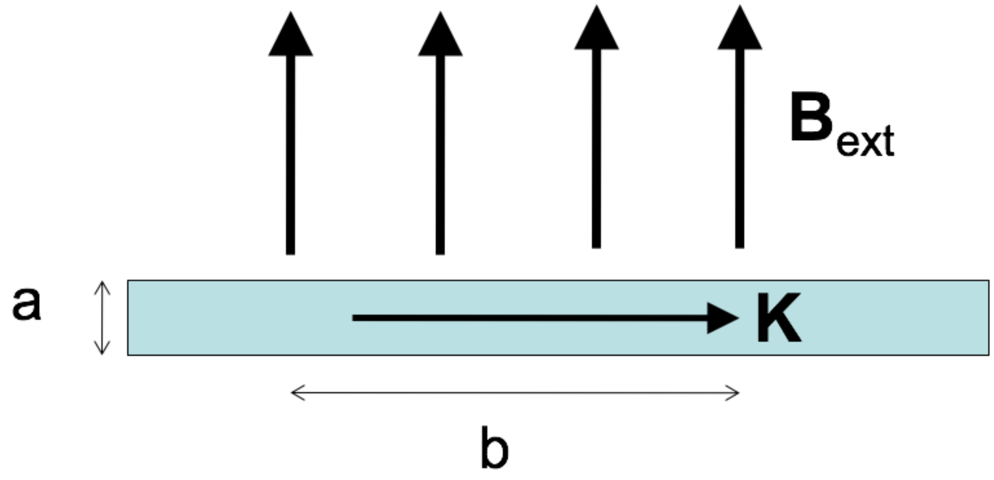
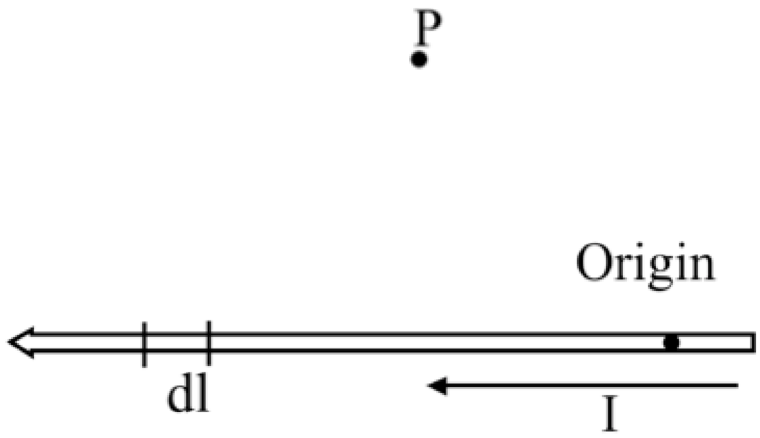
A "ribbon" (width a) with uniform surface current density K passes through a uniform magnetic field $\mathbf{B}_{ext}$. Only the length b along the ribbon is in the field. What is the magnitude of the force on the ribbon?

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



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

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



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

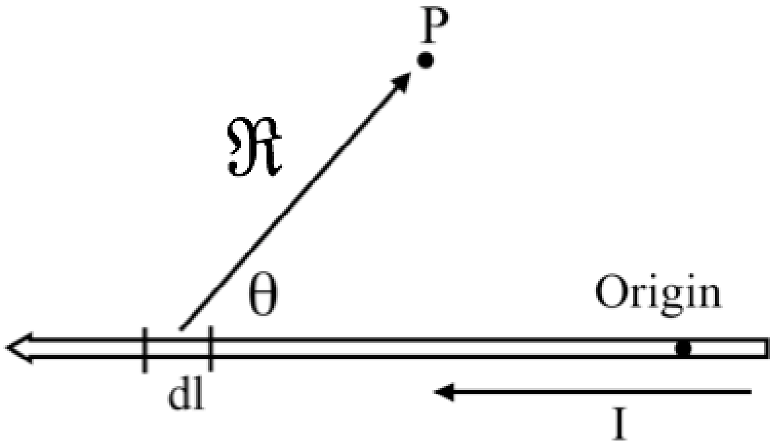
A. $\dfrac{dl \sin\theta}{\mathfrak{R}^2}$

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

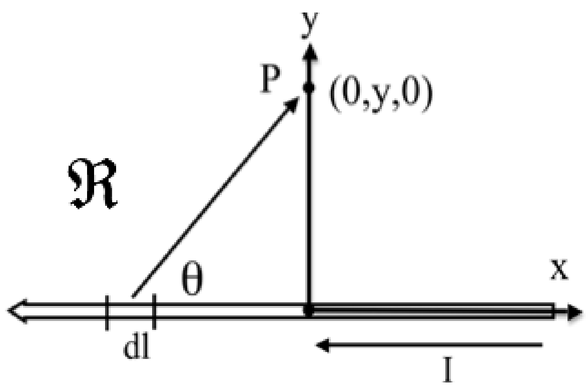
A. $\frac{I\,y\,dx'}{[(x')^2+y^2]^{3/2}}\hat{z}$

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

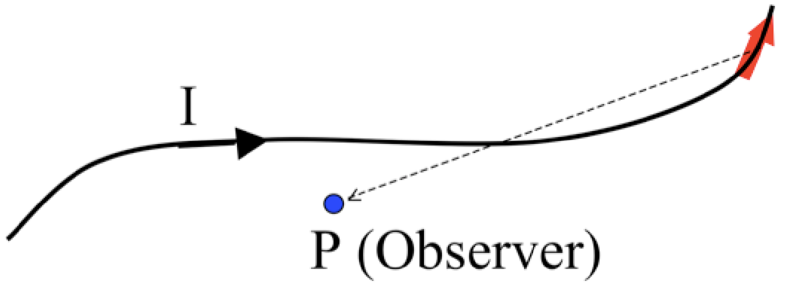
C. $\frac{-I\,x'\,dx'}{[(x')^2+y^2]^{3/2}}\hat{y}$

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

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!!

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

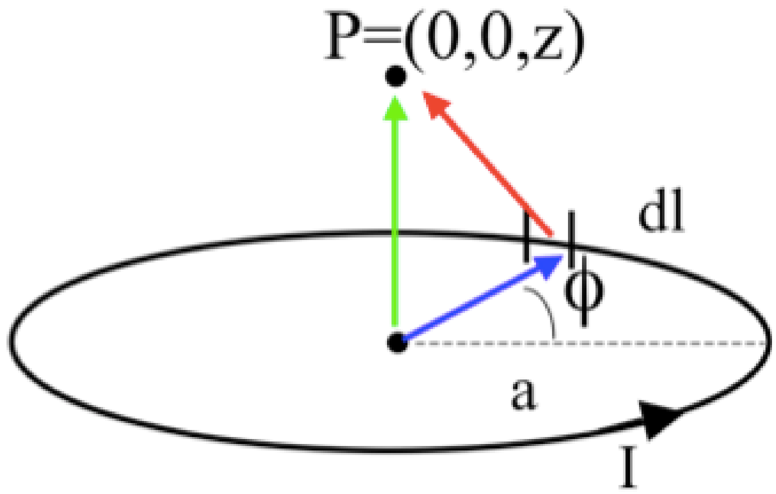
A. $\dfrac{dl \sin \phi}{z^2}$

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!