Wake-up questionnaires during lectures of

ELEC-C9430
Electromagnetism

(period IV, Spring 2022)

Assuming that the following is valid:

$$\mathbf{A} \cdot \mathbf{B} = \mathbf{A} \cdot \mathbf{C}$$

$\rightarrow$ then it is true that

A. $\mathbf{B} \parallel \mathbf{C}$

B. $\theta_{AB} = \theta_{AC}$

C. $B = C$

D. $\mathbf{B} = \mathbf{C}$

$\boxed{\text{E.}}$ something else

$\mathbf{A}$ and $\mathbf{B}$ are non-zero vectors and have different directions. Then we can say that $\mathbf{A} \times (\mathbf{A} \times \mathbf{B})$ is

A. a zero vector

$\boxed{\text{B.}}$ a non-zero vector **in the plane** spanned by vectors $\mathbf{A}$ and $\mathbf{B}$

C. a non-zero vector **perpendicular to the plane** spanned by vectors $\mathbf{A}$ and $\mathbf{B}$

D. something else

Using spherical coordinates $(\boldsymbol{R}, \boldsymbol{\theta}, \boldsymbol{\phi})$,
the two points are:

$P_1 = (4\ \mathrm{m}, \pi/4\ , 0)$ and $P_2 = (3\ \mathrm{m}, 3\,\pi/4\ , \pi)$

The distance between P_1 and P_2 is

A. $1\ \mathrm{m}$
B. $3\ \mathrm{m}$
C. $4\ \mathrm{m}$
D. $5\ \mathrm{m}$
$\boxed{\text{E.}}$ $7\ \mathrm{m}$
F. $12\ \mathrm{m}$
G. $25\ \mathrm{m}$

The angle between unit vectors $\mathbf{a}_{\mathrm{y}}$ and $\mathbf{a}_{\phi}$ is

A. θ

$\boxed{\text{B.}}$ $\boldsymbol{\phi}$

C. $\theta + 90°$

D. $\theta - 90°$

E. $\boldsymbol{\phi} + 90°$

F. $\boldsymbol{\phi} - 90°$

G. something else

spherical coordinates (R,$\boldsymbol{\theta}$,$\boldsymbol{\phi}$)
cylindrical coordinates (r,$\boldsymbol{\phi}$,z)
cartesian coordinates (x,y,z)

In the spherical coordinate system $(R,\boldsymbol{\theta},\boldsymbol{\phi})$, the cross product $\mathbf{a}_{\boldsymbol{\phi}} \times \mathbf{a}_{\theta}$ is equal to

A. 0
B. 1
C. $|\mathbf{a}_{\theta}||\mathbf{a}_{\boldsymbol{\phi}}|\sin(\theta)$
D. $\mathbf{a}_{\theta} \times \mathbf{a}_{\boldsymbol{\phi}}$
E. $+\mathbf{a}_R$
F. $-\mathbf{a}_R$
G. $+\mathbf{a}_z \sin(\theta)$
H. $-\mathbf{a}_z \sin(\theta)$

The vector field is

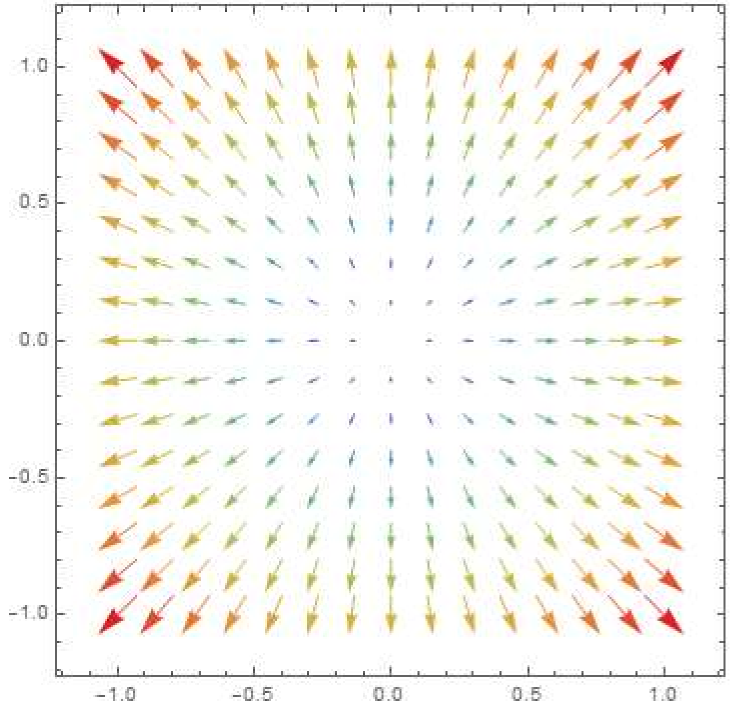
$$\mathbf{F} = x\,\mathbf{a}_x + y\,\mathbf{a}_y$$

A: $\nabla \cdot \mathbf{F} = 0$ and $\nabla \times \mathbf{F} = 0$

B: $\nabla \cdot \mathbf{F} = 0$ and $\nabla \times \mathbf{F} \neq 0$

$\boxed{\text{C:}}$ $\nabla \cdot \mathbf{F} \neq 0$ and $\nabla \times \mathbf{F} = 0$

D: $\nabla \cdot \mathbf{F} \neq 0$ and $\nabla \times \mathbf{F} \neq 0$



divergenceless: $\nabla \cdot \mathbf{F} = 0$

curl-free: $\nabla \times \mathbf{F} = 0$

The vector field is

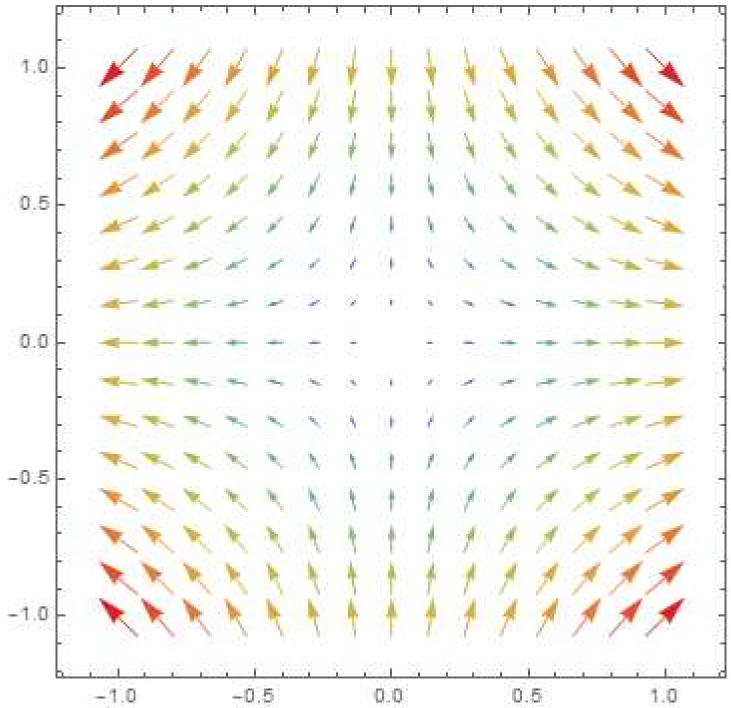
$$\mathbf{F} = x\,\mathbf{a}_x - y\,\mathbf{a}_y$$

$\boxed{\text{A:}}$ $\nabla\cdot\mathbf{F} = 0$ and $\nabla\times\mathbf{F} = 0$

B: $\nabla\cdot\mathbf{F} = 0$ and $\nabla\times\mathbf{F} \neq 0$

C: $\nabla\cdot\mathbf{F} \neq 0$ and $\nabla\times\mathbf{F} = 0$

D: $\nabla\cdot\mathbf{F} \neq 0$ and $\nabla\times\mathbf{F} \neq 0$



divergenceless: $\nabla\cdot\mathbf{F} = 0$

curl-free: $\nabla\times\mathbf{F} = 0$

The vector field is

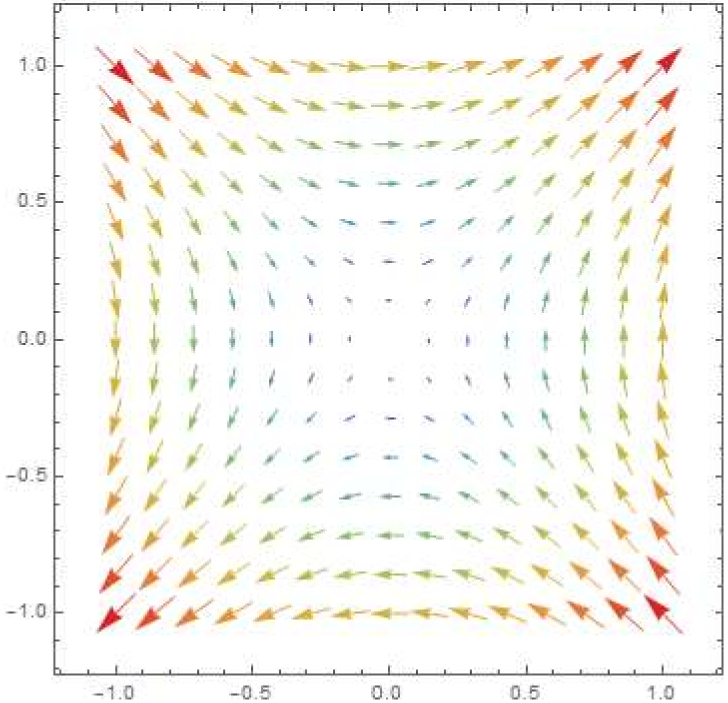
$$\mathbf{F} = y\,\mathbf{a}_x + x\,\mathbf{a}_y$$

$\boxed{\text{A:}}$ $\nabla \cdot \mathbf{F} = 0$ and $\nabla \times \mathbf{F} = 0$

B: $\nabla \cdot \mathbf{F} = 0$ and $\nabla \times \mathbf{F} \neq 0$

C: $\nabla \cdot \mathbf{F} \neq 0$ and $\nabla \times \mathbf{F} = 0$

D: $\nabla \cdot \mathbf{F} \neq 0$ and $\nabla \times \mathbf{F} \neq 0$



divergenceless: $\nabla \cdot \mathbf{F} = 0$

curl-free: $\nabla \times \mathbf{F} = 0$

The vector field is

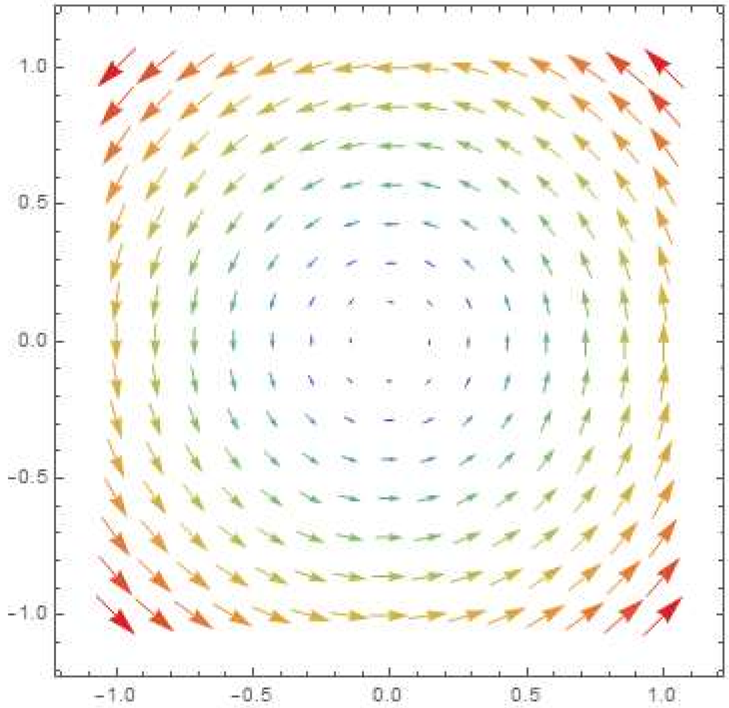
$$\mathbf{F} = -y\,\mathbf{a}_x + x\,\mathbf{a}_y$$

A: $\nabla \cdot \mathbf{F} = 0$ and $\nabla \times \mathbf{F} = 0$

B: $\nabla \cdot \mathbf{F} = 0$ and $\nabla \times \mathbf{F} \neq 0$

C: $\nabla \cdot \mathbf{F} \neq 0$ and $\nabla \times \mathbf{F} = 0$

D: $\nabla \cdot \mathbf{F} \neq 0$ and $\nabla \times \mathbf{F} \neq 0$



divergenceless: $\nabla \cdot \mathbf{F} = 0$

curl-free: $\nabla \times \mathbf{F} = 0$

The vector field

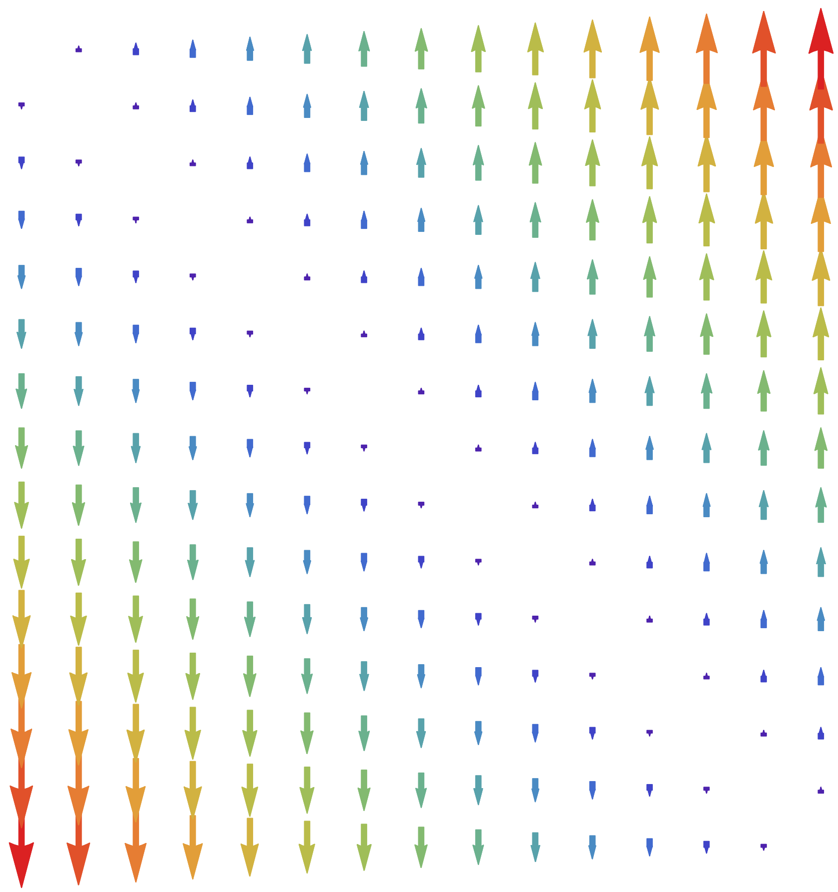
$\mathbf{F} = (x + y)\,\mathbf{a}_y$ is

A: $\nabla \cdot \mathbf{F} = 0$ and $\nabla \times \mathbf{F} = 0$

B: $\nabla \cdot \mathbf{F} = 0$ and $\nabla \times \mathbf{F} \neq 0$

C: $\nabla \cdot \mathbf{F} \neq 0$ and $\nabla \times \mathbf{F} = 0$

D: $\nabla \cdot \mathbf{F} \neq 0$ and $\nabla \times \mathbf{F} \neq 0$



divergenceless: $\nabla \cdot \mathbf{F} = 0$

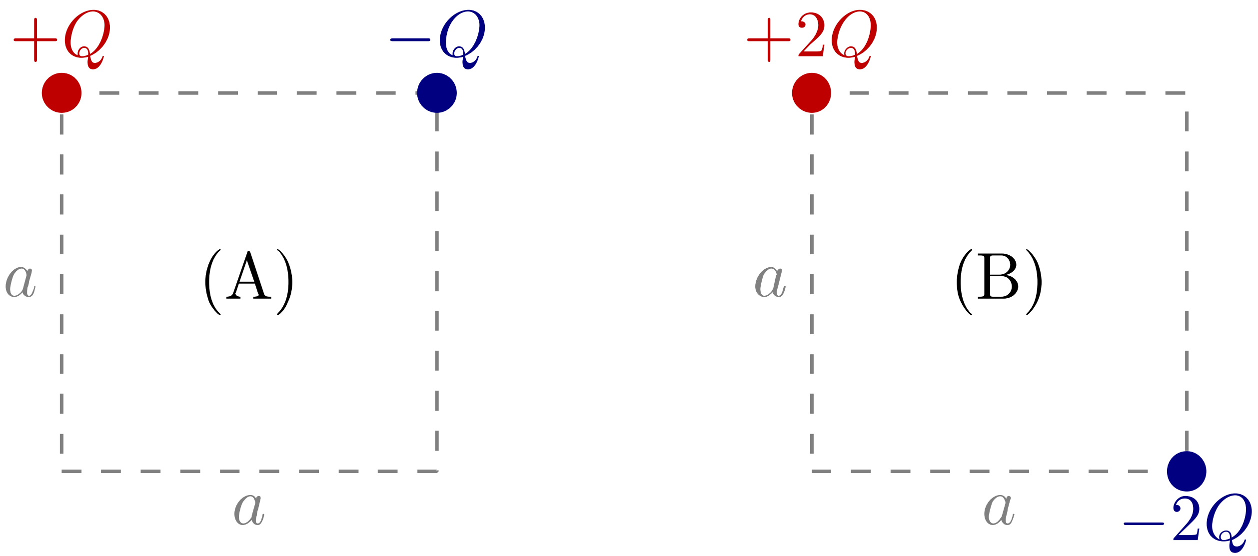
curl-free: $\nabla \times \mathbf{F} = 0$

Two point charges are located at corners of a square. In which case is the force acting on the charges stronger?

A. Case A

B. Case B

C. Equal force in both.



What is valid concerning the electric field at points A, B ja C, when the distances L and d are unknown?

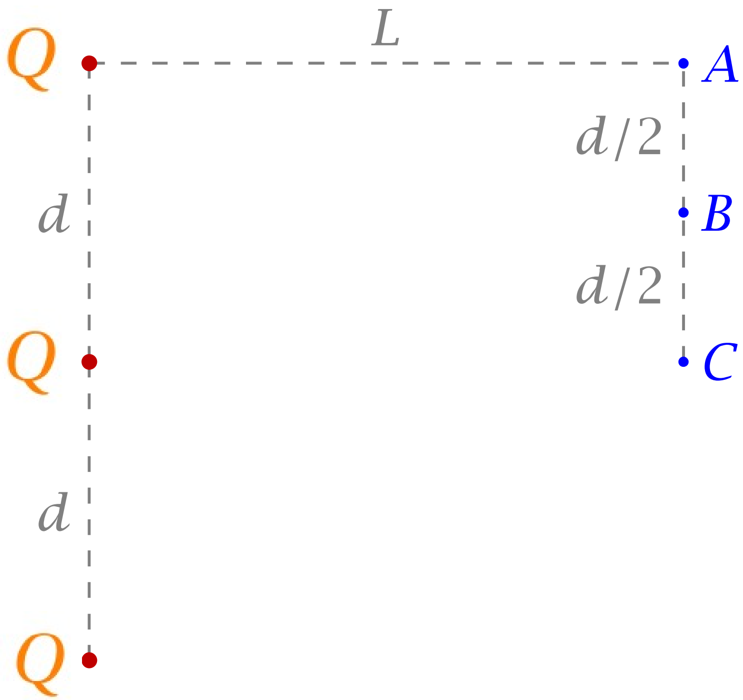
A. Both the direction and magnitude are the same in A–C.

B. Magnitudes same, but directions different at A–C.

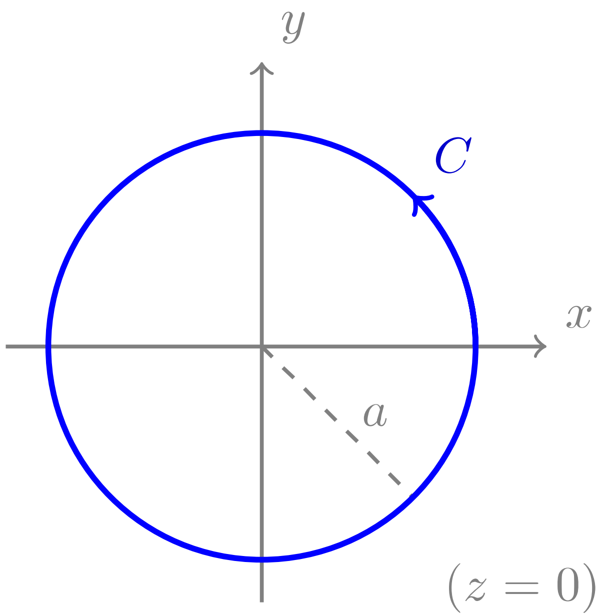
$\boxed{\text{C.}}$ The exact direction can only be concluded at C.

D. The exact direction can only be concluded at A and C.

E. The exact direction cannot be concluded at any point.



The line integral $\oint_C d\mathbf{l}$ is



A. 0 (scalar)

B. $\mathbf{0}$ (vector)

C. $2\pi a$

D. another scalar

E. $2\pi a\,\mathbf{a}_\phi$

F. another vector

The circular line charge ($\boldsymbol{\rho}_l > 0$) generates a field. Inside the blue region in the xy-plane the direction of the field is

A. $+\boldsymbol{a}_r$

B. $+\boldsymbol{a}_\phi$

C. $+\boldsymbol{a}_z$

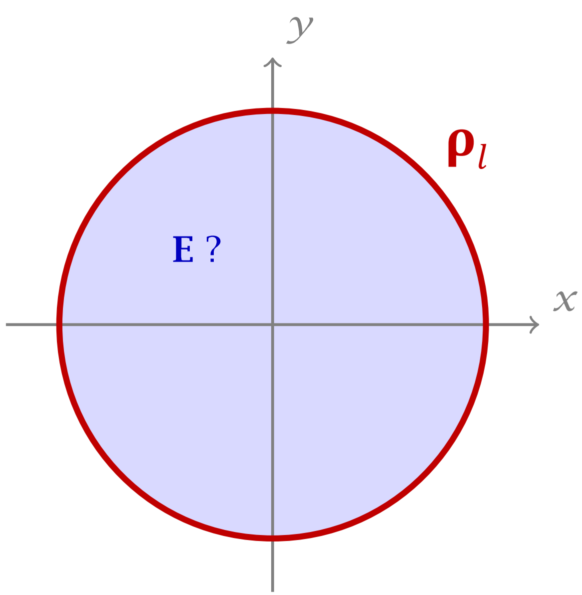
$\boxed{D.}$ $-\boldsymbol{a}_r$

E. $-\boldsymbol{a}_\phi$

F. $-\boldsymbol{a}_z$

G. something else

H. field is zero due to symmetry



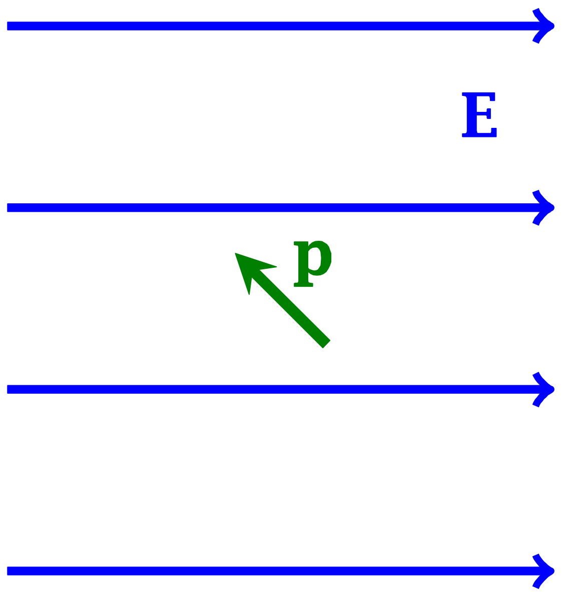
Claim 1: If at a given point in space the potential $V = 0$, at the same point also the electric field $\mathbf{E} = \mathbf{0}$.

Claim 2: If at a given point in space the electric field $\mathbf{E} = \mathbf{0}$, at the same point also the potential $V = 0$.

Which of the following holds?

A. only Claim 1
B. only Claim 2
C. both Claims
D. neither Claim 1 nor Claim 2

A pointwise dipole with dipole moment $\mathbf{p}$ is located in a constant (uniform) electric field $\mathbf{E}$.
Does the dipole experience a total force and/or a torque?



A. only net force
B. only torque
C. both
D. neither force nor torque

A static electric dipole in free space is located in the origin.
The direction of the dipole is along $+z$-axis.
(The dipole moment is $\mathbf{p} = \mathbf{a}_z\, p$ with $p > 0$.)
At the *xy*-plane, the direction of the electric field due to this dipole is

A. $+\mathbf{a}_z$

B. $+\mathbf{a}_R$

C. $-\mathbf{a}_R$

D. $+\mathbf{a}_{\phi}$

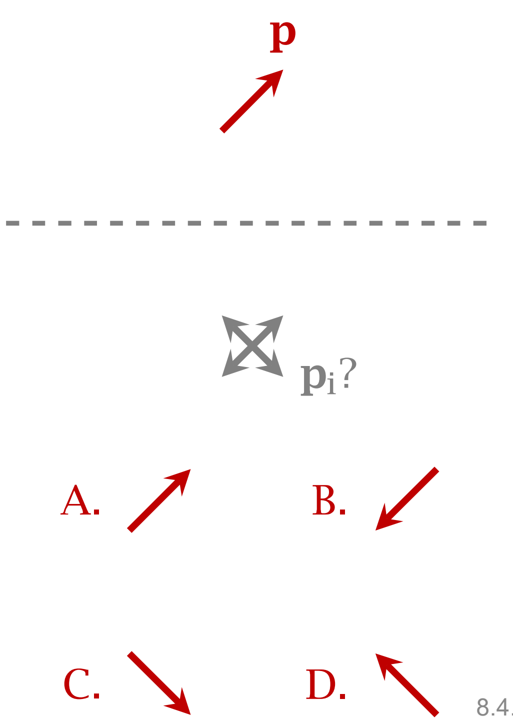
E. $-\mathbf{a}_{\phi}$

$\boxed{\text{F.}}$ something else

G. the field vanishes due to symmetry

An electric dipole $\mathbf{p}$ is located above a perfectly conducting plane. To solve the the field by the image principle, we need the image dipole $\mathbf{p}_\mathrm{i}$ at the mirror image point. The image dipole has the same amplitude as the original dipole: $|\mathbf{p}_\mathrm{i}| = |\mathbf{p}|$.
Which is the direction of the image dipole?

A.
B.
C.
$\boxed{\text{D.}}$
E. (something else)



A positive point charge $+Q$ is located in air close to a perfectly conducting half space. Which of the vectors describes the direction of the electric field at point P in air just at the plane?

A. $\mathbf{E}_1$

B. $\mathbf{E}_2$

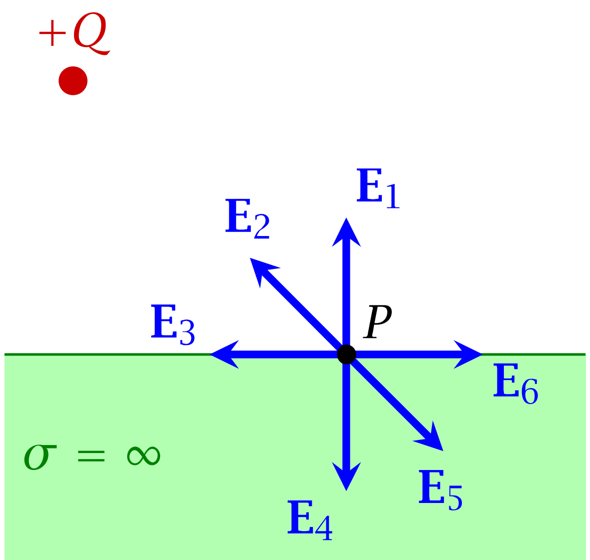
C. $\mathbf{E}_3$

$\boxed{\text{D.}}$ $\mathbf{E}_4$

E. $\mathbf{E}_5$

F. $\mathbf{E}_6$

G. (none, because $\mathbf{E} = \mathbf{0}$)



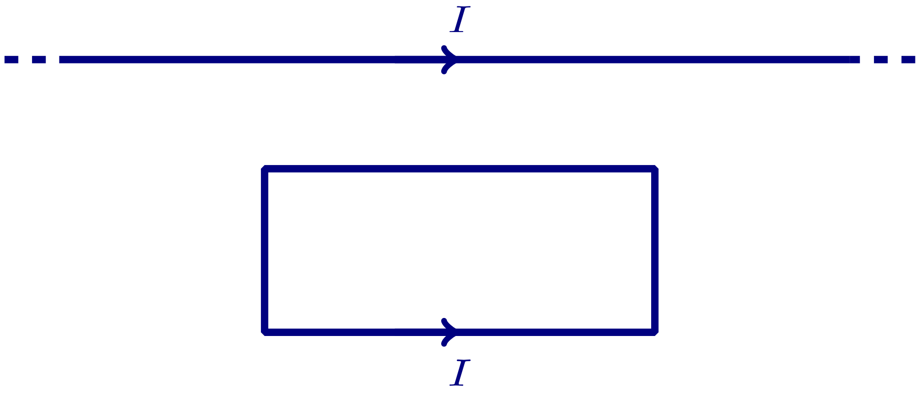
Tesla (T) is the unit for magnetic flux density **B**.
What is tesla in terms of the basic SI-units?
(m, kg, s, A)

(a) $\frac{\mathrm{kg\,s^2}}{\mathrm{m^3}}$ (b) $\frac{\mathrm{A\,s}}{\mathrm{m^2}}$ $\boxed{\text{(c)}}$ $\frac{\mathrm{kg}}{\mathrm{A\,s^2}}$

(d) $\frac{\mathrm{kg^2}}{\mathrm{m^2\,s^2}}$ (e) $\frac{\mathrm{A\,kg}}{\mathrm{m\,s^2}}$ (f) $\frac{\mathrm{A\,m}}{\mathrm{kg\,s}}$

(g) something else

A current loop and a long straight current wire lie in the plane of the screen as in the picture. The force acting on the straight wire has the following direction:



A. left along the wire
B. right along the wire
C. down toward the loop
D. up away from the loop
E. out of the screen
F. into the screen
G. (there is no force acting on the wire.)

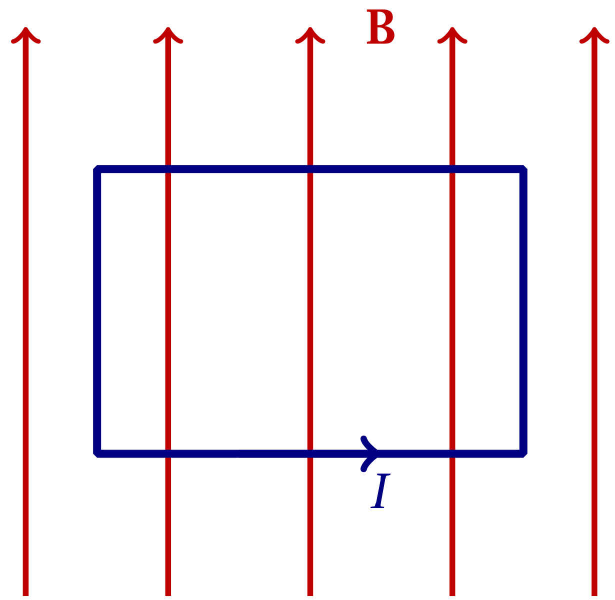
A current loop is located in a a uniform magnetic field. The field exerts on the loop

A. a net force

$\boxed{\text{B.}}$ a net torque

C. both a force and a torque

D. neither force nor torque

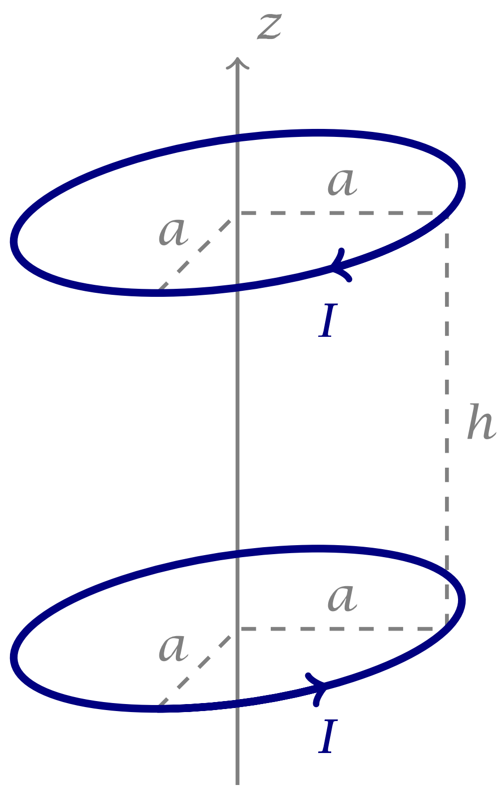


Two circular current loops are located as in the picture.
They experience towards each other

A. an attracting force

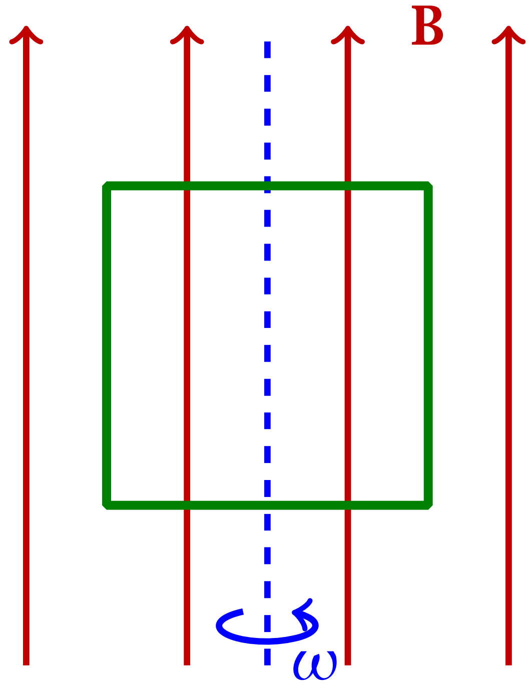
$\boxed{\text{B.}}$ a repelling force

C. no force at all

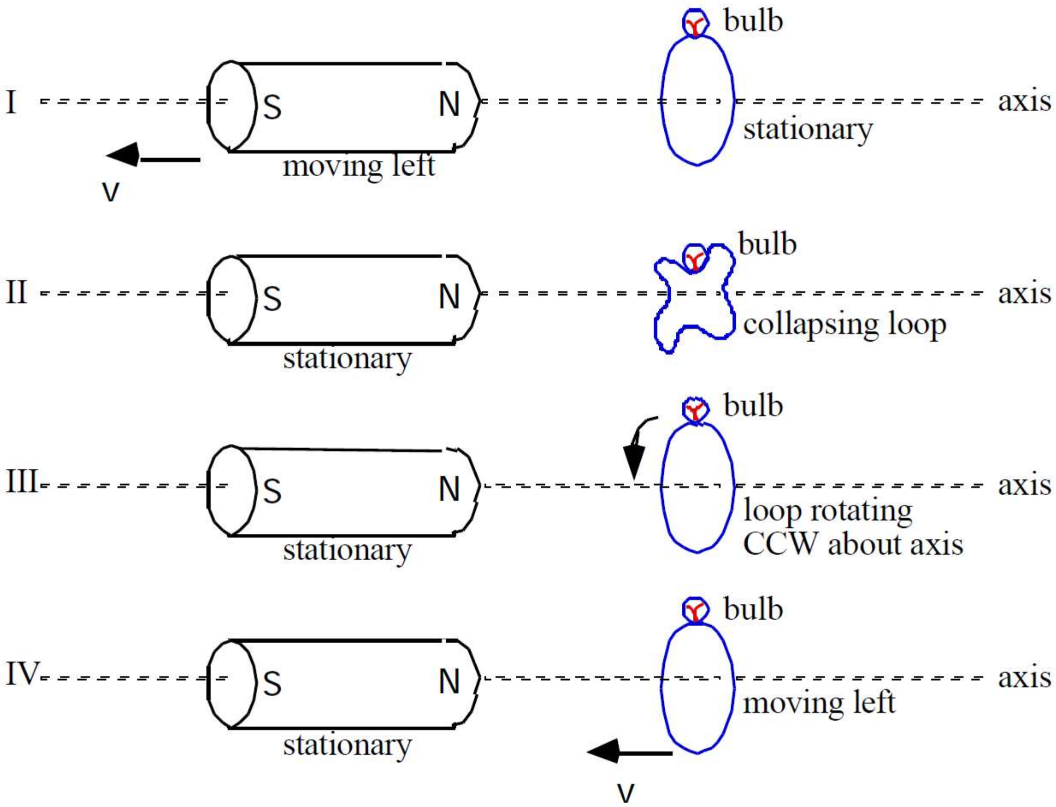


A square-shaped wire loop rotates with uniform angular velocity around its axis as in the picture. What kind of current is induced in the loop?

A. no current
B. a uniform (DC) current
C. sinusoidal current
D. another time-dependent current



The five separate figures below involve a cylindrical magnet and a tiny light bulb connected to the ends of a loop of copper wire. These figures are to be used in the following question. The plane of the wire loop is perpendicular to the reference axis. The states of motion of the magnet and of the loop of wire are indicated in the diagram. Speed will be represented by v and CCW represents counter clockwise.



29. In which of the above figures will the light bulb be glowing?

(a) I, III, IV (b) I, IV $\boxed{\text{(c)}}$ I, II, IV (d) IV (e) None of these

The complex vector field

$$\mathbf{E}(z) = \boldsymbol{a}_x\, E_0 e^{-jkz} \qquad (E_0, k > 0)$$

corresponds to a time-dependent field

A $\mathbf{E}(z,t) = \boldsymbol{a}_x E_0 \sin(\omega t - kz)$

B $\mathbf{E}(z,t) = \boldsymbol{a}_x E_0 \sin(\omega t + kz)$

$\boxed{\text{C}}$ $\mathbf{E}(z,t) = \boldsymbol{a}_x E_0 \cos(\omega t - kz)$

D $\mathbf{E}(z,t) = \boldsymbol{a}_x E_0 \cos(\omega t + kz)$

Choose the correct complex scalar that corresponds to $v(t)$

A. V_0

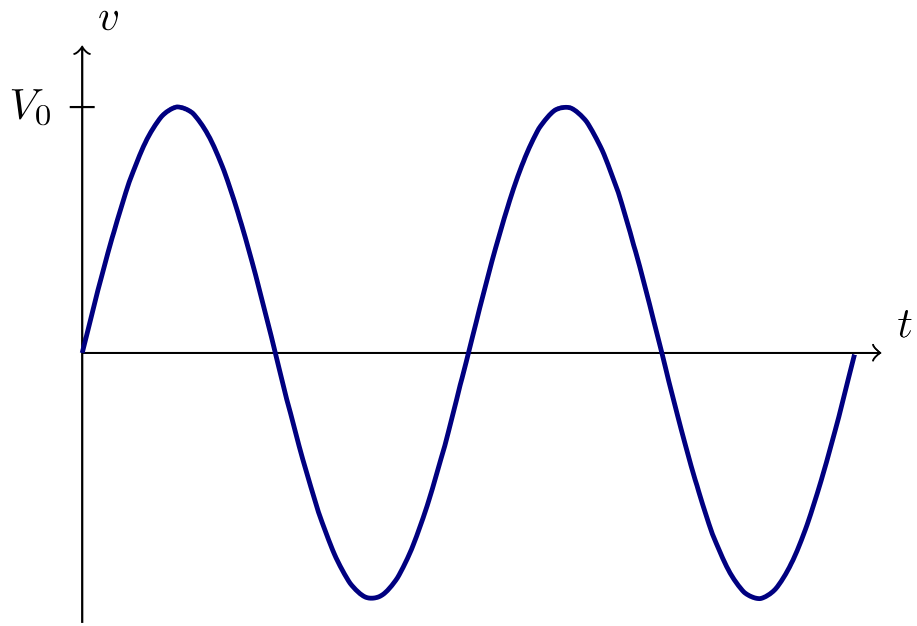
B. $+\mathrm{j}\,V_0$

$\boxed{C.}$ $-\mathrm{j}\,V_0$

D. $V_0\sqrt{2}$

E. $V_0/\sqrt{2}$

F. Something else



The complex vector

$$\mathbf{E}(z) = (\boldsymbol{a}_x - \mathrm{j}\boldsymbol{a}_z) E_0 \, e^{-\mathrm{j}kz} \qquad (E_0, k > 0)$$

satisfies everywhere the Helmholtz equation.
Is it a valid plane wave solution for Maxwell's equations?

A. Yes.
B. No, because it is divergenceless.
C. No, because it is curl-free.
D. No, because it has a longitudinal component.
E. No, because the direction of the elecric field is complex.

An ideal plane wave is not possible in real life. Why?

A. It satisfies the wave equation (Helmholtz equation) but not Mawxell's equations.
B. It satisfies the Maxwell's equations but not the wave equation (Helmholtz equation)
C. The power it carries is infinite.
D. It would propagate faster than light.
E. It does not have longitudinal field components.
F. It is not curl-free.

The power of a radio transmitter is 1 kW.
The receiving antenna captures a power that is 40 dB less, which is

A. 100 W
B. 10 W
C. 1 W
D. 100 mW
E. 10 mW
F. 1 mW

Plane wave A has peak electric field amplitude E_{max} = 1 V/m.
Plane wave B has peak electric field amplitude E_{max} = 2 V/m.

How much stronger is wave B compared to wave A?

A. 1 dB
B. 2 dB
C. 3 dB
D. 6 dB
E. 10 dB
F. 20 dB

A plane wave with left-handed circular polarization is normally incident ($\theta_1 = 0$) on a planar boundary between two materials. What is the polarzation state of the reflected wave?

A. Linear
B. Circular, left-handed
C. Circular, right-handed
D. Elliptical, left-handed
E. Elliptical, right-handed
F. Cannot be determined without further information about the materials

Let’s catch fish using a bow and arrow. How whould we aim the arrow such that it would hit the fish, assuming that the arrow does not change its direction when hitting the water surface?

A. exactly towards the fish
B. slightly above the fish
C. slightly below the fish

Where to aim if we instead try to kill the fish using a green laser beam?

A. exactly towards the fish
B. slightly above the fish
C. slightly below the fish

A transmitting antenna is $z$directed dipole . How should the receiving antenna be directed when it is on the y-axis in the far field of the transmitter?

A. along x-axis

B. along y-axis

$\boxed{\text{C.}}$ along z-axis

D. (does not matter because regardless of the direction, the reception is similarly good.)