B Team - Magnetism Problem Set

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1. True or False:
   (a) The magnetic moment of a bar magnet points from its north pole to its south pole.
   (b) The maximum torque on a current loop placed in a magnetic field occurs when the plane of the loop is perpendicular to the direction of the magnetic field.
   Assuming the current density is constant and uniform in a long straight wire that has a circular cross section:
   (c) The magnitude of the magnetic field produced by this wire is greatest at the surface of the wire.
   (d) The magnetic field strength in the region surrounding the wire varies inversely with the square of the distance from the wire's central axis.

2. The galactic magnetic field in some region of interstellar space has a magnitude of $1.00 * 10^{-9}$ T. A particle of interstellar dust has a mass of 10.0μg and a total charge of 0.300 nC. How many years does it take for the particle to complete a revolution of the circular orbit caused by its interaction with the magnetic field?

3. A magnetic dipole with a dipole moment of magnitude 0.025 J/T is released from rest in a uniform magnetic field of magnitude 58 mT. The rotation of the dipole due to the magnetic force on it is unimpeded. When the dipole rotates through the orientation where its dipole moment is aligned with the magnetic field, its kinetic energy is 0.70 mJ. What is the initial angle between the dipole moment and the magnetic field?

4. A circular loop of wire that has a mass m and a constant current I is in a region with a uniform magnetic field. It is initially in equilibrium and its magnetic moment is aligned with the magnetic field. The loop is given a small angular displacement about an axis through its center and perpendicular to the magnetic field and then released. What is the period of the subsequent motion? (Assume that the only torque exerted on the loop is due to the magnetic field and that there are no other forces acting on the loop.)

5. A simple gaussmeter for measuring horizontal magnetic fields consists of a stiff wire of length L that hangs from a conducting pivot so that its free end makes contact with a pool of mercury in a dish below. The mercury provides an electrical contact without constraining the movement of the wire. The wire has a mass m and conducts a current i directed downward. Derive an expression for B.