What is the value of:

$$\int_{-\infty}^{\infty} x^2 \delta(x-2)dx$$

A. 0

B. 2

C. 4

D. ∞

E. Something else

A point charge (q) is located at position $\mathbf{R}$, as shown. What is $\rho(\mathbf{r})$, the charge density in all space?

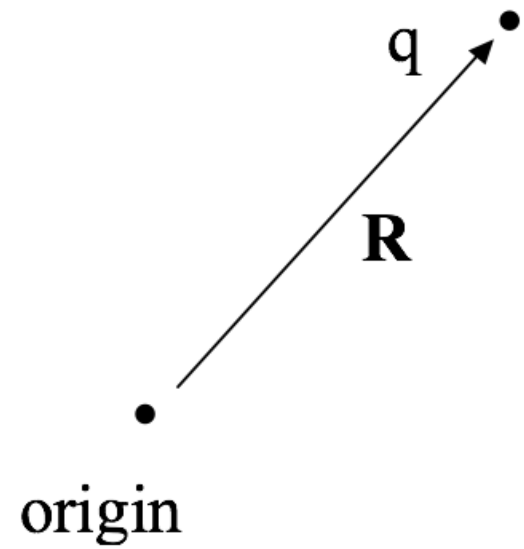
A. $\rho(\mathbf{r}) = q\delta^3(\mathbf{R})$

B. $\rho(\mathbf{r}) = q\delta^3(\mathbf{r})$

C. $\rho(\mathbf{r}) = q\delta^3(\mathbf{R} - \mathbf{r})$

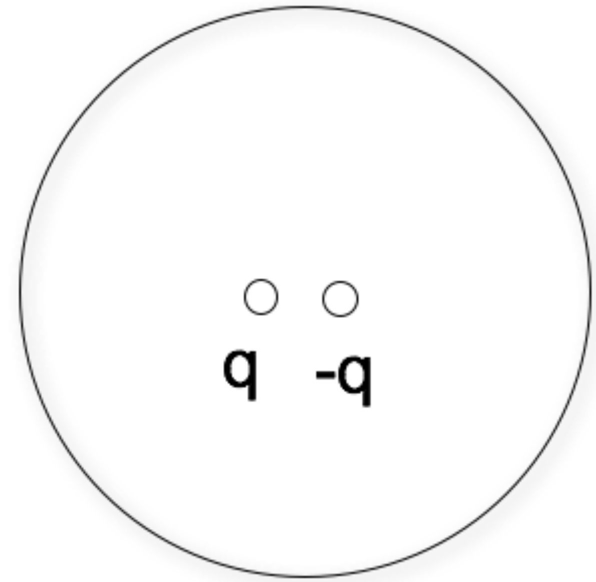
D. $\rho(\mathbf{r}) = q\delta^3(\mathbf{r} - \mathbf{R})$

E. Something else??



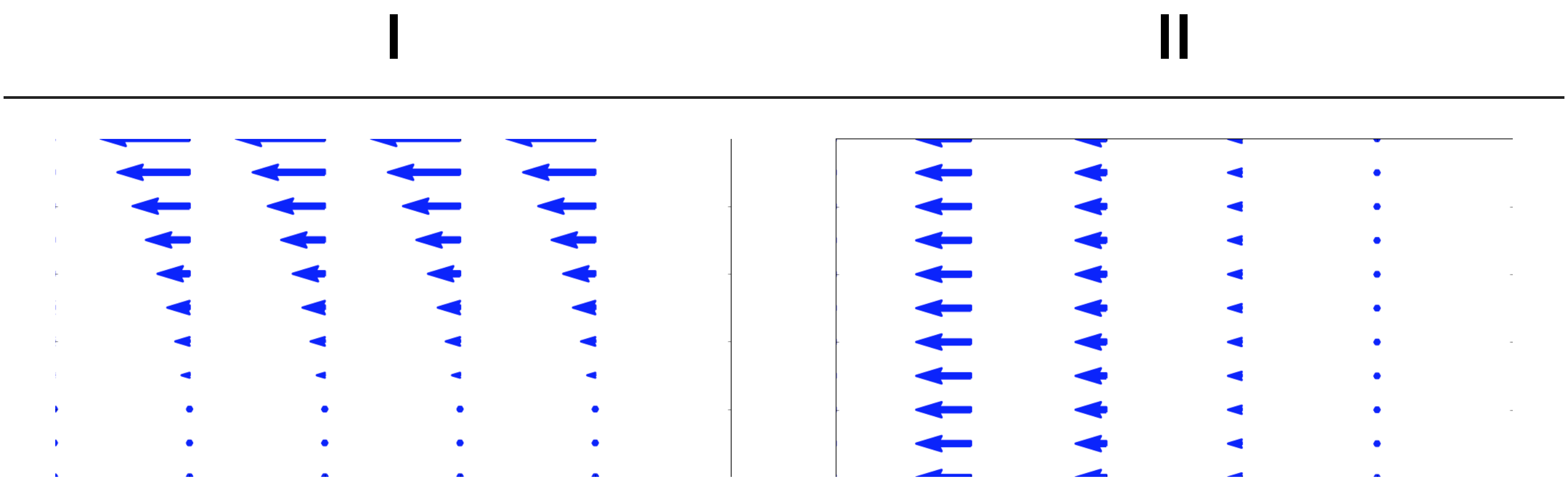
An electric dipole ($+q$ and $-q$, small distance d apart) sits centered in a Gaussian sphere.

What can you say about the flux of $\mathbf{E}$ through the sphere, and $|\mathbf{E}|$ on the sphere?



A. Flux = 0, E = 0 everywhere on sphere surface
B. Flux = 0, E need not be zero *everywhere* on sphere
C. Flux is not zero, E = 0 everywhere on sphere
D. Flux is not zero, E need not be zero...

Which of the following two fields has zero curl?



A. Both do.

B. Only I is zero

C. Only II is zero

D. Neither is zero

E. ???

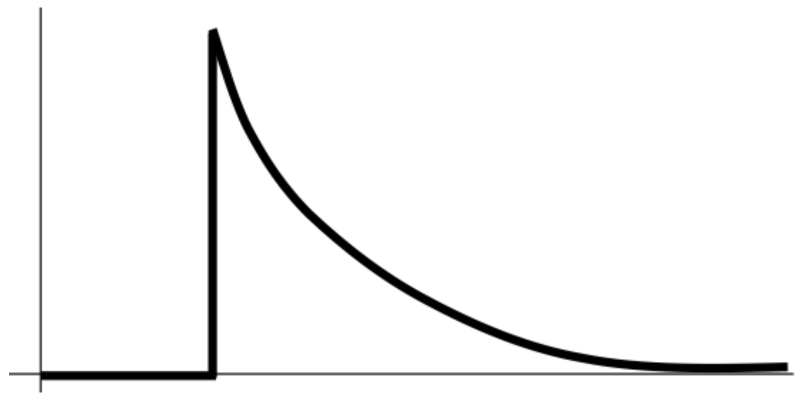
Can superposition be applied to electric potential, V? 

$$V_{tot} \stackrel{?}{=} \sum_i V_i = V_1 + V_2 + V_3 + \ldots$$

A. Yes

B. No

C. Sometimes



Could this be a plot of $|\mathbf{E}(r)|$? Or $V(r)$? (for SOME physical situation?)

A. Could be $E(r)$, or $V(r)$

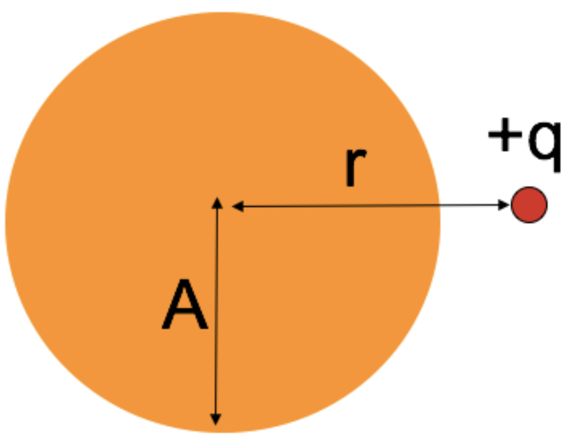
B. Could be $E(r)$, but can't be $V(r)$

C. Can't be $E(r)$, could be $V(r)$

D. Can't be either

E. ???

A point charge $+q$ sits outside a **solid neutral conducting copper sphere** of radius A. The charge q is a distance $r > A$ from the center, on the right side. What is the E-field at the center of the sphere? (Assume equilibrium situation).



A. $|E| = kq/r^2$, to left

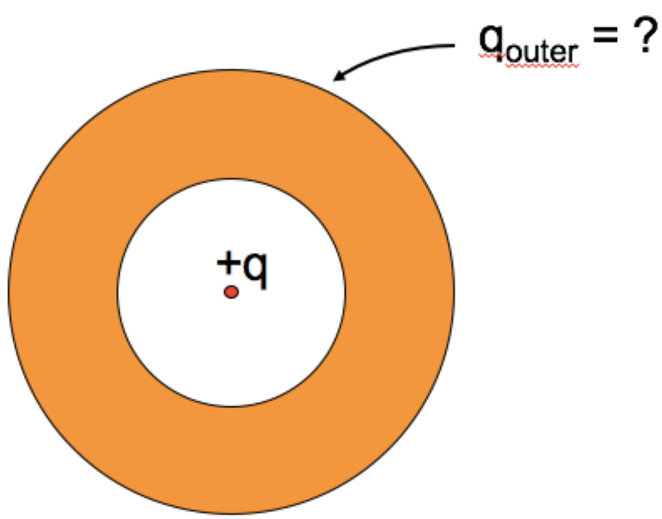
B. $kq/r^2 > |E| > 0$, to left

C. $|E| > 0$, to right

D. $E = 0$

E. None of these

A neutral copper sphere has a spherical hollow in the center. A charge $+q$ is placed in the center of the hollow. What is the total charge on the outside surface of the copper sphere? (Assume Electrostatic equilibrium.)



A. Zero

B. $-q$

C. $+q$

D. $0 < q_{outer} < +q$

E. $-q < q_{outer} < 0$

True or False: The electric field, $\mathbf{E}(\mathbf{r})$, in some region of space is zero, thus the electric potential, $V(\mathbf{r})$, in that same region of space is zero.

A. True

B. False

True or False: The electric potential, $V(\mathbf{r})$, in some region of space is zero, thus the electric field, $\mathbf{E(r)}$, in that same region of space is zero.

A. True

B. False

The general solution for the electric potential in spherical coordinates with azimuthal symmetry (no ϕ dependence) is:

$$V(r,\theta)=\sum_{l=0}^{\infty}\left(A_l r^l+\frac{B_l}{r^{l+1}}\right)P_l(\cos\theta)$$

Consider a metal sphere (constant potential in and on the sphere, remember). Which terms in the sum vanish outside the sphere? (Recall: $V\rightarrow 0$ as $r\rightarrow\infty$)

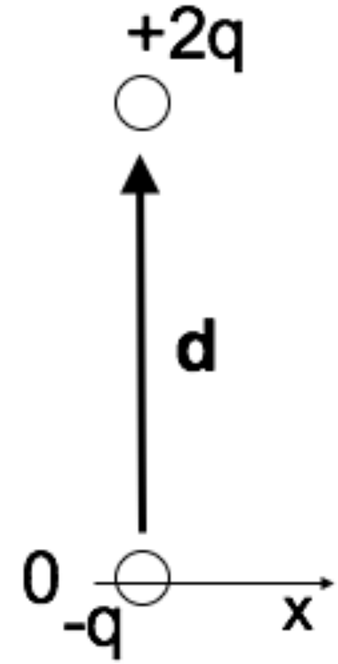
A. All the A_l's
B. All the A_l's except A_0
C. All the B_l's
D. All the B_l's except B_0
E. Something else

$$\mathbf{p} = \sum_i q_i \mathbf{r}_i$$

What is the dipole moment of this system?

(BTW, it is NOT overall neutral!)

A. $q\mathbf{d}$
B. $2q\mathbf{d}$
C. $\frac{3}{2}q\mathbf{d}$
D. $3q\mathbf{d}$
E. Someting else (or not defined)



You have a physical dipole, $+q$ and $-q$ a finite distance d apart. When can you use the expression:

$$V(\mathbf{r}) = \frac{1}{4\pi\varepsilon_0}\frac{\mathbf{p}\cdot\hat{\mathbf{r}}}{r^2}$$

A. This is an exact expression everywhere.

B. It's valid for large r

C. It's valid for small r

D. No idea...

You have a physical dipole, $+q$ and $-q$ a finite distance d apart. When can you use the expression:

$$V(\mathbf{r}) = \frac{1}{4\pi\varepsilon_0} \sum_i \frac{q_i}{\mathfrak{R}_i}$$

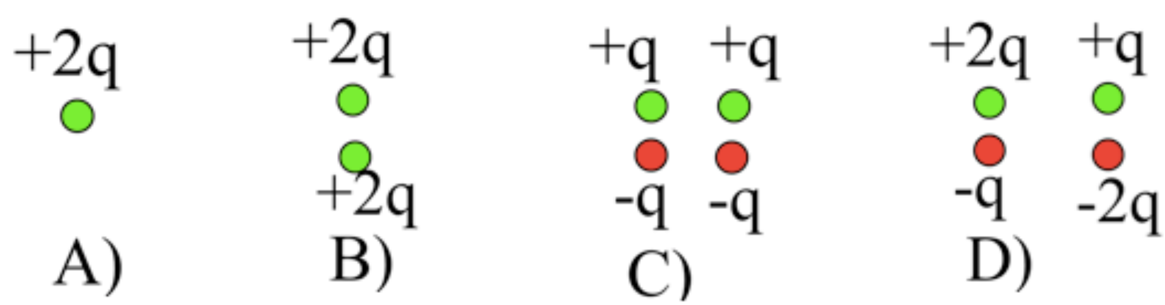
A. This is an exact expression everywhere.

B. It's valid for large r

C. It's valid for small r

D. No idea...

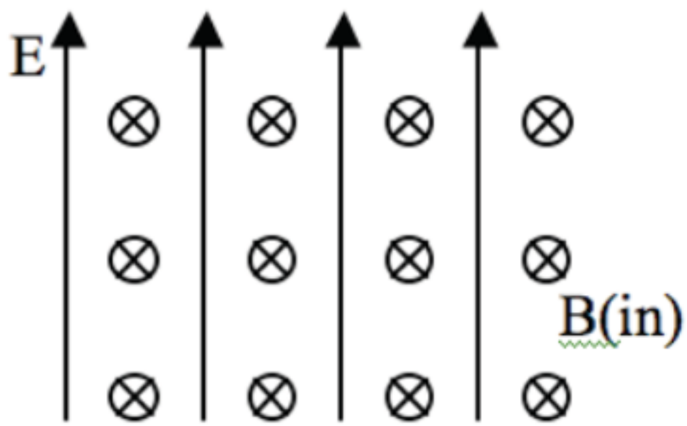
Which charge distributions below produce a potential that looks like $\frac{C}{r^2}$ when you are far away?

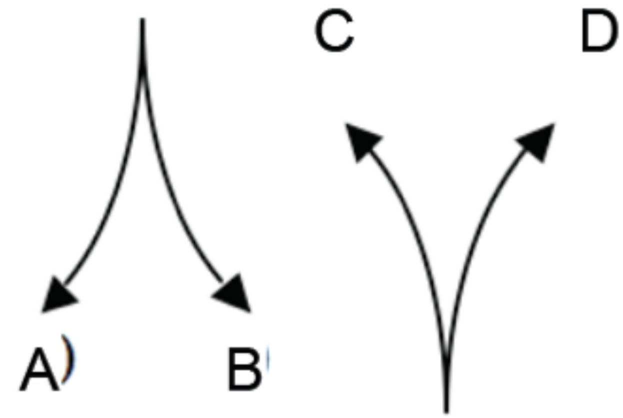


E) None of these, or more than one of these!

(For any which you did not select, how DO they behave at large r?)

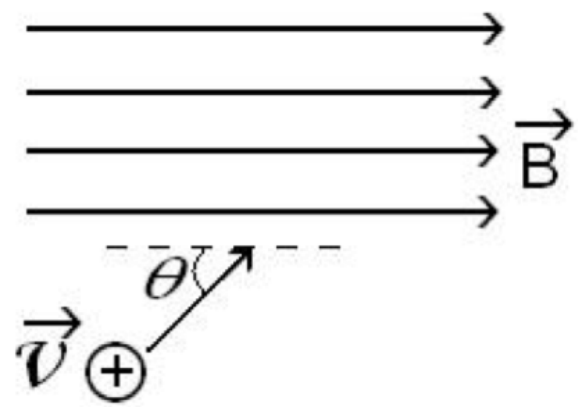
A proton ($q = +e$) is released from rest in a uniform $\mathbf{E}$ and uniform $\mathbf{B}$. $\mathbf{E}$ points up, $\mathbf{B}$ points into the page. Which of the paths will the proton initially follow?





E. It will remain stationary

A proton (speed v) enters a region of uniform $\mathbf{B}$. v makes an angle θ with $\mathbf{B}$. What is the subsequent path of the proton?



A. Helical

B. Straight line

C. Circular motion, $\perp$ to page. (plane of circle is $\perp$ to $\mathbf{B}$)

D. Circular motion, $\perp$ to page. (plane of circle at angle θ w.r.t. $\mathbf{B}$)

E. Impossible. $\mathbf{v}$ should always be $\perp$ to $\mathbf{B}$

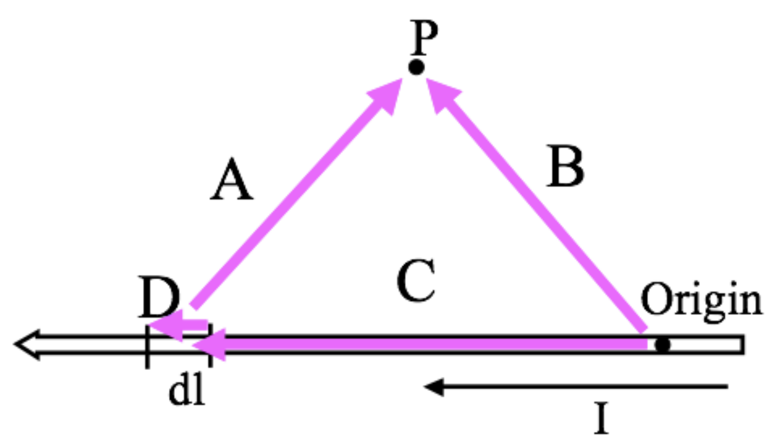
Current I flows down a wire (length L) with a square cross section (side a). If it is uniformly distributed over the entire wire area, what is the magnitude of the volume current density J?

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

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

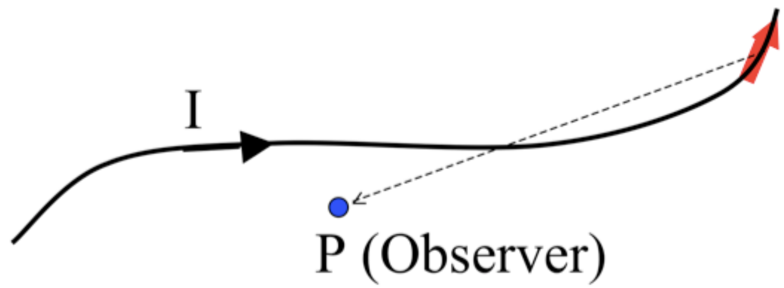
$$\mathbf{B}(\mathbf{r}) = \frac{\mu_0}{4\pi} I \int \frac{d\mathbf{l} \times \hat{\mathfrak{R}}}{\mathfrak{R}^2}$$

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



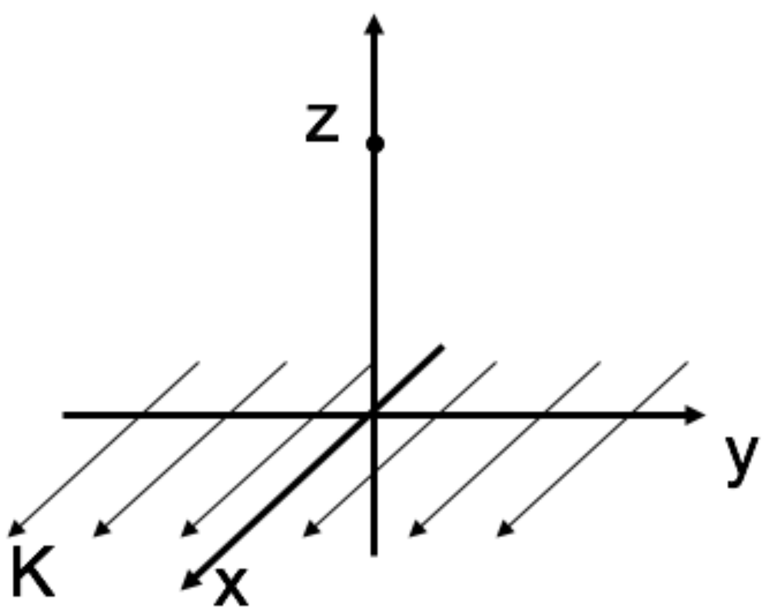
E) None of these!

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!!

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:

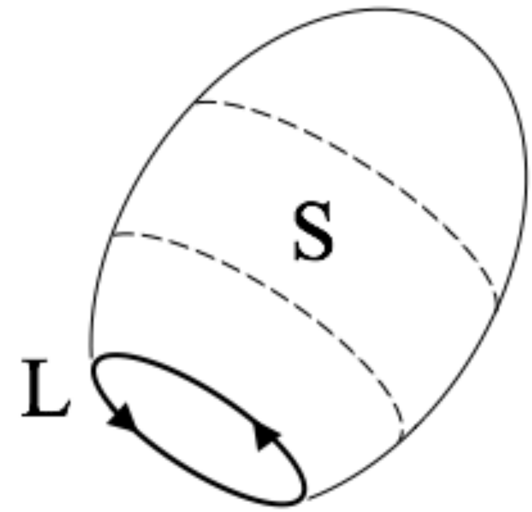


A. y-component only
B. z-component only
C. y and z-components
D. x, y, and z-components
E. Other

Stoke's Theorem says that for a surface S bounded by a perimeter L, any vector field $\mathbf{B}$ obeys:

$$\int_S (\nabla \times \mathbf{B}) \cdot dA = \oint_L \mathbf{B} \cdot d\mathbf{l}$$

Does Stoke's Theorem apply for any surface S bounded by a perimeter L, even this balloon-shaped surface S?

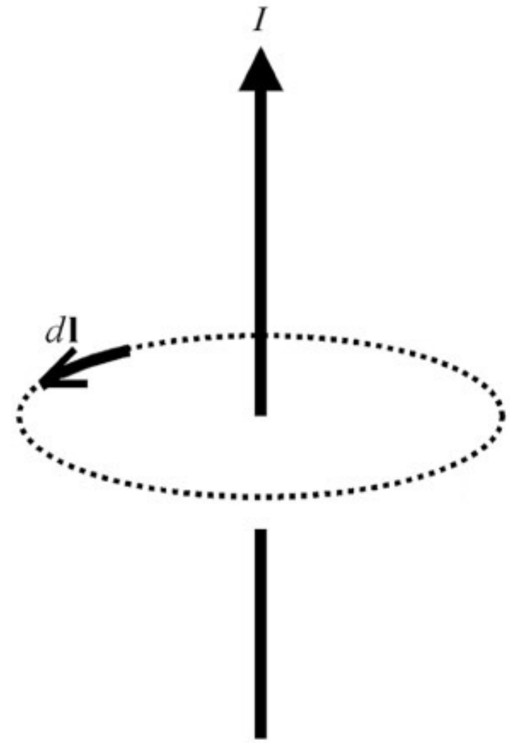


A. Yes

B. No

C. Sometimes

Much like Gauss's Law, Ampere's Law is always true (for magnetostatics), but only useful when there's sufficient symmetry to "pull B out" of the integral.



So we need to build an argument for what $\mathbf{B}$ looks like and what it can depend on.

For the case of an infinitely long wire, can $\mathbf{B}$ point radially (i.e., in the $\hat{s}$ direction)?

A. Yes
B. No
C. ???

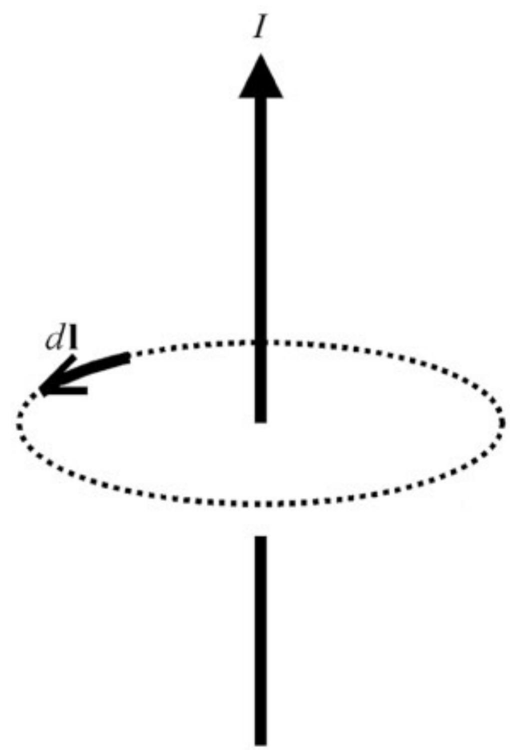
Continuing to build an argument for what $\mathbf{B}$ looks like and what it can depend on.

For the case of an infinitely long wire, can $\mathbf{B}$ depend on z or ϕ?

A. Yes

B. No

C. ???



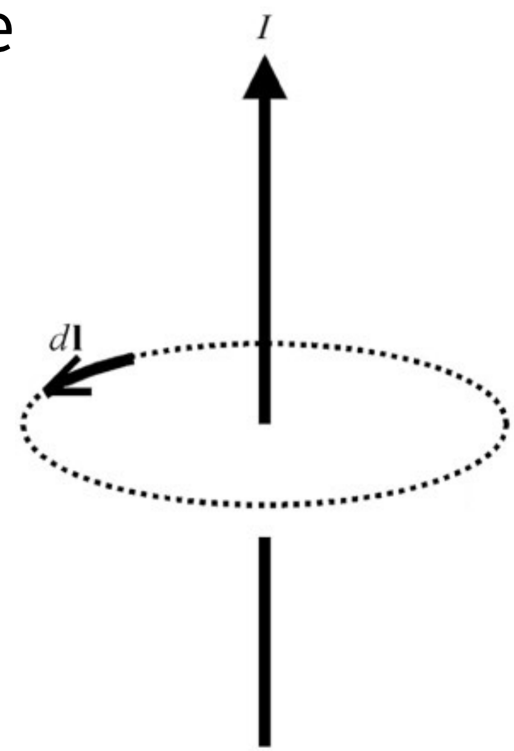
Finalizing the argument for what $\mathbf{B}$ looks like and what it can depend on.

For the case of an infinitely long wire, can $\mathbf{B}$ have a $\hat{z}$ component?

A. Yes

B. No

C. ???



Gauss' Law for magnetism, $\nabla \cdot \mathbf{B} = 0$ suggests we can generate a potential for $\mathbf{B}$. What form should the definition of this potential take (Φ and $\mathbf{A}$ are placeholder scalar and vector functions, respectively)?

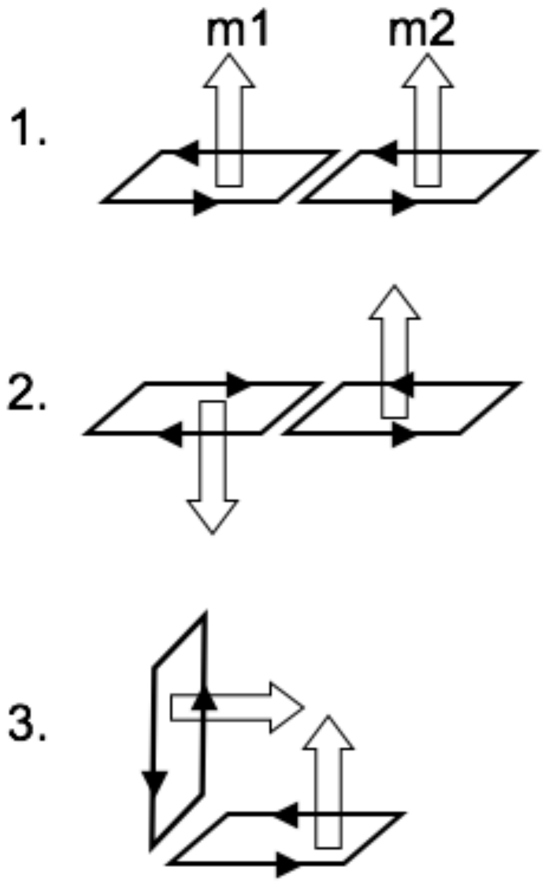
A. $\mathbf{B} = \nabla\Phi$
B. $\mathbf{B} = \nabla \times \Phi$
C. $\mathbf{B} = \nabla \cdot \mathbf{A}$
D. $\mathbf{B} = \nabla \times \mathbf{A}$
E. Something else?!

We can compute $\mathbf{A}$ using the following integral:

$$\mathbf{A}(\mathbf{r}) = \frac{\mu_0}{4\pi} \int \frac{\mathbf{J}(\mathbf{r}')}{\mathfrak{R}} d\tau'$$

Can you calculate that integral using spherical coordinates?

A. Yes, no problem
B. Yes, r' can be in spherical, but $\mathbf{J}$ still needs to be in Cartesian components
C. No.



Two magnetic dipoles m_1 and m_2 (equal in magnitude) are oriented in three different ways.

Which ways produce a dipole field at large distances?

A. None of these

B. All three

C. 1 only

D. 1 and 2 only

E. 1 and 3 only