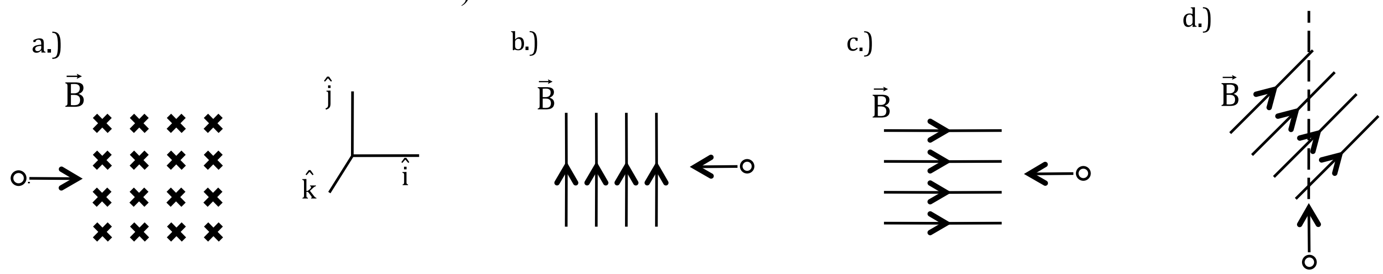
29-Series Problem (B-flds)

29.2) Examine the four magnetic fields shown below. Determine the initial direction of the magnetic force on a *positive* charged particle as it enters each field (this will be the direction of initial deflection in each case).



29.6) A proton experiences a magnetic force whose magnitude is $8.25x10^{-13}$ N as it moves with velocity magnitude $4.00x10^{6}$ m/s through a B-fld of magnitude 1.70 T. Determine the angle between the magnetic field vector and the proton's velocity vector.

29.8) A magnetic field $\vec{B} = \left(\hat{i} + 2\hat{j} - \hat{k}\right)T$ exists in a volume through which a proton moves with velocity $\vec{v} = \left(2\hat{i} - 4\hat{j} + \hat{k}\right)m/s$. Determine the magnetic force on the proton.

29.9) A proton experiences an acceleration of $\vec{a} = \left(2.00x10^{13}\ m/s^2\right)\hat{i}$ due to its motion in a B-fld when its velocity vector is perpendicular to the B-fld and is in the positive *z-direction*. If the proton is moving with a speed of $1.00x10^{7}$ m/s, derive an expression (then put in numbers) for the magnitude and direction of the B-fld.

29.13) A proton with charge +e and mass m_p is accelerated through a potential difference ΔV. A hydrogen isotope deuterium with charge +e and mass $2m_p$ is accelerated through the same potential difference, as is a radioactively produced alpha particle with charge +2e and mass $4m_p$. After acceleration, if all three particles separately enter a magnetic field (call it $\vec{B}$) with their initial velocity vectors *perpendicular* to the B-fld,, each will circle in the field due to the magnetic force on them.

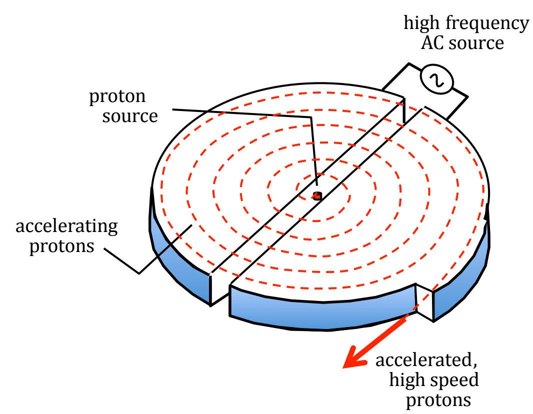
a.) In terms of the proton's radius r_p, derive an expression for the radius r_d of the circular orbit of the deuterium.

b.) In terms of the proton's radius r_p, derive an expression for the radius r_a of the circular orbit of the alpha particle.

29.15) An electron collides with a second resting electron. The collision is elastic. After the collision, both electrons follow a circular path due to the presence of a B-fld of magnitude 0.044 T. If the electron motion is perpendicular to the field, and if the radius of one electron is $r_1 = 1.00\text{ cm}$ and the radius of the second is $r_e = 2.40\text{ cm}$, what must the energy of the incident electron have been?

29.19) A proton in space has energy 10.0 MeV (an eV is the amount of energy required to accelerate an electron through a one-volt potential difference—it is equivalent to $1.6\text{x}10^{-19}\text{ J}$). It is moving in a circular path of radius $5.80\text{x}10^{10}\text{ m}$ due to its presence in a B-fld (note that this is approximately the radius of Mercury's orbit around the Sun). How large must the B-fld be, assuming it is perpendicular to the motion of the proton.

29.24) A cyclotron is comprised of a proton source that produces protons which are accelerated due to an alternating electric field (this is produced by an AC voltage). The protons move in an ever-increasing radius in a circular path produced by a magnetic force. The frequency of the AC source (and, hence, the angular frequency of the AC source) dictates the final velocity of the protons (remember $v = r\omega$?). With all of this in mind, assuming the B-fld's magnitude is 0.45 T and the cyclotron's radius is 1.20 m.



a.) What is the angular frequency of the AC source needed to power this device?

b.) What is the speed of the protons as they exit the cyclotron?

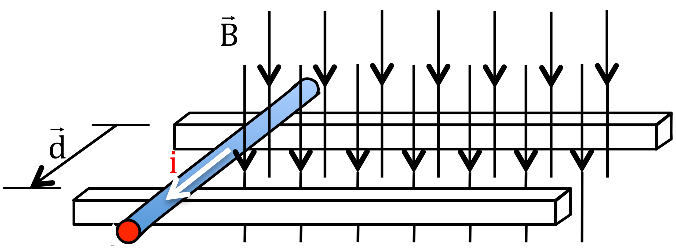
29.29) An old fashion, black and white TV set was essentially an electron-beam that was made to sweep back and forth across a fluorescent screen at very high speed (the frequency of the beam sweeping back and forth was a little under 16,000 cycles per second) as its additionally moved down the screen from top to bottom. The beam was initially accelerated with an electric field (produced by a potential difference), then deflected (for the back-and -forth and up-and-down motion) with varying magnetic fields generated by coils. With the B-flds turned off, the electron beam would hit the center of the screen. For a particular set, the beam was accelerated by a 50.0 kV potential difference before entering a region of uniform B-fld 1.00 cm wide. The screen was located 10.0 cm from the coil-producing B-flds and was 50.0 cm wide. Given these parameters, for the horizontal sweep, what was the maximum B-fld generated in the set. That is, what B-fld was required to make the beam just hit the edge of the screen?

29.35) A horizontal wire carrying 2.00 A oriented southward has a linear mass density of 0.500 gm/cm.

a.) In what direction must a magnetic field be oriented to counteract gravity and hold the wire suspended stationary in mid-air?

b.) What would the magnitude of that magnetic field need to be?

29.37) Two parallel bars of length L = 45.0 cm are d = 12.0 cm apart. A rod of radius $r = 6.00$ cm and mass $m = 0.720$ kg sits at rest at one end. If the rod has a current I = 48.0 A passing through it, and if it is bathed in a B-fld of magnitude 0.240 T as shown, what will the rod's velocity be by the time it reaches the end of the track (assumed frictionless).



29.44) A 2.00 circumference, single wire loop has 17.0 mA passing through it. A B-fld whose magnitude is 0.800 T passes through the loop exactly perpendicular to the plane of the loop.

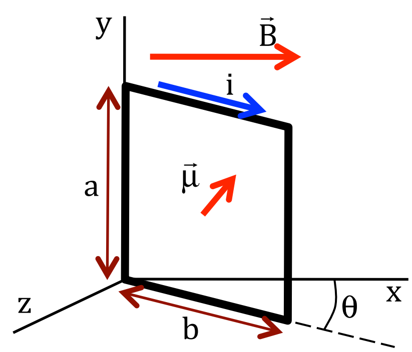
a.) Determine the loop's magnetic moment.

b.) Determine the torque produced by the B-fld on the loop.

29.47) A 100 turn, closely wrapped rectangular coil of dimensions a = 0.400 m and b = 0.300 m is hinged along the *y-axis* so that it's plane makes an angle of $\theta = 30^{\circ}$ with the *x-axis*.

a.) With a current of I = 1.20 A directed as shown, how large a torque will be produced on the coil by a B-fld directed along the *positive x-axis* whose magnitude is 0.800 T.

b.) How will the coil rotate? (That is, in what direction would you expect?)



29.51) The Hall experiment is the only way one can "prove" that it's electrons that move in an electric circuit. The idea is that if you make current flow through a plate that is, itself, bathed in a magnetic field perpendicular to the plate, the moving charge will feel a magnetic force via $q\vec{v}x\vec{B}$ and will migrate either toward the top of the plate or the bottom of the plate. That will produce a *voltage difference* between the top and bottom of the plate, called a Hall voltage. (The *polarity* of that *voltage difference* tells you whether you have a preponderance of positive charge or negative charge at, say, the top of the bar, which in turn tells you what kind of charge is actually moving through the circuit). Our problem is a little different. In it, a 0.500 cm thick copper bar is positioned along an east-west direction (this is important because it is the earth's B-fld that is going to provide the magnetic field in our problem). If the number of "free" electrons per cubic meter in the bar is $n = 8.46x10^{28}\ e^{-}/m^{3}$ and the plane of the bar is perpendicular to the earth's magnetic field, a current of 8.00 A through the bar will produce a Hall voltage equal to

$V_{hall} = 5.10x10^{-12}$ V . That being the case, what must the magnitude of the earth's B-fld be at that location?