# PHY2049 Summer 2018 Extra Credit Assignment #1

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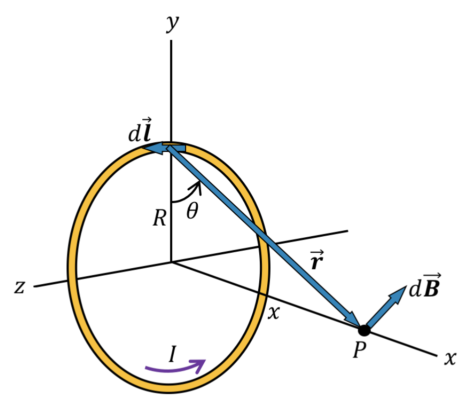
**Abstract**

This extra credit assignment is worth **2 points towards your final grade**. This means that if, for example, you end with an 83 in the class, which is a B, these 2 points would carry you to an 85 in the class, which is an A. Each step in this assignment must be fully completed, with all work outlined clearly, for the full 2 points to be awarded. Any work not fully completed will be assigned some partial credit. **This assignment is due Monday, July 23, 2018.**

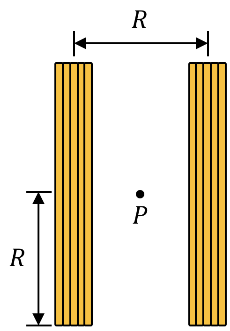



(a) As shown in the figure above, a single loop, with radius R and current $i$, produces a magnetic field. Using the Biot-Savart law, prove that the magnetic field down the center of the coil, some distance $x$ away from the coil, is:

$$\vec{B} = \frac{\mu_0 I R^2}{2(R^2 + x^2)^{3/2}} \hat{i}$$

*Note: all I'm indicating by the above is that the magnetic field points in the $x$-direction; you can ignore the vector notation, prove that magnitude of the above equation, and simply say "in the $x$-direction" to denote the same answer.*

(b) If instead of a single coil, there were $N$ coils (each with the same radius $R$) stacked on top of each other in the previous problem, how would the equation in the previous problem change? *Note: the coils are stacked very closely together, so the total thickness of the $N$ coils is much less than the radius of each coil.*




(c) Two of these $N$ loop configurations, described in part (b), are set a center-to-center distance apart of $R$. Prove that the magnetic field at the point $P$ indicated in the above figure, exactly half-way between each set of coils (each carrying a current $I$), is:

$$B = \left(\frac{4}{5}\right)^{3/2} \frac{\mu_0 N I}{R}$$