



Given: Consider a current segment \overline{CD} with current I . Let \vec{B} be the magnetic field vector at P due to this segment.

The direction and the magnitude of \vec{B} are

- A) into the page, $B = \frac{\mu_0}{4\pi a} \hat{k}$.
- B) into the page, $B = \frac{\sqrt{2}\mu_0}{4\pi a} \hat{k}$.
- C) out of the page, $B = -\frac{\mu_0}{4\pi a} \hat{k}$.
- D) out of the page, $B = -\frac{\sqrt{2}\mu_0}{4\pi a} \hat{k}$.

Consider $I\delta y$ at y where $\sin\theta = \frac{a}{r}$, $\frac{\delta y}{r^2} = \frac{\delta\theta}{a}$. Its contribution at P is $\delta B = \frac{\mu_0}{4\pi} \frac{I\delta y}{r^2} \sin\theta = \frac{\mu_0 I \delta\theta}{4\pi a} \sin\theta$. By inspection $I\delta\vec{y} \times \vec{r}$ gives the direction of $\delta\vec{B}$ to be into the paper. So \vec{B} at P due to \overline{CD} is into the page. Integrating from C to D , one obtains at P

$$B = \int_{\frac{\pi}{4}}^{\frac{3\pi}{4}} \frac{\mu_0 I}{4\pi} \frac{d\theta}{a} \sin\theta = \frac{\sqrt{2}\mu_0 I}{4\pi a}.$$

Answer **B**.