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Institution: Beijing-Dublin International College
Module: University Physics 2 (BDIC2008J)
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Problem Set 5

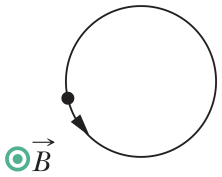
Magnetic Fields

Problem 1. *An alpha particle travels at a velocity $\vec{v}$ of magnitude* $550\,\mathrm{m/s}$ *through a uniform magnetic field $\vec{B}$ of magnitude 0.045* T. *(An alpha particle has a charge of* $+3.2 \times 10^{-19}\,\mathrm{C}$ *and a mass of* $6.6 \times 10^{-27}\,\mathrm{kg}$.*) The angle between $\vec{v}$ and $\vec{B}$ is 52 °. What is the magnitude of* ***(a)*** *the force $\vec{F}_B$ acting on the particle due to the field and* ***(b)*** *the acceleration of the particle due to $\vec{F}_B$? **(c)** Does the speed of the particle increase, decrease, or remain the same?*

Problem 2. *A proton travels through uniform magnetic and electric fields. The magnetic field is* $B = -2.50\hat{i}\,\mathrm{mT}$. *At one instant, the velocity of the proton is* $\vec{v} = 2000\hat{j}\,\mathrm{m/s}$. *At that instant and in unit-vector notation, what is the net force acting on the proton if the electric field is* ***(a)*** $4.00\hat{k}\,\mathrm{V/m}$, ***(b)*** $-4.00\hat{k}\,\mathrm{V/m}$, *and* ***(c)*** $4.00\hat{i}\,\mathrm{V/m}$*? (Hint: The type* $3\,\mathrm{N}\hat{i} + 4\,\mathrm{N}\hat{j} + 5\,\mathrm{N}\hat{k}$ *is called unit-vector notation.)*

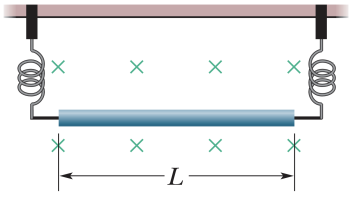
Problem 3. *An ion source is producing* ^{6}Li *ions, which have charge* $+e$ *and mass* $9.99 \times 10^{-27}\,\mathrm{kg}$. *The ions are accelerated by a potential difference of* $10\,\mathrm{kV}$ *and pass horizontally into a region in which there is a uniform vertical magnetic field of magnitude* $B = 1.2\,\mathrm{T}$. *Calculate the strength of the smallest electric field, to be set up over the same region, that will allow the* ^{6}Li *ions to pass through undeflected.*

Problem 4. *In the Figure below, a particle moves along a circle in a region of uniform magnetic field of magnitude* $B = 4.00\,\mathrm{mT}$. *The particle is either a proton or an electron (you must decide which). It experiences a magnetic force of magnitude* $3.20 \times 10^{-15}\,\mathrm{N}$. *What are* ***(a)*** *the particle's speed,* ***(b)*** *the radius of the circle, and* ***(c)*** *the period of the motion?*



Problem 5. *An electron follows a helical path in a uniform magnetic field of magnitude* $0.300\,\mathrm{T}$. *The pitch of the path is* $6.00\,\mu\mathrm{m}$, *and the magnitude of the magnetic force on the electron is* $2.00 \times 10^{-15}\,\mathrm{N}$. *What is the electron's speed?*

Problem 6. *A* $13.0\,\mathrm{g}$ *wire of length* $L = 62.0\,\mathrm{cm}$ *is suspended by a pair of flexible leads in a uniform magnetic field of magnitude* $0.440\,\mathrm{T}$ *(see the Figure below). What are the* ***(a)*** *magnitude and* ***(b)*** *direction (left or right) of the current required to remove the tension in the supporting leads?*



Problem 7. *A single-turn current loop, carrying a current of* 4.00 A*, is in the shape of a right triangle with sides* 50.0*,* 120*, and* 130 cm*. The loop is in a uniform magnetic field of magnitude* 75.0 mT *whose direction is parallel to the current in the* 130 cm *side of the loop. What is the magnitude of the magnetic force on* ***(a)*** *the* 130 cm *side,* ***(b)*** *the* 50 cm *side, and* ***(c)*** *the* 120 cm *side?* ***(d)*** *What is the magnitude of the net force on the loop?*

Problem 8. *A wire* $50.0\,\mathrm{cm}$ *long carries a* $0.500\,\mathrm{A}$ *current in the positive direction of an* x*-axis through a magnetic field* $\vec{B} = (3.00\,\mathrm{mT})\hat{j} + (10.0\,\mathrm{mT})\hat{k}$*. In unit-vector notation, what is the magnetic force on the wire?*

Problem 9. *A circular wire loop of radius* $15.0\,\mathrm{cm}$ *carries a current of* $2.60\,\mathrm{A}$. *It is placed so that the normal to its plane makes an angle of* 41.0° *with a uniform magnetic field of magnitude* $12.0\,\mathrm{T}$. ***(a)*** *Calculate the magnitude of the magnetic dipole moment of the loop.* ***(b)*** *What is the magnitude of the torque acting on the loop?*

Problem 10. *The magnetic dipole moment of Earth has magnitude* $8.00 \times 10^{22}\,\mathrm{J/T}$. *Assume that this is produced by charges flowing in Earth's molten outer core. If the radius of their circular path is* $3500\,\mathrm{km}$*, calculate the current they produce.*