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

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

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

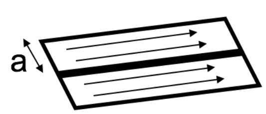
A. Never
B. Always
C. I is uniform
D. I is uniform and A is $\perp$ to I
E. None of these

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

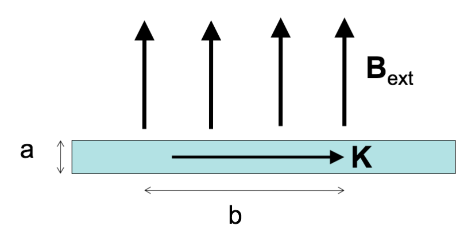
A "ribbon" (width a) of surface current flows (with surface current density K). Right next to it is a second identical ribbon of current. Viewed collectively, what is the new total surface current density?

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

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

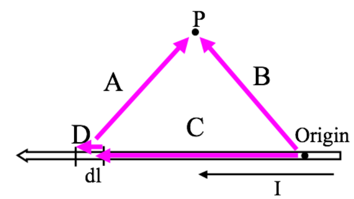
C. $\frac{\partial \rho}{\partial t} = -\int \nabla \cdot \mathbf{J} d\tau$

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

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

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

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



E) None of these!

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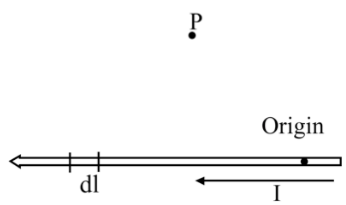


What is the direction of the infinitesimal contribution $\mathbf{B}(P)$ created by current in $d\mathbf{l}$?

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

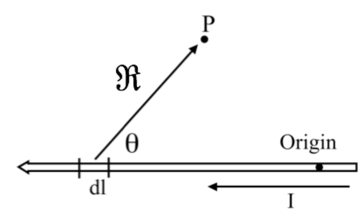
A. $\frac{dl \sin\theta}{\mathfrak{R}^2}$

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

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

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

E. something else!



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

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!