We defined the volume current density in terms of the differential, $\mathbf{J} \equiv \dfrac{d\mathbf{I}}{da_\perp}$.

When is ok to determine the volume current density by taking the ratio of current to cross-sectional area?

$$\mathbf{J} \stackrel{?}{=} \frac{\mathbf{I}}{A}$$

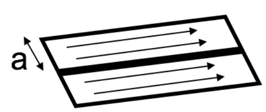
A. Never
B. Always
C. I is uniform
D. I is uniform and A is $\perp$ to I
E. None of these

Current I flows down a wire (length L) with a square cross section (side a). If it is uniformly distributed over the outer surfaces only, what is the magnitude of the surface current density K?

A. $K = I/a^2$
B. $K = I/a$
C. $K = I/4a$
D. $K = aI$
E. None of the above

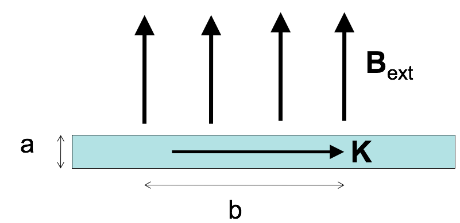
A "ribbon" (width a) of surface current flows (with surface current density K). Right next to it is a second identical ribbon of current. Viewed collectively, what is the new total surface current density?

A. K
B. $2K$
C. $K/2$
D. Something else



A "ribbon" (width a) with uniform surface current density K passes through a uniform magnetic field $\mathbf{B}_{ext}$. Only the length b along the ribbon is in the field. What is the magnitude of the force on the ribbon?

A. KB
B. aKB
C. $abKB$
D. bKB/a
E. $KB/(ab)$



Which of the following is a statement of charge conservation?

A. $\dfrac{\partial \rho}{\partial t} = -\nabla \mathbf{J}$

B. $\dfrac{\partial \rho}{\partial t} = -\nabla \cdot \mathbf{J}$

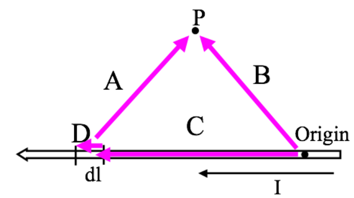
C. $\dfrac{\partial \rho}{\partial t} = -\int \nabla \cdot \mathbf{J} d\tau$

D. $\dfrac{\partial \rho}{\partial t} = -\oint \mathbf{J} \cdot d\mathbf{A}$

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

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

In the figure, with $d\mathbf{l}$ shown, which purple vector best represents $\mathfrak{R}$?

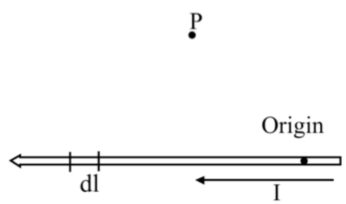


E) None of these!

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

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

What is the direction of the infinitesimal contribution $\mathbf{B}(P)$ created by current in $d\mathbf{l}$?



A. Up the page

B. Directly away from $d\mathbf{l}$ (in the plane of the page)

C. Into the page

D. Out of the page

E. Some other direction

What is the magnitude of $\dfrac{d\mathbf{l} \times \mathfrak{R}}{\mathfrak{R}^2}$?

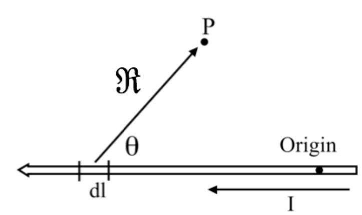
A. $\dfrac{dl \sin\theta}{\mathfrak{R}^2}$

B. $\dfrac{dl \sin\theta}{\mathfrak{R}^3}$

C. $\dfrac{dl \cos\theta}{\mathfrak{R}^2}$

D. $\dfrac{dl \cos\theta}{\mathfrak{R}^3}$

E. something else!



What is the value of $I\dfrac{d\mathbf{l}\times\mathfrak{R}}{\mathfrak{R}^2}$?

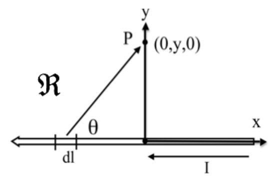
A. $\dfrac{I\;y\;dx'}{[(x')^2+y^2]^{3/2}}\hat{z}$

B. $\dfrac{I\;x'\;dx'}{[(x')^2+y^2]^{3/2}}\hat{y}$

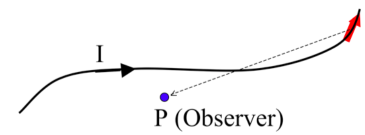
C. $\dfrac{-I\;x'\;dx'}{[(x')^2+y^2]^{3/2}}\hat{y}$

D. $\dfrac{-I\;y\;dx'}{[(x')^2+y^2]^{3/2}}\hat{z}$

E. Other!



What do you expect for direction of $\mathbf{B}(P)$? How about direction of $d\mathbf{B}(P)$ generated JUST by the segment of current $d\mathbf{l}$ in red?



A. $\mathbf{B}(P)$ in plane of page, ditto for $d\mathbf{B}(P$, by red)

B. $\mathbf{B}(P)$ into page, $d\mathbf{B}(P$, by red) into page

C. $\mathbf{B}(P)$ into page, $d\mathbf{B}(P$, by red) out of page

D. $\mathbf{B}(P)$ complicated, ditto for $d\mathbf{B}(P$, 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?

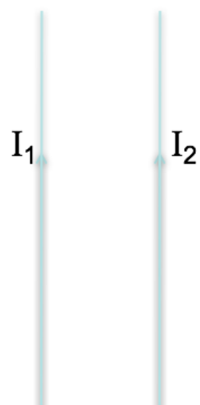
A. Up

B. Down

C. Right

D. Left

E. Into or out of the page



What is the magnitude of $\dfrac{d\mathbf{l}\times\mathfrak{R}}{\mathfrak{R}^2}$?

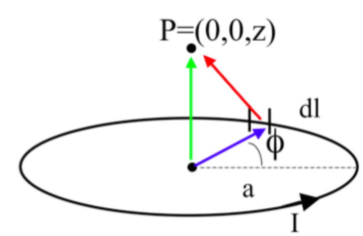
A. $\dfrac{dl\sin\phi}{z^2}$

B. $\dfrac{dl}{z^2}$

C. $\dfrac{dl\sin\phi}{z^2+a^2}$

D. $\dfrac{dl}{z^2+a^2}$

E. something else!



What is $d\mathbf{B}_z$ (the contribution to the vertical component of $\mathbf{B}$ from this $d\mathbf{l}$ segment?)

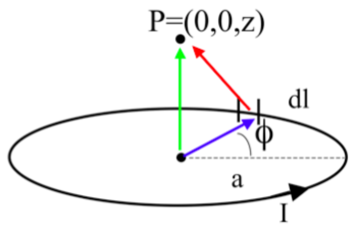
A. $\frac{dl}{z^2+a^2}\frac{a}{\sqrt{z^2+a^2}}$

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

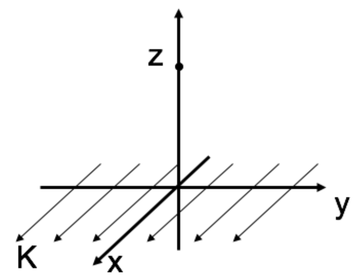
C. $\frac{dl}{z^2+a^2}\frac{z}{\sqrt{z^2+a^2}}$

D. $\frac{dl\cos\phi}{\sqrt{z^2+a^2}}$

E. Something else!



Consider the B-field a distance z from a current sheet (flowing in the +x-direction) 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