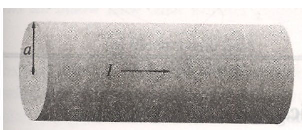
1. **[G 5.2]** In a region there is a uniform magnetic field $\mathbf{B}$ in x-direction and uniform electric field $\mathbf{E}$ in y-direction. Find and sketch the trajectory of a particle, if it starts at the origin with velocity
   (a) $\mathbf{v}(0) = (E/B)\,\hat{\mathbf{y}}$,
   (b) $\mathbf{v}(0) = (E/2B)\,\hat{\mathbf{y}}$,
   (c) $\mathbf{v}(0) = (E/B)\,(\hat{\mathbf{y}} + \hat{\mathbf{z}})$.

2. **[G 5.4]** Suppose that the magnetic field in some region has the form

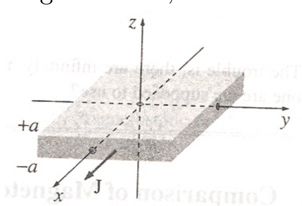
$$\mathbf{B} = kz\,\hat{\mathbf{x}}$$

(where k is a constant). Find the force on a square loop (side a), lying in the yz plane and centered at the origin, if it carries a current I, flowing counterclockwise, when you look down the x axis.

3. **[G 5.13]** A steady current I flows down a long cylindrical wire of radius a (Fig.).
   Find the magnetic field, both inside and outside the wire, if
   (a) The current is uniformly distributed over the outside surface of the wire.
   (b) The current is distributed in such a way that J is proportional to s, the distance from the axis.



4. **[G 5.14]** A thick slab extending from $z = -a$ to $z = +a$ carries a uniform volume current $\mathbf{J} = J\hat{\mathbf{x}}$ (Fig.). Find the magnetic field, as a function of z, both inside and outside the slab.



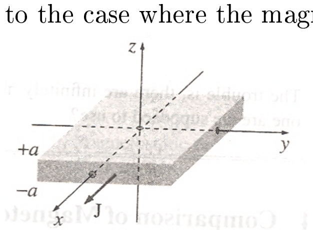
5. **[G 5.23]** What current density would produce the vector potential, $\mathbf{A} = k\hat{\boldsymbol{\phi}}$ (where k is a constant), in cylindrical coordinates?

6. **[G 5.24]** If $\mathbf{B}$ is *uniform*, show that $\mathbf{A}(\mathbf{r}) = -\frac{1}{2}(\mathbf{r} \times \mathbf{B})$. That is, check that $\boldsymbol{\nabla} \cdot \mathbf{A} = 0$ and $\boldsymbol{\nabla} \times \mathbf{A} = \mathbf{B}$. Is this result unique, or are there other functions with the same divergence and curl?

7. **[G 5.35]** A phonograph record of radius R, carrying a uniform surface charge σ, is rotating at constant angular velocity ω. Find its magnetic dipole moment.

8. **[G 5.37]** Find the exact magnetic field a distance z above the center of a square loop of side w, carrying a curent I. Verify that it reduces to the field of a dipole, with the appropriate dipole moment, when $z \gg w$.

9. **[G 5.40]** A plane wire loop of irregular shape is situated so that part of it is in a uniform magnetic field $\mathbf{B}$ (in Fig. the field occupies the shaded region, and points perpendicular to the plane of the loop). The loop carries a current I. Show that the net magnetic force on the loop is $F = IBw$, where w is the chord subtended. Generalize this result to the case where the magnetic field region itself has an irregular shape. What is the direction of the force?



10. [**G 5.55**]A magnetic dipole$\mathbf{m} = -m_0\hat{\mathbf{z}}$ is situated at the origin, in an otherwise uniform magnetic field $\mathbf{B} = B_0\hat{\mathbf{z}}$. Show that there exists a spherical surface, centered at the origin, through which no magnetic field lines pass. Find the radius of this sphere and sketch the field lines, inside and out.