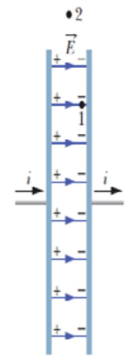
Chapter 24
Example Problems

1. A parallel-plate capacitor with circular plates of radius R is being charged. Find the magnetic field at a distance of $r = R/5 = 11.0$ mm if the electric field changes in time as $\Delta E/\Delta t = 1.50 \times 10^{12}$ V/m·s.



(a)

2. What is the measured component of the orbital magnetic dipole moment of an electron with $m_l = 1$ and $m_l = -2$?

3. A paramagnetic gas at room temperature ($T = 300$ K) is placed in an external uniform magnetic field of magnitude $B = 1.5$ T; the atoms of the gas have magnetic dipole moment $\mu = 1.0\mu_B$. Calculate the mean translational kinetic energy K of an atom of the gas and the energy difference U_B between parallel alignment and antiparallel alignment of the atom's magnetic dipole moment with the external field. Assume that the mean translational kinetic energy for a gas can be approximated as $KE = (3/2)k_BT$, where k_b is the Boltzmann constant given by 1.38×10^{-23} J/K.

4. A compass needle made of pure iron (density 7900 kg/m^3) has a length of 3.0 cm, a width of 1.0 mm, and a thickness of 0.50 mm. The magnitude of the magnetic dipole moment of an iron atom is $\mu_{Fe} = 2.1 \times 10^{-23}$ J/T. If the magnetization of the needle is equivalent to the alignment of 10% of the atoms in the needle, what is the magnitude of the needle's magnetic dipole moment **μ**?

5. When you look at the North Star (Polaris), you intercept light from a star at a distance of 431 ly and emitting energy at a rate of 2200 times that of our sun ($P_{sun} = 3.90 \times 10^{26}$ W). Neglecting any atmospheric absorption, find the rms values of the electric and magnetic fields when the starlight reaches you. (Note that 1 ly = 9.46×10^{15} m)

6. Assume that a TV station acts as a point source broadcasting isotropically at 1.0 MW. What is the intensity of transmitted signal reaching Proxima Centauri, the star nearest our solar system, 4.3 ly away? (Note that 1 ly = 9.46×10^{15} m)

7. Radiation from the sun reaching Earth has an intensity of 1.4 kW/m^2. Assuming that the Earth behaves like a flat disk perpendicular to the Sun's rays and that all the incident energy is absorbed. Note that $R_E = 6.37 \times 10^6$ m, $M_E = 5.98 \times 10^{24}$ kg, $M_S = 2.0 \times 10^{30}$ kg, and $R_{SE} = 1.5 \times 10^{11}$ m.
   a. Calculate the force on the Earth due to radiation pressure.
   b. For comparison, calculate the force due to the sun's gravitational attraction.