



Current  $I$  flows around the loop  $ACDE$  in a counter-clockwise direction.

The direction of the magnetic field  $\vec{B}$  at  $O$  due to the current loop

- A) is out of the page.
- B) is into the page.
- C) is  $\vec{B} = 0$
- D) can't be determined.
- E) is at an angle of  $45^\circ$  counter-clockwise from  $+\hat{i}$  in the  $xy$ -plane.

$\vec{B} = \vec{B}_{AC} + \vec{B}_{CD} + \vec{B}_{DE} + \vec{B}_{EA}$ , where  $\vec{B}_{AC}$ ,  $\vec{B}_{DE}$  are the magnetic fields due to line segments  $\overline{AC}$  and  $\overline{DE}$  respectively; and where  $\vec{B}_{CD}$ ,  $\vec{B}_{EA}$  are the magnetic fields due to the arcs  $\overline{CD}$  and  $\overline{EA}$ , respectively. According to the Biot-Savart law, we have

$$\delta\vec{B} = \frac{\mu}{4\pi} \frac{\vec{r} \times I \delta\vec{L}}{r^3}, \quad \text{so for arcs,} \quad \|\vec{B}\| = \frac{\mu_0 I r \pi}{4\pi 2r^2} \Big|_{r=a \text{ or } a+b}.$$

$$\text{At } O, \quad \vec{B}_{DE} = \vec{B}_{EA} = 0, \quad \text{and}$$

$$B_{AC} = \frac{\mu_0 I}{8a} \quad (\text{into the paper}) \quad \text{and}$$

$$B_{CD} = \frac{\mu_0 I}{8(a+b)} \quad (\text{out of the paper}).$$

Since  $B_{AC} > B_{CD}$ , the resultant  $\vec{B}$  due to the entire current loop will point into the paper.

Answer **B**.

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