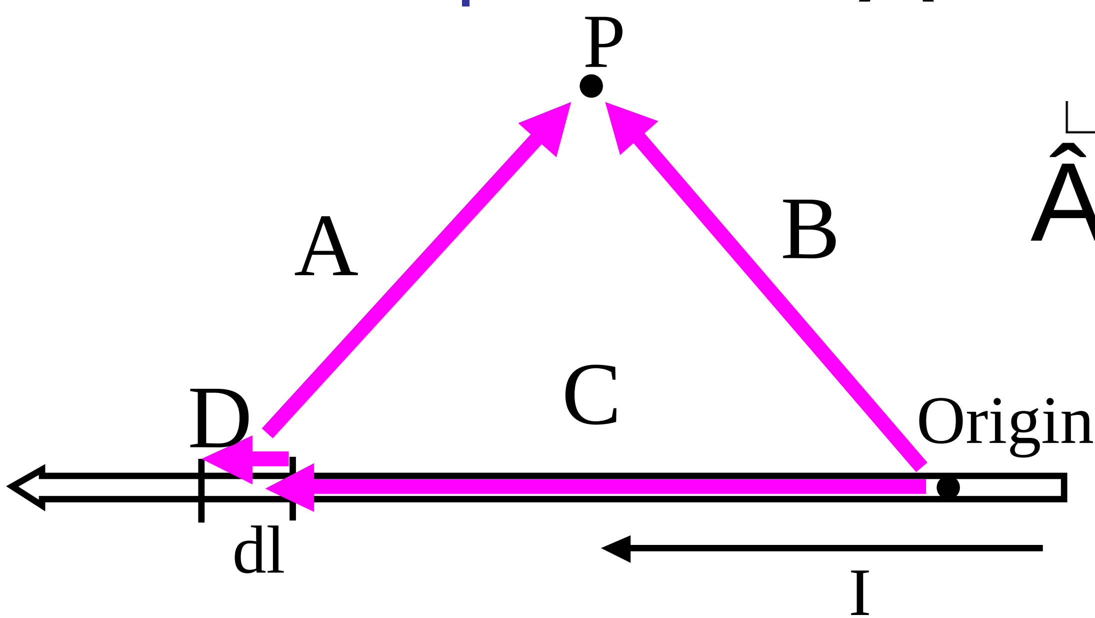
BIOT SAVART LAW

5.11 To find the magnetic field B at P due to a current-carrying wire we use the Biot-Savart law,

$$\vec{B}(\vec{r}) = \frac{\mu_0}{4\pi} I \int \frac{d\vec{l} \times \hat{\mathfrak{R}}}{\mathfrak{R}^2}$$

In the figure, with “dl” shown, which purple vector best represents Â ?



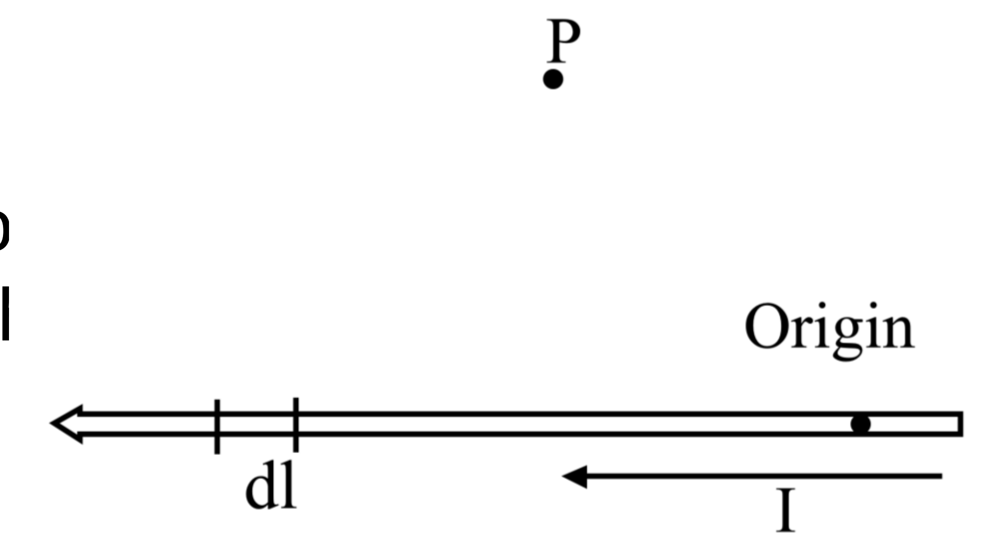
$$\hat{A} = r - r'$$

E) None of these!

To find the magnetic field B at P due to a current-carrying wire we use the Biot-Savart law,

$$\vec{B}(\vec{r}) = \frac{\mu_0}{4\pi} I \int \frac{d\vec{l} \times \hat{\mathfrak{R}}}{\mathfrak{R}^2}$$

What is the *direction* of the infinitesimal contribution d**B**(P) created by current in d**l**?



A) Up the page

B) Directly away fro
(in the plane of tl

C) Into the page

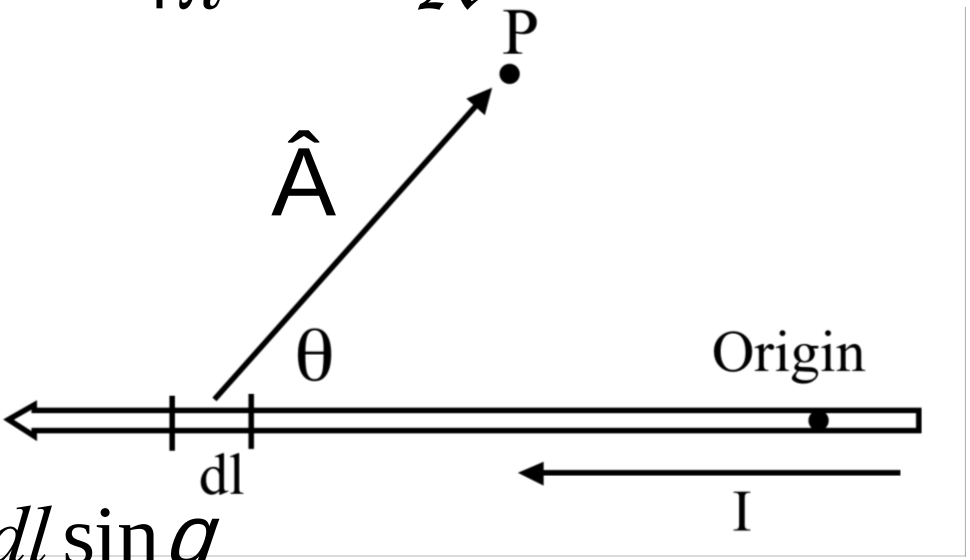
D) Out of the page

E) Some other direction

To find the magnetic field B due to a current-carrying wire, below, we use the Biot-Savart law, $\vec{B}(\vec{r}) = \frac{\mu_0}{4\pi} I \int \frac{d\vec{l} \times \hat{\mathfrak{R}}}{\mathfrak{R}^2}$

What is the magni

$\frac{d\vec{l} \times \hat{\mathfrak{R}}}{\mathfrak{R}^2}$?



a) $\frac{dl \sin q}{\hat{A}^2}$

b) $\frac{dl \sin q}{\hat{A}^3}$

c) $\frac{dl \cos q}{\hat{A}^2}$

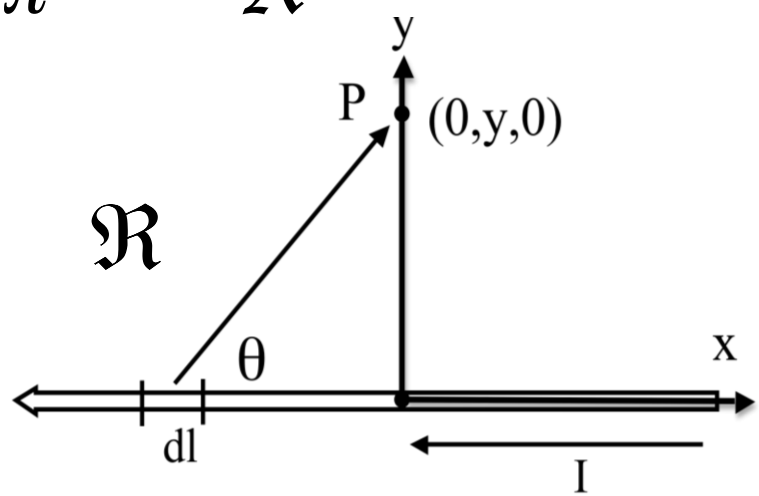
d) $\frac{dl \cos q}{\hat{A}^3}$

e) something else!

To find the magnetic field B due to a current-carrying wire, below, we use the Biot-Savart law, $\vec{B}(\vec{r}) = \frac{\mu_0}{4\pi} I \int \frac{d\vec{l} \times \hat{\mathfrak{R}}}{\mathfrak{R}^2}$

What is the value of

$I \frac{d\vec{l} \times \hat{\mathfrak{R}}}{\mathfrak{R}^2}$?



a) $\frac{Iy\,dx'\hat{z}}{[(x')^2 + y^2]^{3/2}}$

b) $\frac{Ix'\,dx'\,\hat{y}}{[(x')^2 + y^2]^{3/2}}$

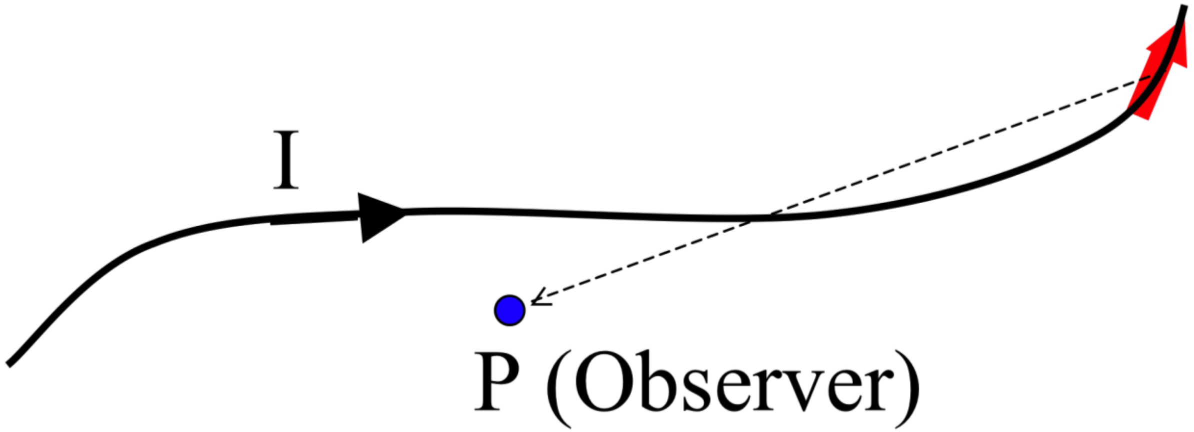
c) $\frac{-Ix'dx'\,\hat{y}}{[(x')^2 + y^2]^{3/2}}$

d) $\frac{-Iy\,dx'\hat{z}}{[(x')^2 + y^2]^{3/2}}$

e) Other!

What do you expect for direction of **B**(P)?

How about direction of d**B**(P) generated JUST by the segment of current dl in red?



A) **B**(p) in plane of page, ditto for d**B**(P, by red)

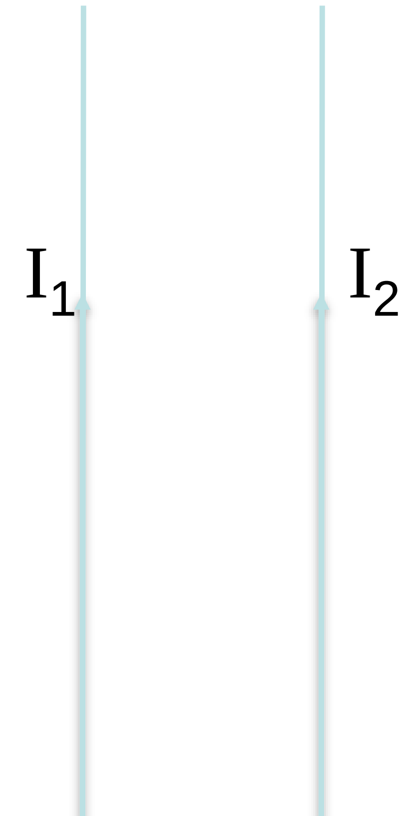
B) **B**(p) into page, d**B**(P, by red) into page

C) **B**(p) into page, d**B**(P, by red) out of page

D) **B**(p) complicated - has mult component (*not* $\perp$ or || to page), ditto for d**B**(P, by red)

E) Something else!!

I have two very long, parallel wires each carrying a current I_1 and I_2, respectively. In which direction is the force on the wire with the current I_2?



A) Up
B) Down
C) Right
D) Left
E) Into or out of the page

(How would your answer change if you reverse the direction of *both* currents?)

5.15 To find the magnetic field B due to a current-carrying loop, we use the Biot-Savart law, $\vec{B}(\vec{r}) = \frac{\mu_0}{4\pi} I \int \frac{d\vec{l} \times \hat{\mathfrak{R}}}{\mathfrak{R}^2}$

What is the magnitude of $\frac{d\vec{l} \times \hat{\mathfrak{R}}}{\mathfrak{R}^2}$?

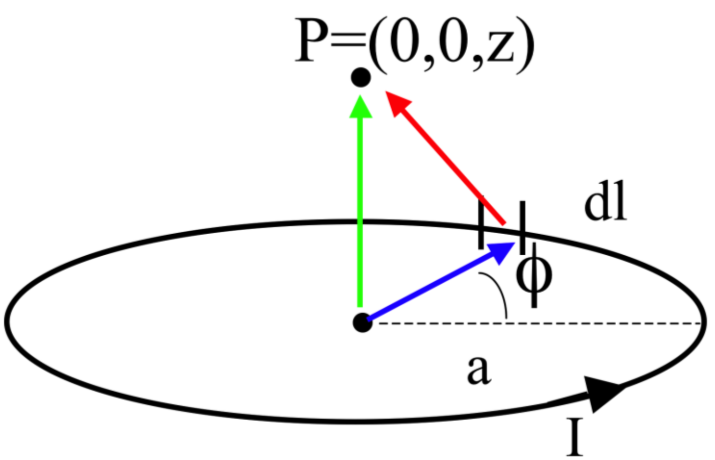
A) $\frac{dl \sin f}{z^2}$

B) $\frac{dl}{z^2}$

C) $\frac{dl \sin f}{(z^2 + a^2)}$

D) $\frac{dl}{(z^2 + a^2)}$

E) Something quite different!



(Which colored arrow is Â ? **r**? **r'**?)

To find the magnetic field B due to a current-carrying loop, we use the Biot-Savart law, $\vec{B}(\vec{r}) = \frac{\mu_0}{4\pi} I \int \frac{d\vec{l} \times \hat{\mathfrak{R}}}{\mathfrak{R}^2}$

What is d**B**$_z$ (the contribution to the vertical component of **B** from this dl segment?)

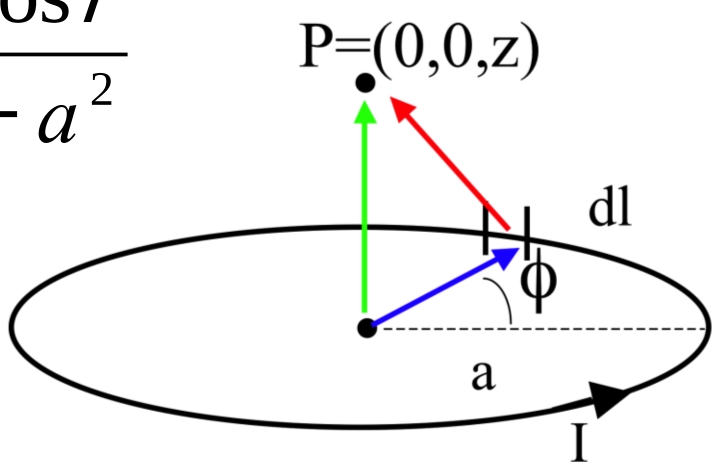
A) $\frac{dl}{z^2 + a^2} \frac{a}{\sqrt{z^2 + a^2}}$

B) $\frac{dl}{z^2 + a^2}$

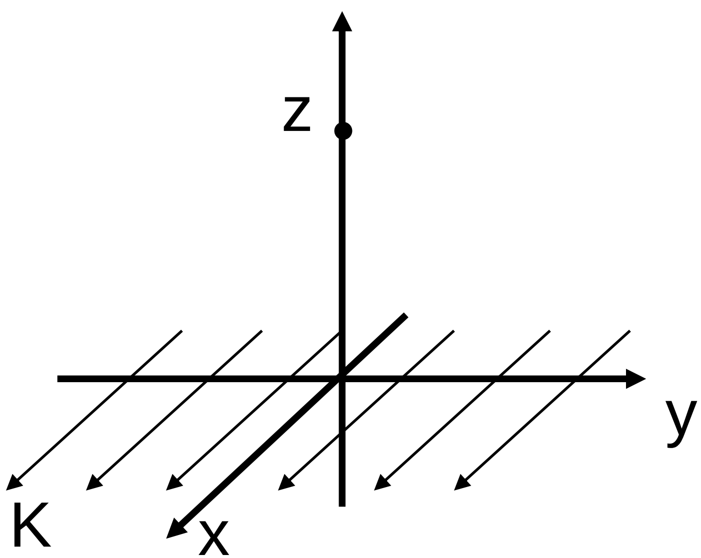
C) $\frac{dl}{z^2 + a^2} \frac{z}{\sqrt{z^2 + a^2}}$

D) $\frac{dl \cos f}{z^2 + a^2}$

E) Something quite different!



Consider the B-field a distance z from a current sheet in the z = 0 plane:



The B-field has

A) y-component only

B) z-component only

C) y and z-components

D) x, y, and z-components

E) Other

DIVERGENCE & CURL OF B; STOKES THEOREM

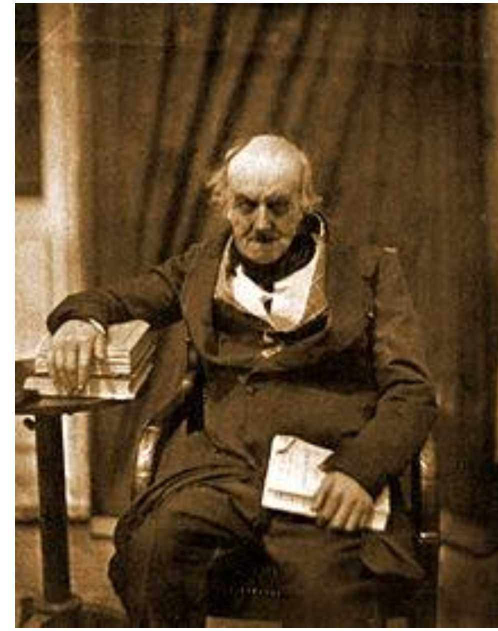
Jean-Baptiste Biot

1774 – 1862 French physicist

Discovered Biot-Savart law

Established that meteorites were from space

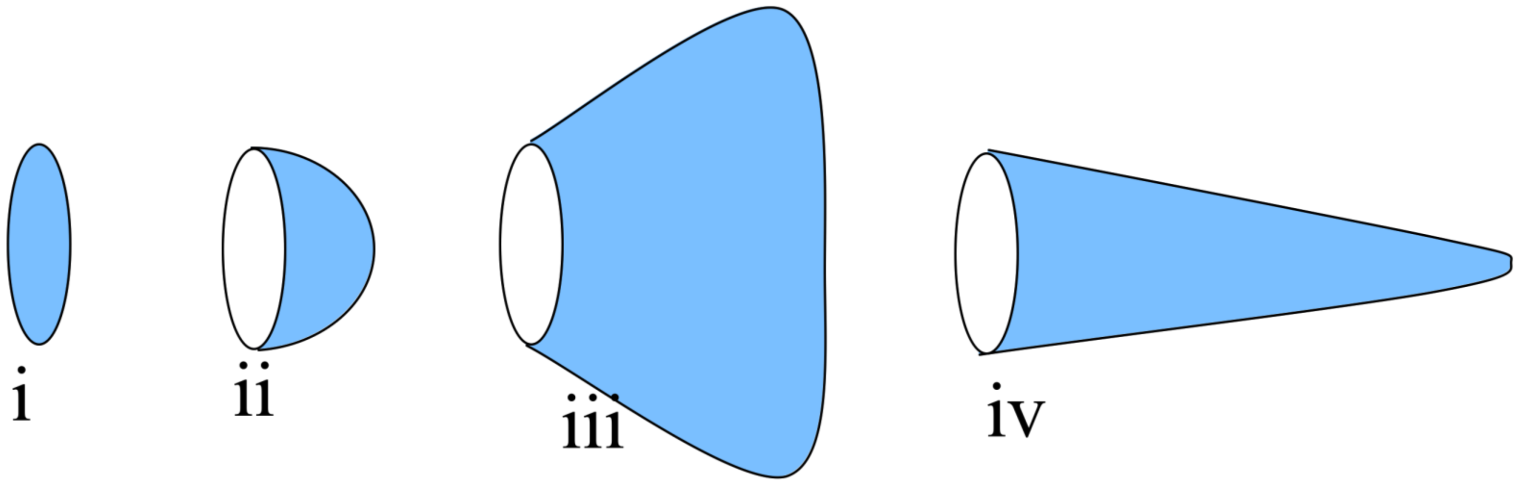
Made first scientific balloon flight



Demonstrated rotation of polarization of ight

Mineral biotite named in his honor.

5.16 Rank order $\left|\iint \vec{\mathbf{J}} \cdot d\vec{\mathbf{A}}\right|$ (over blue surfaces) where **J** is uniform, going left to right:



A) iii > iv > ii > i

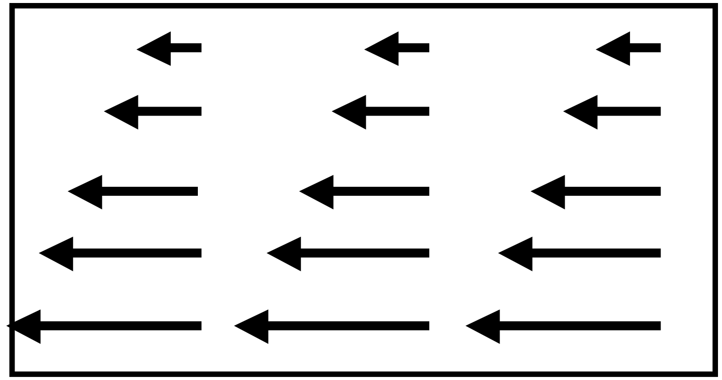
B) iii > i > ii > iv

C) i > ii > iii > iv

D) Something else!!

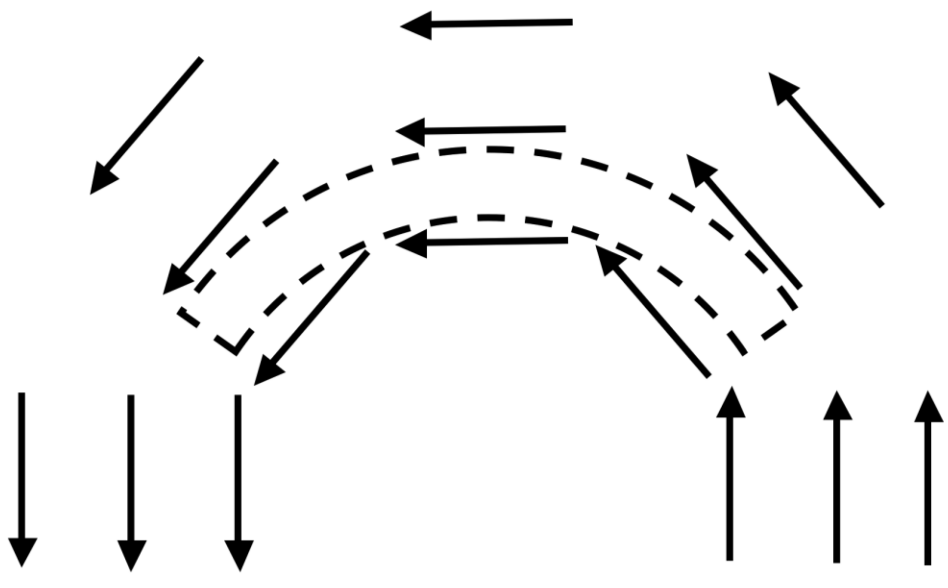
E) Not enough info given!!

The figure shows a static magnetic field in a region of space. Could this region of space be "empty"?



A) Yes, it could be empty space (with currents somewhere off to the sides creating it)
B) No, there must be static charges (ρ) in there.
C) No, there must be a current density (J) in the plane of the page in this (boxed) region
D) No, there must be a current density (J) perpendicular to the plane of the page in this region.
E) Other/???

If the arrows represent a B field (note that |B| is the same everywhere), is there a nonzero **J** (perpendicular to the page) in the dashed region?



$\vec{B} = B_0 \hat{j}$

A. Yes

B. No

C. Need more information to decide