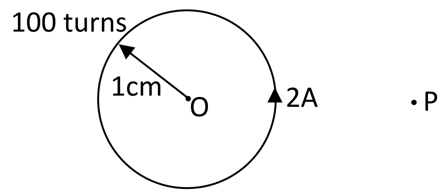
Name: ______________________________

PHY 232 Summer 2016 Class Work

Class 29. Biot-Savart Law

Consider a 100 turn coil of 1cm in radius, and a current of 2A is passing through the coil.



(a) Calculate the magnetic field at the center of the coil (point O). What is the direction of the magnetic field at that point?

$$|\vec{B}| = 100 \times \frac{\mu_0 I}{2R} = 100 \times \frac{4\pi \times 10^{-7} \times 2}{2 \times 0.01} = \underline{\underline{0.0126T}}$$

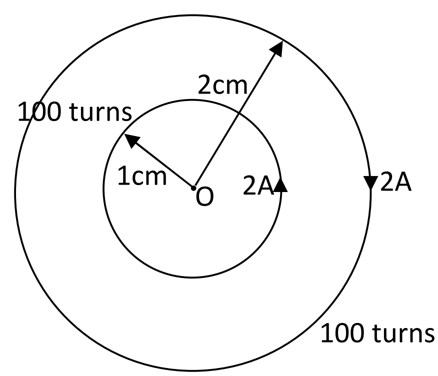
Direction: ⊙

(b) What is the direction of the magnetic field at point P?

⊗

(see reasoning below)

(c) Another ring (also 100 turns) of 2cm in radius is placed concentrically to the original ring. The outer ring carries the same magnitude of current (2A) but in opposite direction, as shown in the diagram. Calculate the magnetic field at the center of the two coils (point O). What is the direction of the magnetic field at that point?



$$\vec{B}_{inner} = 0.0126T \odot \qquad \text{(from part (a))}$$

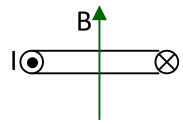
$$\vec{B}_{outer} = 100 \times \frac{\mu_0 I}{2R} = 100 \times \frac{4\pi \times 10^{-7} \times 2}{2 \times 0.02} = 0.00628T \otimes$$

$$\begin{aligned} \therefore \vec{B} = \vec{B}_{inner} + \vec{B}_{outer} &= 0.0126T \odot + \ 0.00628T \otimes \\ &= 0.0126T \odot - \ 0.00628T \odot \\ &= \underline{\underline{0.00628T \odot}} \end{aligned}$$

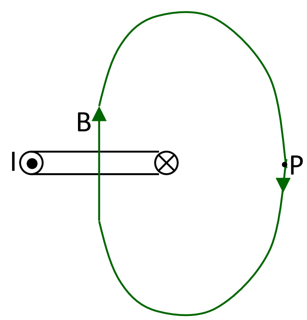
There are two ways to reason the answer of part (b):

Reason 1.

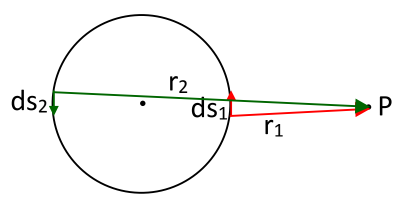
If you take a side view of the ring, field near the center is pointing up:



But we know the magnet field line has to loop back, so it must be pointing down when it passes through point P:



Reason 2:



According to Biot-Savart Law, line segment ds_1 will produce a field pointing into the page (⊙) and line segment ds_2 will produce a field pointing out of the page (⊗). ds_1 is closer to point P, so the field it produces should be stronger than that produced by ds_1. So the total magnetic field should be pointing into the page at point P.