**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.

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

A certain fluid has a velocity field given by $\mathbf{v} = x\hat{x} + z\hat{y}$. If we intend to calculate the "fluid flux" integral ($\int_S \mathbf{v} \cdot d\mathbf{A}$) through the x-z plane, what is $d\mathbf{A}$ in this case? Be specific!

A. $\langle dx\, dy, 0, 0 \rangle$
B. $\langle dx\, dz, 0, 0 \rangle$
C. $\langle dy\, dz, 0, 0 \rangle$
D. It's none of these

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

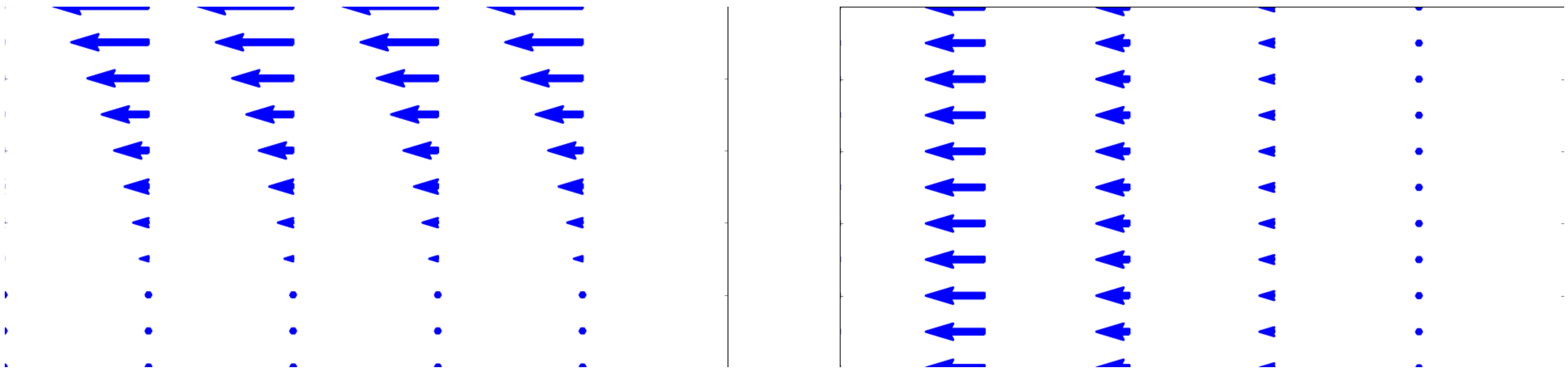
A rod (radius $R$) with a hole (radius $r$) drilled down its entire length $L$ has a mass density of $\frac{\rho_0 \phi}{\phi_0}$ (where $\phi$ is the normal polar coordinate).

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 $(r, \phi, \theta)$
C. Cylindrical $(s, \phi, z)$
D. It doesn't matter, just pick one.

Which of the following two fields has zero divergence?

| I | II |
|---|---|



A. Both do.

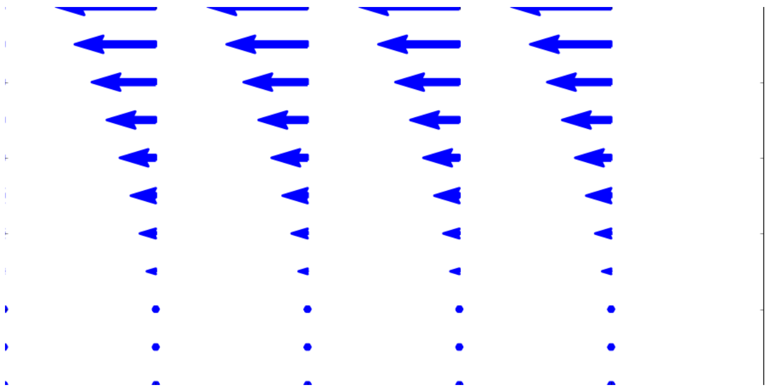
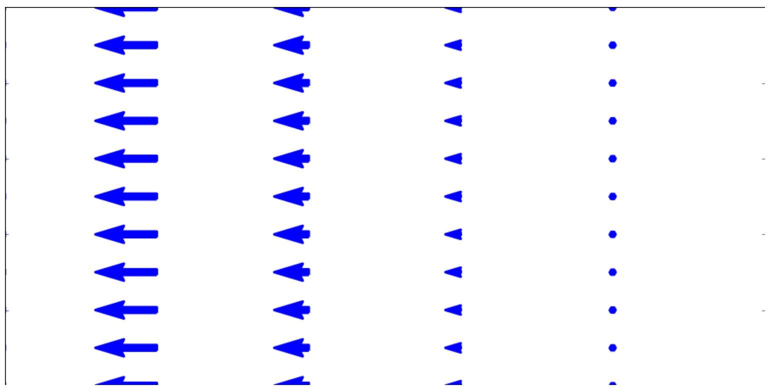
B. Only I is zero

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

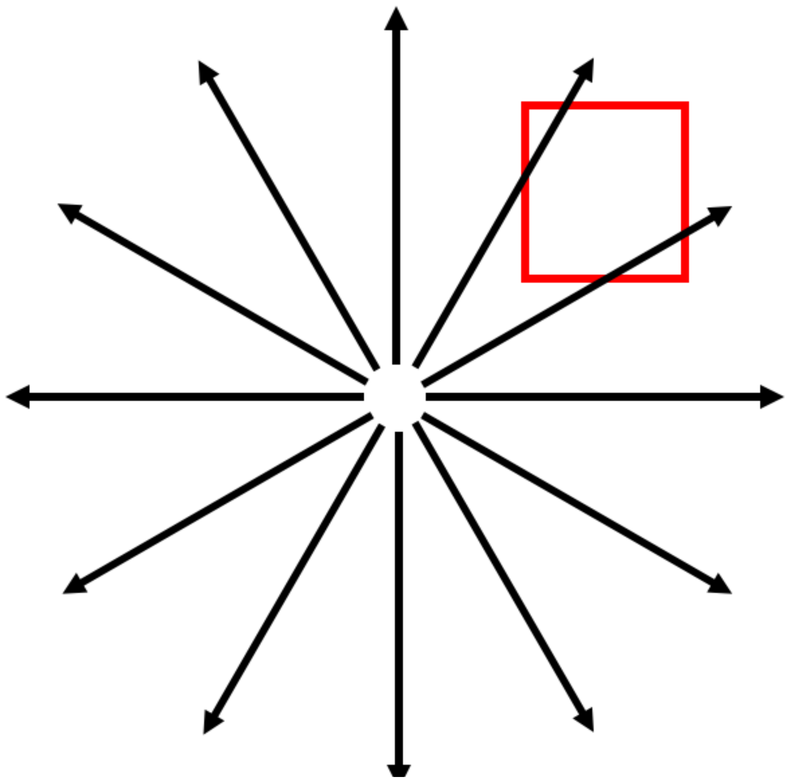
C. Only II is zero

D. Neither is zero

E. ???

What is the divergence in the boxed region?

A. Zero
B. Not zero
C. ???



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 $T$