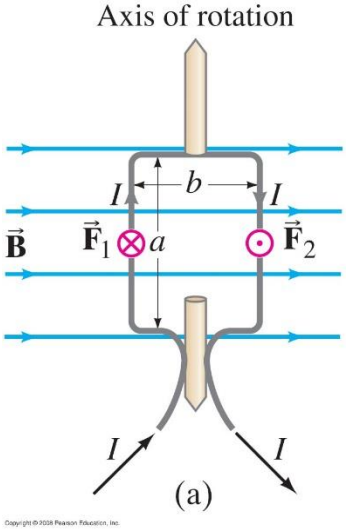
5) An electron enters a uniform magnetic field $B = 0.28\,T$ at a 45° angle to $\vec{B}$. Determine the radius r and pitch p (distance between loops) of the electron's helical path assuming its speed is $3.0 \times 10^6\ m/s$. See Figure below.

[Answer: a) $r = 4.3 \times 10^{-5}\ m$, b) $p = 2.7 \times 10^{-4}\ m$]



6) *** How much work is required to rotate the current loop (Fig. 27–22) in a uniform magnetic field $\vec{\mathbf{B}}$ from (*a*) $\theta = 0$ ($\vec{\mu}$II$\vec{\mathbf{B}}$) to $\theta = 180^0$? (*b*) $\theta = 90^0$ to $\theta = -90^0$?

[Answer: a) 2NIabB, b) 0]



7) Show that the magnetic dipole moment μ of an electron orbiting the proton nucleus of a hydrogen atom is related to the orbital momentum *L* of the electron by

$$\mu = \frac{e}{2m} L.$$

$$\mu = NIA = \frac{e}{T}\pi r^2 = \frac{e}{2\pi r/v}\pi r^2 = \frac{e\pi r^2 v}{2\pi r} = \frac{erv}{2} = \frac{emrv}{2m} = \frac{e}{2m}mrv = \frac{e}{2m}L$$

8) What is the value of q/m for a particle that moves in a circle of radius 8.0 mm in a 0.46-T magnetic field if a crossed 260-V/m electric field will make the path straight?
[Answer: $\mathbf{1.5 \times 10^5\ C/kg}$]

9) A rectangular sample of a metal is 3.0 cm wide and 680 μm thick. When it carries a 42-A current and is placed in a 0.80-T magnetic field it produces a 6.5 μV Hall emf. Determine: (*a*) the Hall field in the conductor; (*b*) the drift speed of the conduction electrons; (*c*) the density of free electrons in the metal.
[Answer: a) $\mathbf{2.2 \times 10^{-4}}$ V/m, b) $\mathbf{2.7 \times 10^{-4}}$ m/s, c) $\mathbf{4.7 \times 10^{28}}$ electrons/$\mathbf{m^3}$]

10) A mass spectrometer is being used to monitor air pollutants. It is difficult, however, to separate molecules with nearly equal mass such as CO (28.0106 u) and N_2 $(28.0134\,\mathrm{u})$. How large a radius of curvature must a spectrometer have if these two molecules are to be separated at the film or detectors by 0.65 mm?
[Answer: 3.3 m]