Physics Prelab #5: Magnetic Fields and the Magnetic Dipole
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Objective: The objective for this lab is to plot the magnetic field against 1/r^3 and then to plot the frequency squared versus the magnetic field.

Theory: The magnetic field created by a ring magnet is similar to the field produced by a dipole. The equation for the magnetic field produced by the ring magnet at a point on a line intersecting the magnet is given by $B_z(z)=\frac{\mu_0}{2\pi}\frac{\mu}{((\frac{R_1+R_2}{2})^2+z^2)^{\frac{3}{2}}}$. The torque on a dipole in a magnetic field is given by the equation $\vec{\tau}=\vec{\mu}\times\vec{B}_e=-I\alpha$, where I is the moment of inertia, Be is the external field, and alpha is the angular acceleration. For small angles of deflection, we can get the function $\mu B\sin\theta\approx\mu B_e\theta=-I\frac{\partial^2\theta}{\partial t^2}$. The solution to this differential equation is $\theta=A\sin(\omega t+\delta)$. We can replace omega with $\omega=\sqrt{(\frac{\mu B_e}{I})}$. We can find the moment of inertia for a ring to be $I=\frac{m}{4}(R_1^2+R_2^2)$ .The field at the center of a coil can be found to be $B_e=\frac{\mu i N}{R^3}(\frac{4}{5})^{\frac{3}{2}}$.

Procedure:
1. Show calculations
2. Run datastudio program dipole2.ds, set sensor to axial field measurement and scale to 10x. Hit tare when the sensor is far from any magnetic fields.
3. Measure the magnetic field as a function of distance along the z axis. Plot Bx v 1/(R^2 + z^2)^3/2 and get slope.
4. Weigh magnet and calculate moment of inertia.
5. Hang the magnet directly in the middle of the two hemholtz coil. Use 20A hole in ammeter. Set current to 0.05A. Displace the coil so the angle wiggles no more than 15 degrees. Time 50 oscillations. Repeat for 0.1A-0.5A with 0.05A difference.
6. Calculate frequency.