Homework 4 : Dielectric, Magnetostatics & Lorentz force

1. Determine the energy stored in the electric field created by two plates capacitor whose space is filled with a dielectric.

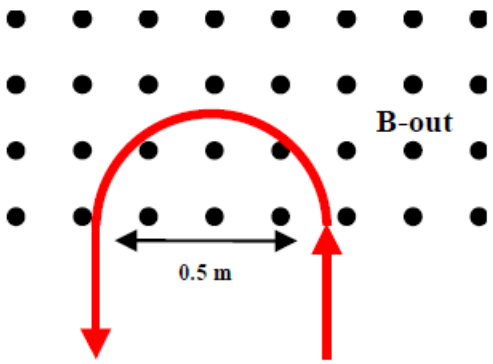
2. A charged particle, $Q = 0.5\ C$, enters a region with a uniform magnetic field $\vec{B} = 2\hat{x} + 3\hat{y} + 4\hat{z}$ (in Tesla). If its velocity is given by $\vec{v} = 2\hat{x} + 3\hat{y} + 2\hat{z}$ (in m/s), what is the magnitude of the magnetic force on the particle (in N)?

3. One end of a straight wire segment is located at $(x, y, z) = (0,0,0)$ and the other end is at $(1m, 2m, 3m)$. A current of $2\ A$ flows through the segment. The segment sits in a uniform magnetic field $\vec{B} = 2\hat{x} - 1\hat{y}$ (inTesla). What is the magnitude of the magnetic force (in N) on the wire segment?

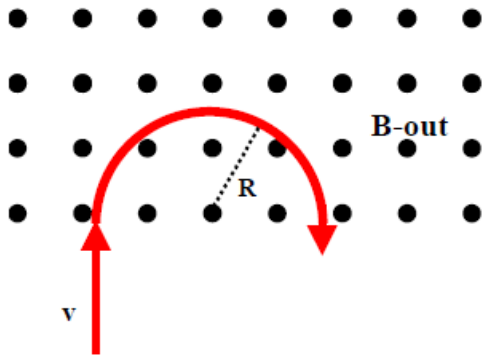
4. An electric power transmission line located an average distance of $20\ m$ above the earth's surface carries a current of 800 Amps from east to west, in a region where the earth's magnetic field is 0.8 gauss due north at $60°$ below the horizontal. What is the magnitude of the force per meter on the line?

5. A charged particle, $Q = 0.1\ C$, traveling in the x −direction with velocity $\vec{v} = v_0\hat{x}$ enters a region of space that has an electric field in the y −direction given by $\vec{E} = E_0\,\hat{y}$ with $E_0 = 10\ V$ and a magnetic field in the z −direction given by $\vec{B} = B_0\,\hat{z}$ with $E_0 = 0.2\ Tesla$. If the particle experiences no net force and continues with the same speed and direction, what is its speed v_0 (in m/s)?

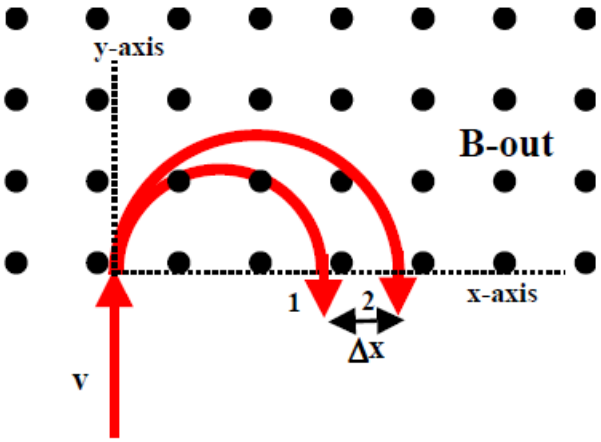
6. A charged particle traveling in the y −direction with a momentum of $0.01\ kg\ ms$ enters a region of space that has a uniform $1\ Tesla$ magnetic field in the z −direction as shown the Figure. If the particle enters the magnetic field at the point A and then exits the magnetic field at the point B located a distance of $0.5\ m$ to the left of the point A, what is the charge of the particle (in mC)?



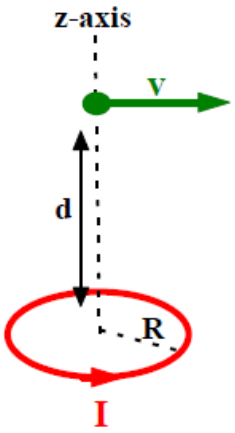
7. A charged particle traveling in the y −direction enters a region of space that has a uniform $2\ Tesla$ magnetic field in the z-direction as shown in the Figure. If the particle has a charge of $0.1\ C$ and a mass of $0.2\ kg$ how long (in $seconds$) does it take for the particle to reverse direction and exit the region?



8. Particle #1 and particle #2 travel along the y −axis and enter a region of space that has a uniform $2\ Tesla$ magnetic field in the z −direction as shown in the Figure. Both particles have the same charge, $Q = 0.1\ C$, and both have the same speed, $v = 10\ m/s$. If the particles are a distance $\Delta x = x2 - x1 = 0.3$ meters apart when they exit the region, what is the difference in their mass, $\Delta M = M2 - M1$ (in $grams$)?



9. A circular loop of wire of radius $R = 1\ m$ is carrying a current of $2\ A$ as shown in the Figure, A particle with charge $Q = 3 \times 10^{-3} C$ is on the axis of the loop (z-axis) a distance of $d = 0.5$ meters away from the loop and is moving with a speed of $2 \times 10^{6} m/s$ along the x −axis (i.e. perpendicular to the axis of the loop). What is the magnitude of the magnetic force on the particle due to the loop?


z-axis
v
d
R
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