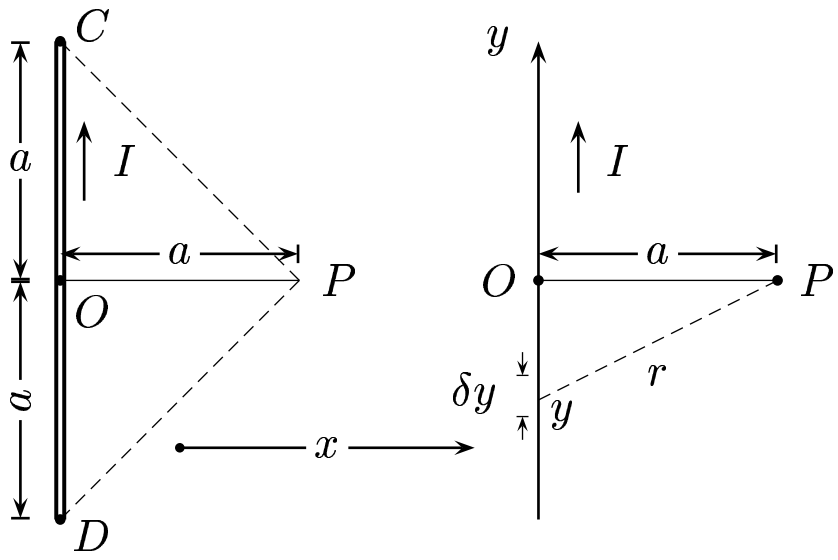

Given: Consider a current segment $\overline{CD}$ with current I. Let $\vec{B}$ be the magnetic field vector at P due to this segment.

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

A) into the page, $B = \dfrac{\mu_0}{4\,\pi\,a}\,\hat{k}\,.$

B) into the page, $B = \dfrac{\sqrt{2}\,\mu_0}{4\,\pi\,a}\,\hat{k}\,.$

C) out of the page, $B = -\dfrac{\mu_0}{4\,\pi\,a}\,\hat{k}\,.$

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

Consider $I\delta y$ at y where $\sin\theta = \dfrac{a}{r}$, $\dfrac{\delta y}{r^2} = \dfrac{\delta\theta}{a}$. Its contribution at P is

$\delta B = \dfrac{\mu_0}{4\pi}\dfrac{I\,\delta y}{r^2}\sin\theta = \dfrac{\mu_0}{4\pi}\dfrac{I\,\delta\theta}{a}\sin\theta$. By inspection $I\delta\vec{y}\times r$ gives the direction

of $\delta\vec{B}$ to be into the paper. So $\vec{B}$ at P due to $\bar{C}D$ 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**.

30.01-04˙Magnetic˙Field˙due˙to˙a˙Straight˙Segment 2004-10-12