One of Maxwell's equations, $\nabla \times E = 0$ made it useful for us to define a scalar potential V, where $E = -\nabla V$

Similarly, another one of Maxwell's equations makes it useful for us to define the vector potential, **A.** Which one?

A) $\nabla \times E = 0$
B) $\nabla \cdot E = \rho / \varepsilon_0$
C) $\nabla \times B = \mu_0 J$
D) $\nabla \cdot B = 0$
E) something else!

$$\nabla \times \vec{\mathbf{E}} = 0 \rightarrow \boxed{\vec{\mathbf{E}} = -\nabla V}$$

Can add a constant 'c' to V without changing **E** ("Gauge freedom"): ∇constant = 0,

$$\vec{\nabla} \cdot \vec{\mathbf{B}} = 0 \rightarrow \boxed{\vec{\mathbf{B}} = \vec{\nabla} \times \vec{\mathbf{A}}}$$

Can add any vector function '**a**' with ∇x**a**=0 to **A** without changing **B** ("Gauge freedom")
∇ x (**A**+**a**) = ∇ x **A** + ~~∇ x **a**~~ = ∇ x **A** = **B**
(0)

5.25

$$\nabla^2 \vec{\mathbf{A}} = -\mu_0 \vec{\mathbf{J}}$$

In Cartesian coordinates, this means:

$\nabla^2 \mathrm{A}_x = -\mu_0 \mathrm{J}_x$, etc.

Does it also mean, in spherical coordinates, that $\nabla^2 \mathrm{A}_r = -\mu_0 \mathrm{J}_r$

A) Yes
B) No

5.25 b

$$\vec{\mathbf{A}}(\vec{r}) = \frac{\mu_0}{4\pi}\iiint \frac{\vec{\mathbf{J}}(r')}{\Re}\, d\tau'$$

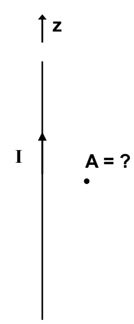
Can you calculate that integral using spherical coordinates?

A) Yes, no problem
B) Yes, r' can be in spherical, but **J** still needs to be in Cartesian components
C) No.

MD12-3

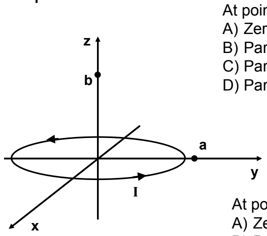
The vector potential **A** due to a long straight wire with current I along the z-axis is in the direction parallel to:

A) $\hat{z}$
B) $\hat{\varphi}$ (azimuthal)
C) $\hat{s}$ (radial)



MD12-4a,b

A circular wire carries current I in the xy plane. What can you say about the vector potential **A** at the points shown?



At point a, the vector potential A is:
A) Zero
B) Parallel to x-axis
C) Parallel to y-axis
D) Parallel to z-axis

At point b, the vector potential A is:
A) Zero
B) Parallel to x-axis
C) Parallel to y-axis
D) Parallel to z-axis

AFTER you are done with the front side:

The left figure shows the B field from a long, fat, uniform wire.

What is the physical situation associated with the RIGHT figure?

A) **A** field from a long, fat wire
B) **A** field from a long solenoid pointing to the right
C) **A** field from a long solenoid pointing up the page
D) **A** field from a torus
E) Something else/???

5.27 b Suppose A is azimuthal, given by

$$\vec{\mathbf{A}} = \frac{c}{s}\hat{\varphi}$$

What can you say about curl(**A**)?

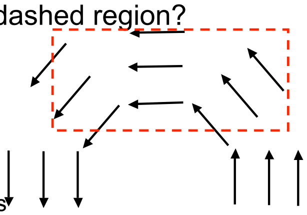
A) curl(**A**)=0 everywhere

B) curl(**A**) = 0 everywhere except at s=0.

C) curl(**A**) is nonzero everywhere

D) ???

5.24 If the arrows represent the vector potential **A** (note that |A| is the same everywhere), is there a nonzero **B** in the dashed region?



A. Yes
B. No
C. Need more information to decide

Compare the magnetostatic triangle (p. 240) with the electrostatic triangle (pg. 87). How is the potential similar/different to the vector potential?

What is $\oint \vec{\mathbf{A}}(\vec{r}) \bullet d\vec{\mathbf{l}}$

A) The current density **J**
B) The magnetic field **B**
C) The magnetic flux Φ_B
D) It's none of the above, but is something simple and concrete
E) It has no particular physical interpretation at all