MATHEMATICAL PRELIMINARIES

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

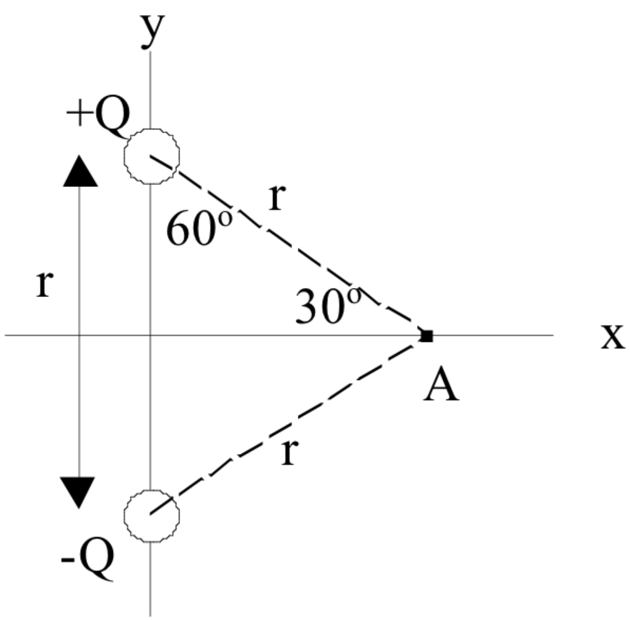
$$\nabla \cdot \mathbf{B} = 0 \qquad \int \mathbf{B} \cdot d\mathbf{A} = 0$$

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

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

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

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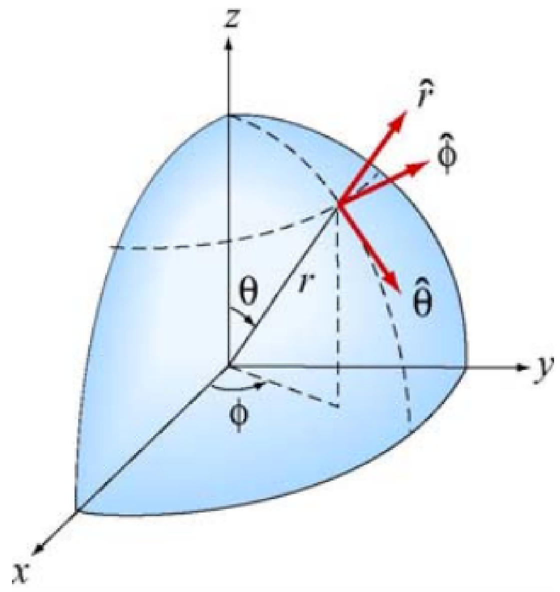
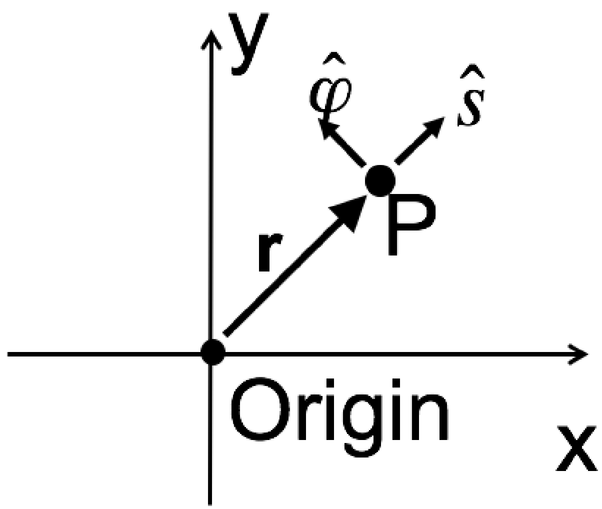
Consider the radial unit vector ($\hat{r}$) in the spherical coordinate system as shown in the figure to the right.

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



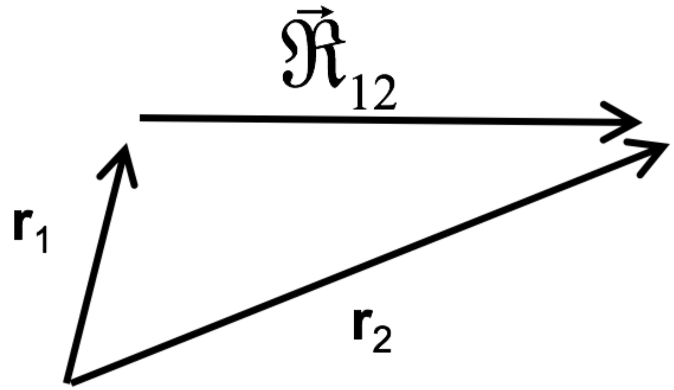
In cylindrical (2D) coordinates, what would be the correct description of the position vector $\mathbf{r}$ of the point P shown at $(x, y) = (1, 1)$?

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

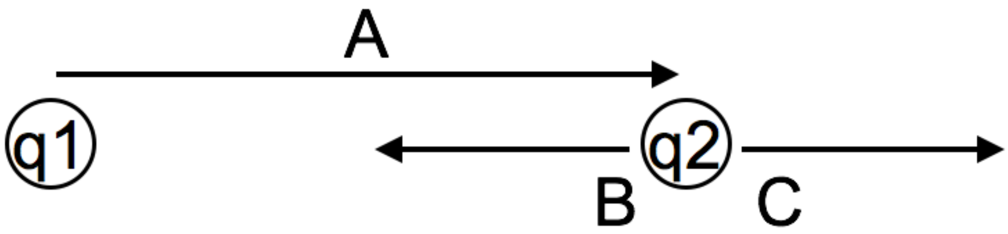


How is the vector $\mathfrak{R}_{12}$ related to $\mathbf{r}_1$ and $\mathbf{r}_2$?

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