On Wednesday, you took an assessment of electromagnetism concepts.

How did that assessment feel for you?

A. I think it went fine; I felt like I knew most of the answers.
B. I was concerned about one or two questions; but most of the questions were familiar.
C. I guessed (or left blank) most of the questions; none of the questions really felt familiar.

ANNOUNCEMENTS

- Exams!!!
  - Evening Exams
  - Oct 3 (BCH 101) and Nov 7 (1415 BPS), 7pm-9pm
- Homework Help Session
  - Wednesday 5:00pm-6:30pm in 1300 BPS
  - Thursday 4:30pm-6:00pm in A158 PSS

MATHEMATICAL PRELIMINARIES

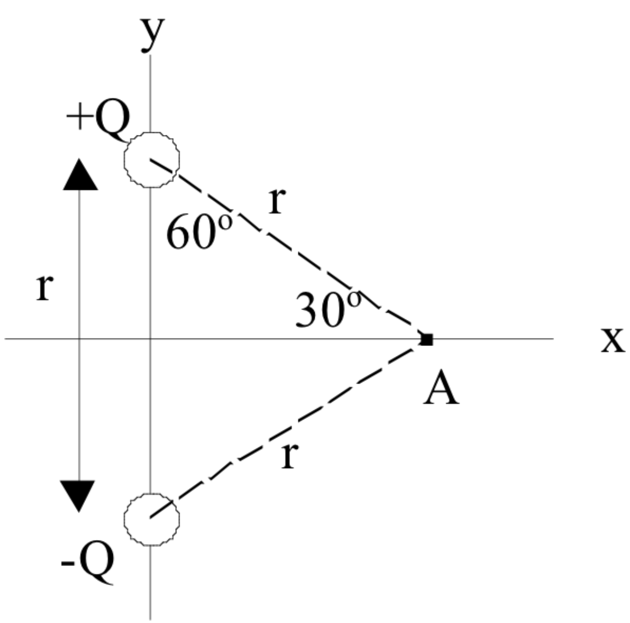
$$\nabla \cdot \mathbf{E} = \frac{\rho}{\epsilon_0} \qquad \int \mathbf{E} \cdot d\mathbf{A} = \int \frac{\rho}{\epsilon_0} d\tau$$

$$\nabla \cdot \mathbf{B} = 0 \qquad \int \mathbf{B} \cdot d\mathbf{A} = 0$$

$$\nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t} \qquad \int \mathbf{E} \cdot d\mathbf{l} = -\int \frac{\partial \mathbf{B}}{\partial t} \cdot d\mathbf{A}$$

$$\nabla \times \mathbf{B} = \mu_0 \mathbf{J} + \mu_0 \epsilon_0 \frac{\partial \mathbf{E}}{\partial t} \qquad \int \mathbf{B} \cdot d\mathbf{A} = \mu_0 \int \left(\mathbf{J} + \epsilon_0 \frac{\partial \mathbf{E}}{\partial t} \right)$$

Two charges +Q and -Q are fixed a distance r apart. The direction of the force on a test charge -q at A is...



A. Up
B. Down
C. Left
D. Right
E. Some other direction, or $F = 0$

In a typical Cartesian coordinate system, vector $\mathbf{A}$ lies along the $+\hat{x}$ direction and vector $\mathbf{B}$ lies along the $-\hat{y}$ direction. What is the direction of $\mathbf{A} \times \mathbf{B}$?

A. $-\hat{x}$
B. $+\hat{y}$
C. $+\hat{z}$
D. $-\hat{z}$
E. Can't tell

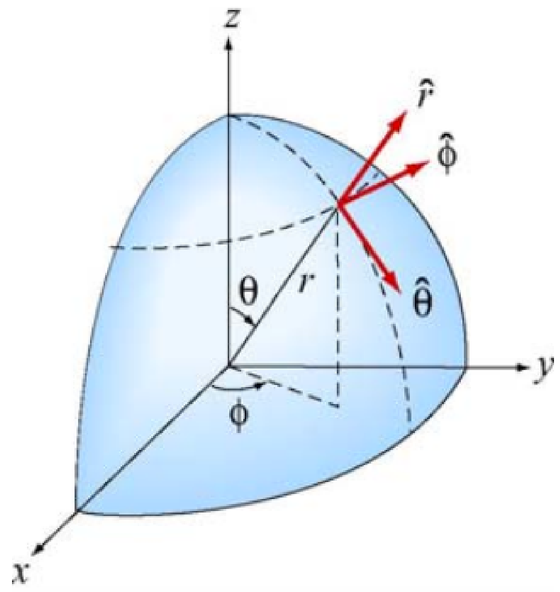
In a typical Cartesian coordinate system, vector $\mathbf{A}$ lies along the $+\hat{x}$ direction and vector $\mathbf{B}$ lies along the $-\hat{y}$ direction. What is the direction of $\mathbf{B} \times \mathbf{A}$?

A. $-\hat{x}$
B. $+\hat{y}$
C. $+\hat{z}$
D. $-\hat{z}$
E. Can't tell

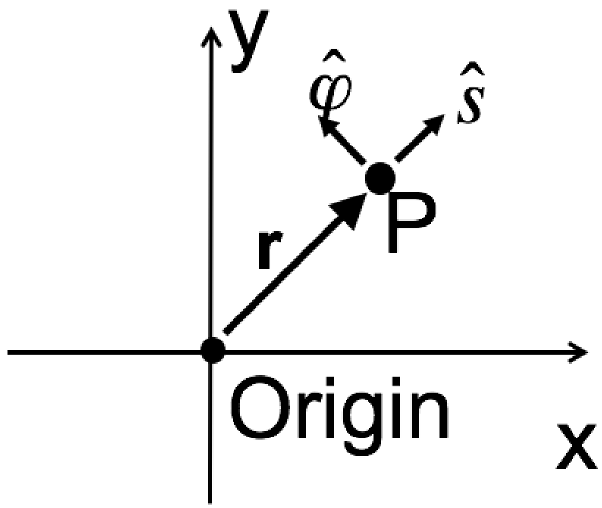
YOU DERIVE IT

Consider the radial unit vector ($\hat{r}$) in the spherical coordinate system as shown in the figure to the right.

Determine the z component of this unit vector in the Cartesian (x, y, z) system as a function of r, θ, ϕ.



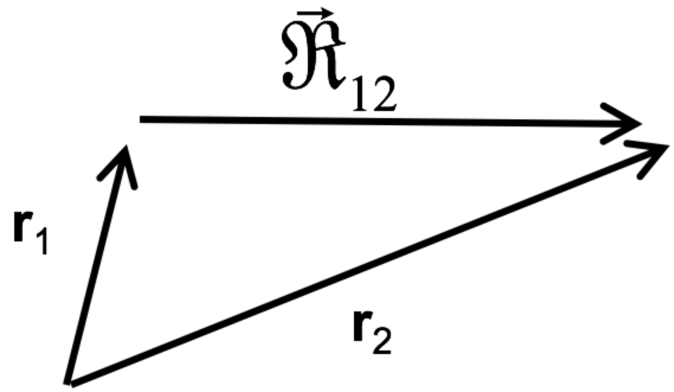
In cylindrical (2D) coordinates, what would be the correct description of the position vector $\mathbf{r}$ of the point P shown at $(x, y) = (1, 1)$?



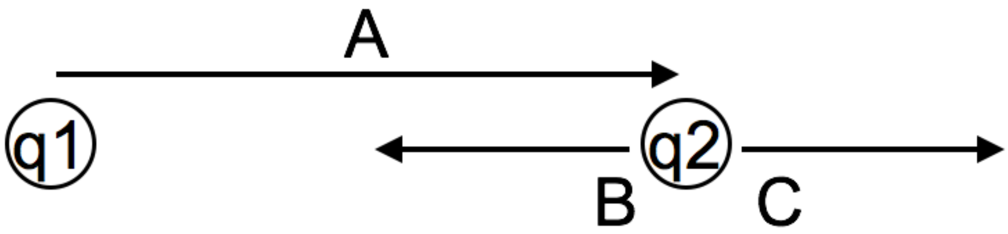
A. $\mathbf{r} = \sqrt{2}\hat{s}$
B. $\mathbf{r} = \sqrt{2}\hat{s} + \pi/4\hat{\phi}$
C. $\mathbf{r} = \sqrt{2}\hat{s} - \pi/4\hat{\phi}$
D. $\mathbf{r} = \pi/4\hat{\phi}$
E. Something else entirely

How is the vector $\mathfrak{R}_{12}$ related to $\mathbf{r}_1$ and $\mathbf{r}_2$?

A. $\mathfrak{R}_{12} = \mathbf{r}_1 + \mathbf{r}_2$
B. $\mathfrak{R}_{12} = \mathbf{r}_1 - \mathbf{r}_2$
C. $\mathfrak{R}_{12} = \mathbf{r}_2 - \mathbf{r}_1$
D. None of these



Coulomb's Law: $\mathbf{F} = \frac{kq_1q_2}{|\mathfrak{R}|^2}\hat{\mathfrak{R}}$ where $\mathfrak{R}$ is the relative position vector. In the figure, q_1 and q_2 are 2 m apart. Which arrow **can** represent $\hat{\mathfrak{R}}$?



A. A

B. B

C. C

D. More than one (or NONE) of the above

E. You can't decide until you know if q_1 and q_2 are the same or opposite charges

True or False The following mathematical operation makes sense and is technically valid.

$$\nabla \cdot \nabla T(x, y, z)$$

A. Yes, it will produce a vector field.
B. Yes, it will produce a scalar field.
C. No, you can not take the divergence of a scalar field.
D. I don't remember what this means.

You are trying to compute the work done by a force, $\mathbf{F} = a\hat{x} + x\hat{y}$, along the line $y = 2x$ from $\langle 0, 0 \rangle$ to $\langle 1, 2 \rangle$. What is $d\mathbf{l}$?

A. dl
B. $dx\ \hat{x}$
C. $dy\ \hat{y}$
D. $2dx\ \hat{x}$
E. Something else

You are trying to compute the work done by a force, $\mathbf{F} = a\hat{x} + x\hat{y}$, along the line $y = 2x$ from $\langle 0, 0\rangle$ to $\langle 1, 2\rangle$. Given that $d\mathbf{l} = dx\ \hat{x} + dy\ \hat{y}$, which of the following forms of the integral is correct?

A. $\int_0^1 a\ dx + \int_0^2 x\ dy$
B. $\int_0^1 (a\ dx + 2x\ dx)$
C. $\frac{1}{2} \int_0^2 (a\ dy + y\ dy)$
D. More than one is correct

A certain fluid has a velocity field given by $\mathbf{v} = x\hat{x} + z\hat{y}$. Which component(s) of the field contributed to "fluid flux" integral ($\int_S \mathbf{v} \cdot d\mathbf{A}$) through the x-z plane?

A. v_x
B. v_y
C. both
D. neither

For the same fluid with velocity field given by $\mathbf{v} = x\hat{x} + z\hat{y}$. What is the value of the "fluid flux" integral ($\int_S \mathbf{v} \cdot d\mathbf{A}$) through the entire x-y plane?

A. It is zero
B. It is something finite
C. It is infinite
D. I can't tell without doing the integral

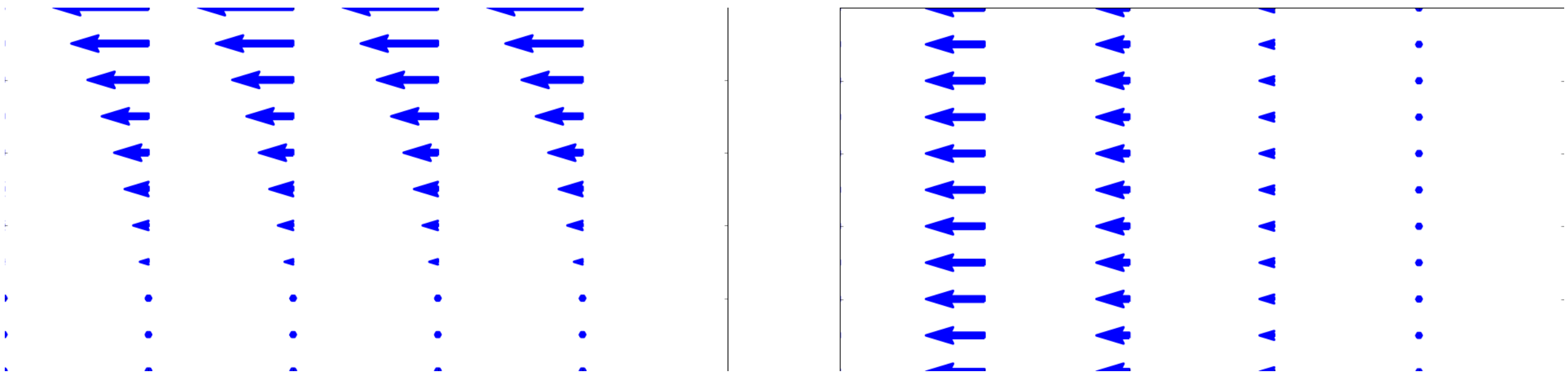
A rod (radius R) with a hole (radius r) drilled down its entire length L has a mass density of $\frac{\rho_0 \phi}{\phi_0}$ (where ϕ is the normal polar coordinate).

To find the total mass of this rod, which coordinate system should be used (take note that the mass density varies as a function of angle):

A. Cartesian (x, y, z)
B. Spherical (r, ϕ, θ)
C. Cylindrical (s, ϕ, z)
D. It doesn't matter, just pick one.

Which of the following two fields has zero divergence?

I	II



A. Both do.

B. Only I is zero

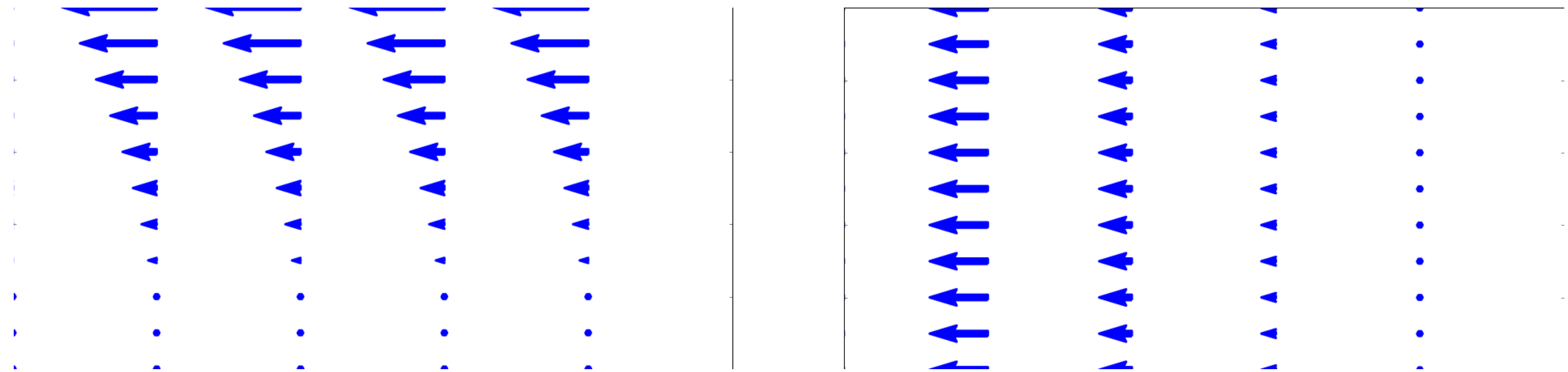
C. Only II is zero

D. Neither is zero

E. ???

Which of the following two fields has zero curl?

I	II



A. Both do.

B. Only I is zero

C. Only II is zero

D. Neither is zero

E. ???