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.

Given that we do not have class on Monday (Labor Day holiday), would you be more comfortable turning in this first homework set on Fri. Sept. 8 instead of Wed. Sept. 13?

(*This gives us another lecture on math review before the homework is due.*)

A. Yes
B. No
C. I don't really care either way; I'll finish it by Wednesday anyway

Week 2's homework will still be assigned Wed. Sept. 6 and due the following Wed. Sept. 13.

ANNOUNCEMENTS

- Exams!!!
  - Evening Exams
  - Oct 4 (A149 PSS) and Nov 8 (1415 BPS), 7pm-9pm
- Homework Help Session
  - Monday 4-5pm in 1420 BPS
  - Tuesday 4-5pm in 1300 BPS
- Danny also has open door office hours
  - Mornings are good and Tuesdays

MATHEMATICAL PRELIMINARIES

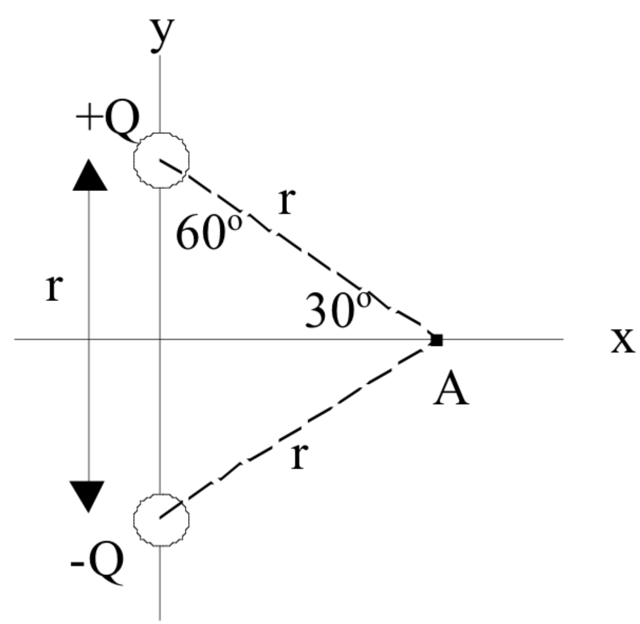
$$\nabla \cdot \mathbf{E} = \frac{\rho}{\epsilon_0} \qquad \int \mathbf{E} \cdot d\mathbf{A} = \int \frac{\rho}{\epsilon_0} d\tau$$

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

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

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

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. $+\hat{z}$

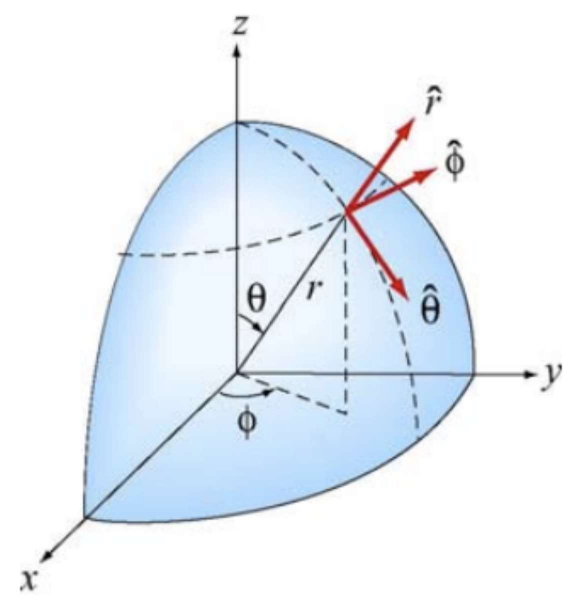
D. $-\hat{z}$

E. Can't tell

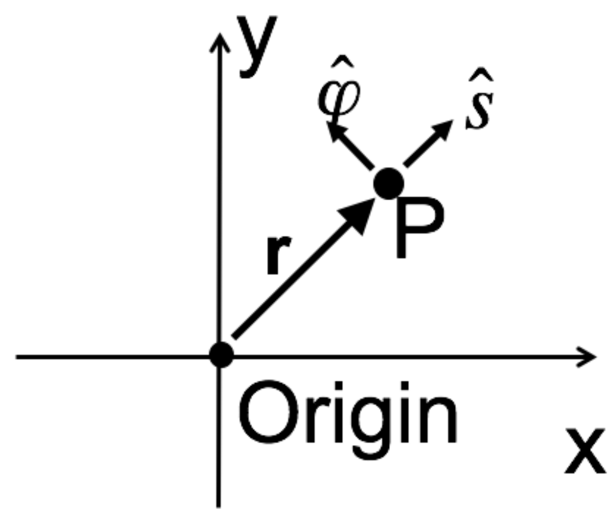
YOU DERIVE IT

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. $\mathbf{r} = \sqrt{2}\hat{s} + \pi/4\hat{\phi}$

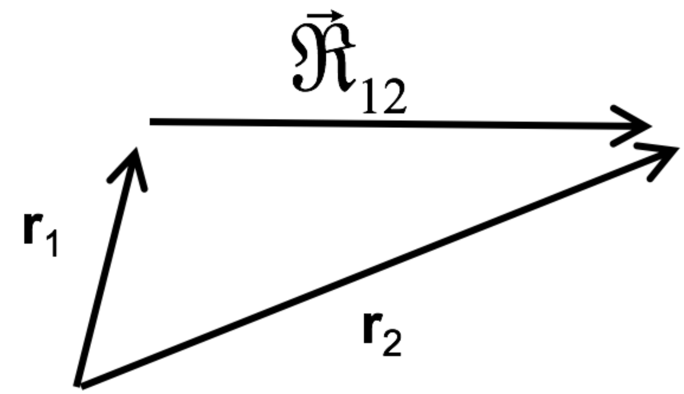
C. $\mathbf{r} = \sqrt{2}\hat{s} - \pi/4\hat{\phi}$

D. $\mathbf{r} = \pi/4\hat{\phi}$

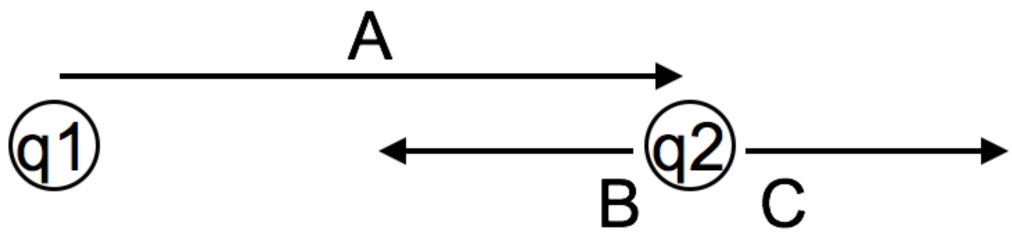
E. Something else entirely

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: $\mathbf{F} = \frac{k q_1 q_2}{|\mathfrak{R}|^2} \hat{\mathfrak{R}}$ 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

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

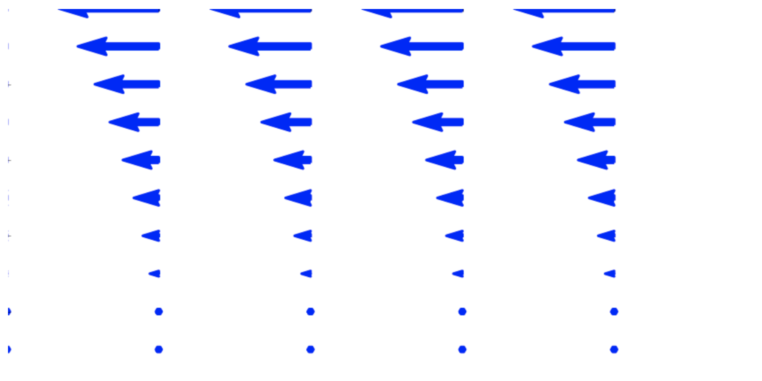
A rod (radius R) with a hole (radius r) drilled down its entire length L has a mass density of $\frac{\rho_0 \phi}{\phi_0}$ (where ϕ is the normal polar coordinate).

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):

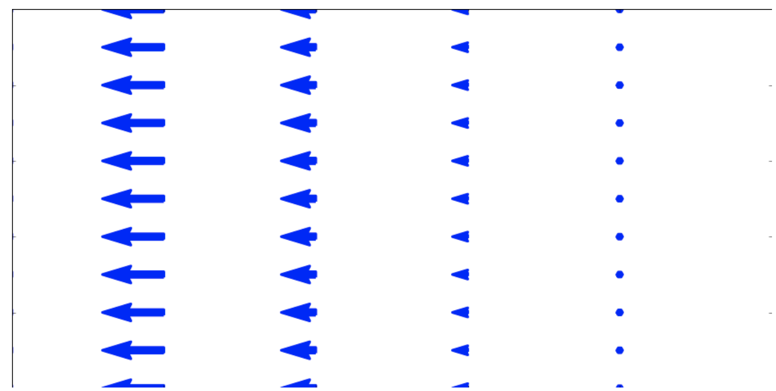
A. Cartesian (x, y, z)
B. Spherical (r, ϕ, θ)
C. Cylindrical (s, ϕ, z)
D. It doesn't matter, just pick one.

Which of the following two fields has zero divergence?

I



II



A. Both do.

B. Only I is zero

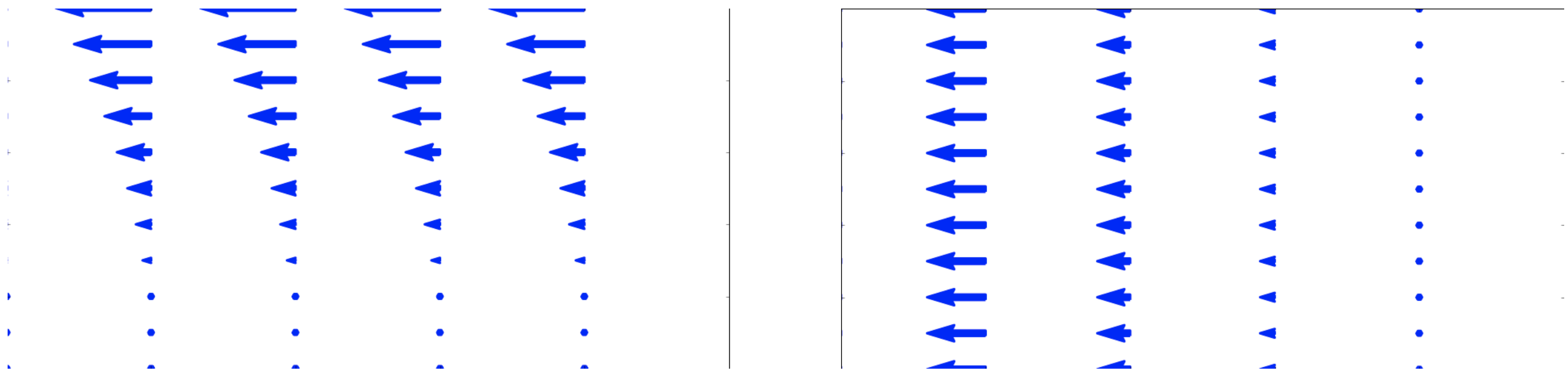
C. Only II is zero

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. ???

Consider a vector field defined as the gradient of some well-behaved scalar function:

$$\mathbf{v}(x, y, z) = \nabla T(x, y, z).$$

What is the value of $\oint_C \mathbf{v} \cdot d\mathbf{l}$?

A. Zero
B. Non-zero, but finite
C. Can't tell without a function for T