Warm-Up for April 20th, 2022

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1 Memory Bank

1. Magnetic dipole field, assuming $\mathbf{m} = m\hat{\mathbf{z}}$ ($\mathbf{m} = I \int d\mathbf{a}$):

$$\mathbf{B} = \frac{\mu_0 m}{4\pi r^3} \left(2 \cos\theta \hat{\mathbf{r}} + \sin\theta \hat{\boldsymbol{\theta}} \right) \tag{1}$$

2. Torque on a magnetic dipole:

$$\boldsymbol{\tau} = \boldsymbol{\mu} \times \mathbf{B} \tag{2}$$

2 Magnetic Dipole Moment, and Dipole Field

1. A circular loop of wire, with radius R, lies in the xy plane (centered at the origin) and carries a current I running counterclockwise as viewed from the positive z axis. (a) What is the magnetic dipole moment? (b) What is the approximate magnetic field at points far from the origin? (c) Show that, for points on the z axis, your answer is consistent with the *exact* field when $z \gg R$. (d) Compute the torque on the system in the presence of an external **B**-field: $\mathbf{B} = B_0 \hat{\mathbf{y}}$.