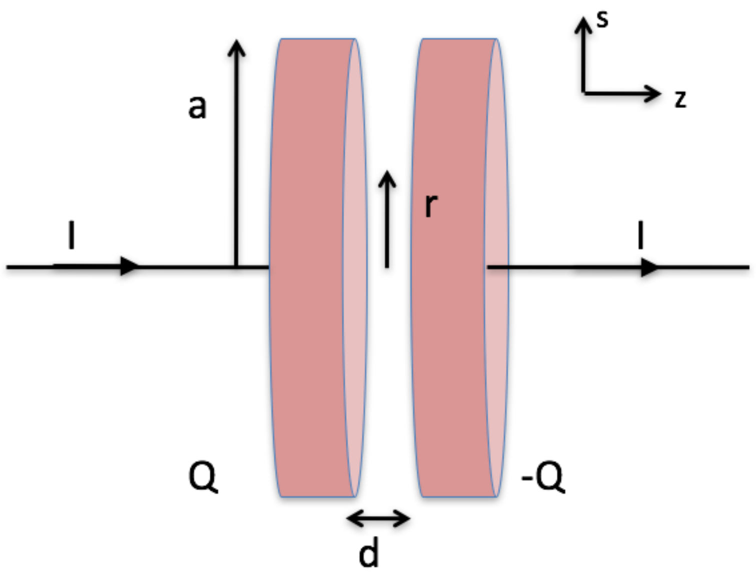
Same capacitor with $Q = Q_0 + \beta t$ on the positively charged plate. What is the magnitude of the magnetic field $\mathbf{B}$ halfway between the plates, at a radius r?



A. $\frac{\mu_0 \beta}{2\pi r}$

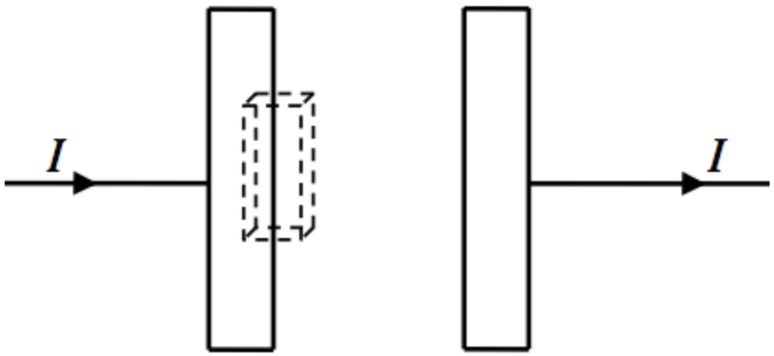
B. $\frac{\mu_0 \beta r}{2 d^2}$

C. $\frac{\mu_0 \beta d}{2 a^2}$

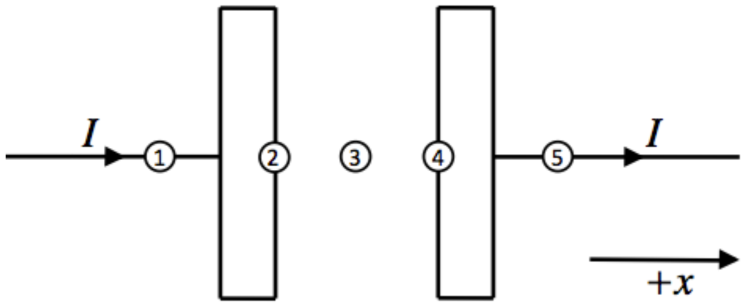
D. $\frac{\mu_0 \beta a}{2\pi r^2}$

E. None of the above

Consider the surface of an imaginary volume (dashed lines, at right) that partly encloses the left capacitor plate. For this closed surface, is the total flux of the current density, $\iint \mathbf{J} \cdot d\mathbf{A}$ positive, negative or zero?



A. Positive
B. Negative
C. Zero

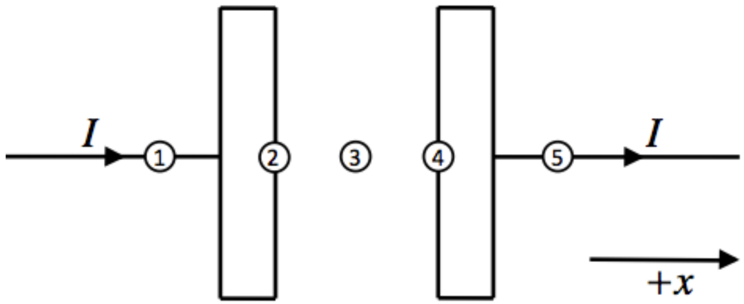


At each location, we will evaluate the sign of $\partial\rho/\partial t$ and $\nabla \cdot \mathbf{J}$.

At location 3, the signs of $\partial\rho/\partial t$ and $\nabla \cdot \mathbf{J}$ are:

A. both zero
B. both negative
C. both positive
D. $\partial\rho/\partial t$ is positive and $\nabla \cdot \mathbf{J}$ is negative
E. $\partial\rho/\partial t$ is negative and $\nabla \cdot \mathbf{J}$ is positive

Recall that charge is conserved locally!

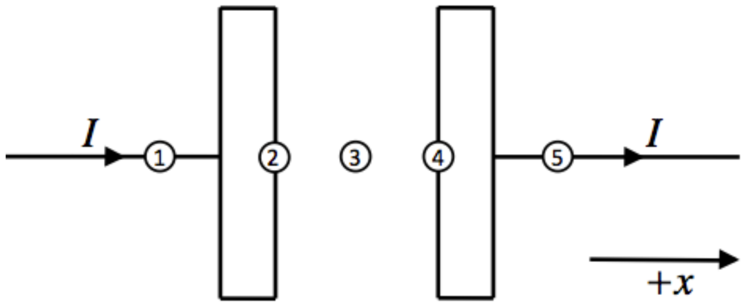


At each location, we will evaluate the sign of $\partial\rho/\partial t$ and $\nabla \cdot \mathbf{J}$.

At location 2, the signs of $\partial\rho/\partial t$ and $\nabla \cdot \mathbf{J}$ are:

A. both zero
B. both negative
C. both positive
D. $\partial\rho/\partial t$ is positive and $\nabla \cdot \mathbf{J}$ is negative
E. $\partial\rho/\partial t$ is negative and $\nabla \cdot \mathbf{J}$ is positive

Recall that charge is conserved locally!

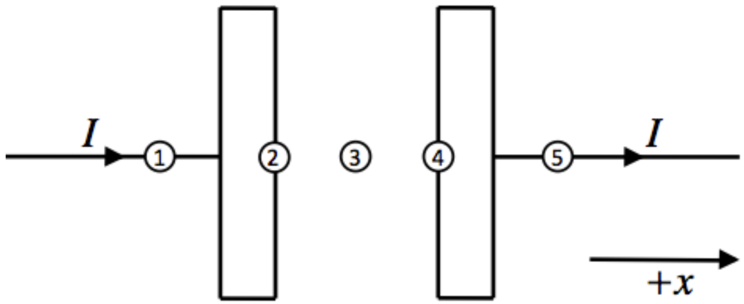


At each location, we will evaluate the sign of $\partial\rho/\partial t$ and $\nabla \cdot \mathbf{J}$.

At location 4, the signs of $\partial\rho/\partial t$ and $\nabla \cdot \mathbf{J}$ are:

A. both zero
B. both negative
C. both positive
D. $\partial\rho/\partial t$ is positive and $\nabla \cdot \mathbf{J}$ is negative
E. $\partial\rho/\partial t$ is negative and $\nabla \cdot \mathbf{J}$ is positive

Recall that charge is conserved locally!

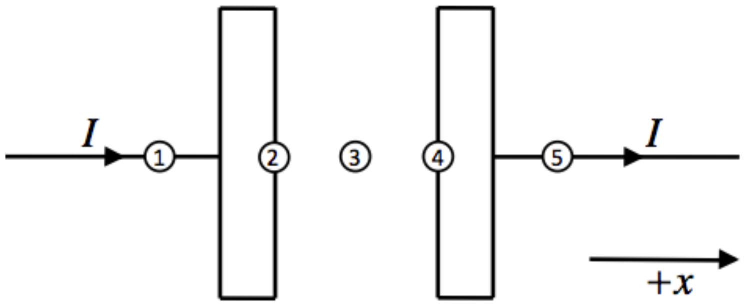


At each location, we will evaluate the sign of $\partial\rho/\partial t$ and $\nabla \cdot \mathbf{J}$.

At location 1, the signs of $\partial\rho/\partial t$ and $\nabla \cdot \mathbf{J}$ are:

A. both zero
B. both negative
C. both positive
D. $\partial\rho/\partial t$ is positive and $\nabla \cdot \mathbf{J}$ is negative
E. $\partial\rho/\partial t$ is negative and $\nabla \cdot \mathbf{J}$ is positive

Recall that charge is conserved locally!

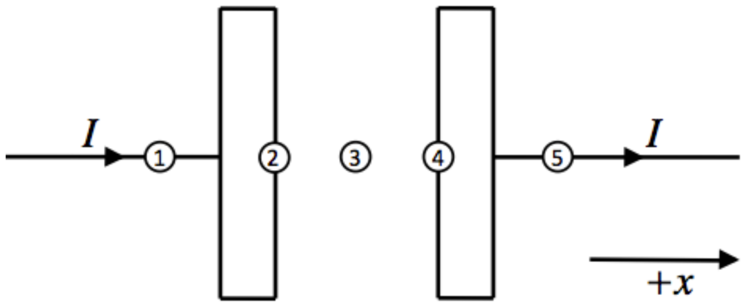


At each location, we will evaluate the sign of $\partial\rho/\partial t$ and $\nabla \cdot \mathbf{J}$.

At location 5, the signs of $\partial\rho/\partial t$ and $\nabla \cdot \mathbf{J}$ are:

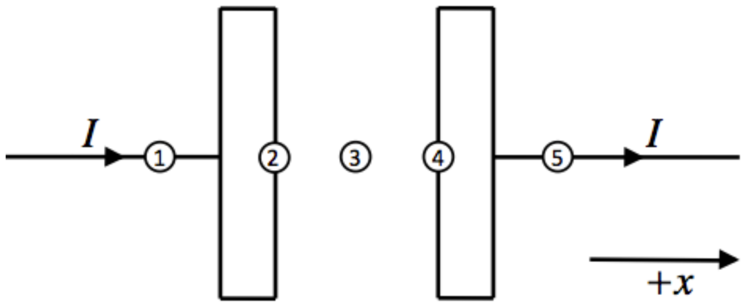
A. both zero
B. both negative
C. both positive
D. $\partial\rho/\partial t$ is positive and $\nabla \cdot \mathbf{J}$ is negative
E. $\partial\rho/\partial t$ is negative and $\nabla \cdot \mathbf{J}$ is positive

Recall that charge is conserved locally!



Suppose the original Ampere's law $\nabla \times \mathbf{B} = \mu_0 \mathbf{J}$ were correct without any correction from Maxwell (it’s not, but suppose for a moment that it is). What would this imply about $\nabla \cdot \mathbf{J}$ at points 2 and 4 in the diagram?

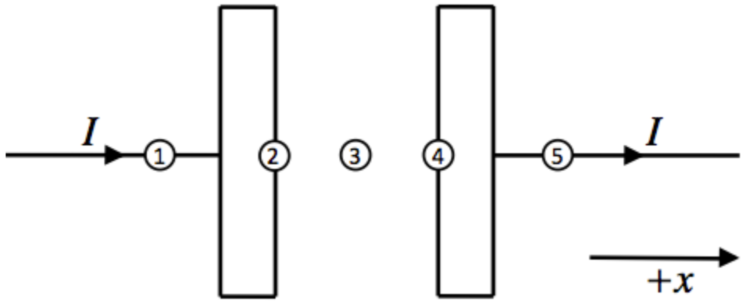
A. The remain unchanged
B. They swap signs
C. They become zero
D. ???



Let's continue with the (incomplete) definition of Ampere's Law: $\nabla \times \mathbf{B} = \mu_0 \mathbf{J}$.

What does this form tell you about the signs of $(\nabla \times \mathbf{B})_x$ at locations 1, 3, and 5?

A. All positive
B. All negative
C. Positive at 1 and 5, zero at 3
D. Negative at 1 and 5, zero at 3
E. Something else

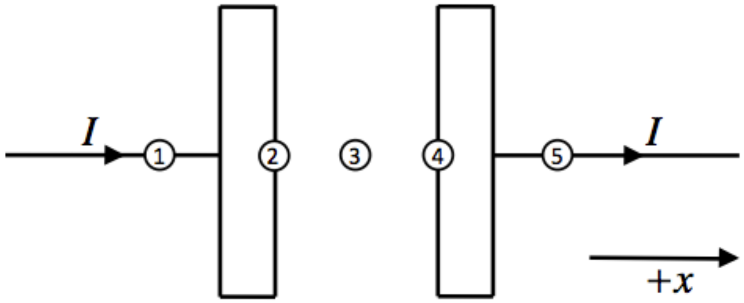


Let's return to the complete definition of Ampere's Law:

$$\nabla \times \mathbf{B} = \mu_0 \mathbf{J} + \varepsilon_0 \mu_0 \frac{d\mathbf{E}}{dt}.$$

At location 1, what are the signs of J_x, dE_x/dt, and $(\nabla \times \mathbf{B})_x$?

A. $J_x < 0, dE_x/dt < 0, (\nabla \times \mathbf{B})_x < 0$
B. $J_x = 0, dE_x/dt > 0, (\nabla \times \mathbf{B})_x > 0$
C. $J_x > 0, dE_x/dt = 0, (\nabla \times \mathbf{B})_x > 0$
D. $J_x > 0, dE_x/dt > 0, (\nabla \times \mathbf{B})_x > 0$
E. Something else

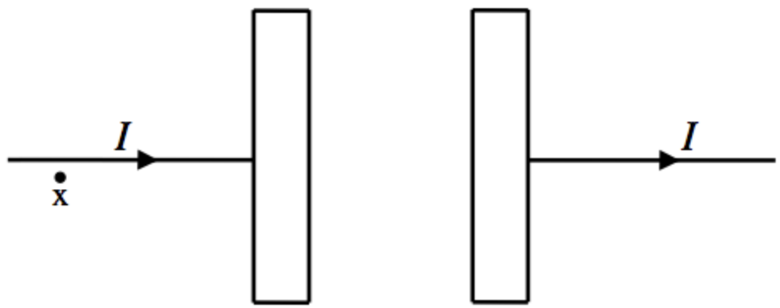


Let's return to the complete definition of Ampere's Law:

$$\nabla \times \mathbf{B} = \mu_0 \mathbf{J} + \varepsilon_0 \mu_0 \frac{d\mathbf{E}}{dt}.$$

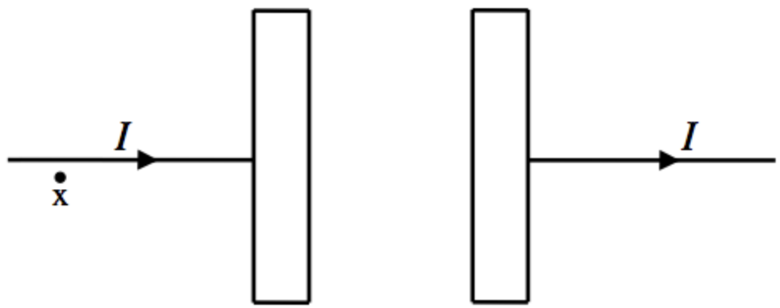
At location 3, what are the signs of J_x, dE_x/dt, and $(\nabla \times \mathbf{B})_x$?

A. $J_x < 0, dE_x/dt < 0, (\nabla \times \mathbf{B})_x < 0$
B. $J_x = 0, dE_x/dt > 0, (\nabla \times \mathbf{B})_x > 0$
C. $J_x > 0, dE_x/dt = 0, (\nabla \times \mathbf{B})_x > 0$
D. $J_x > 0, dE_x/dt > 0, (\nabla \times \mathbf{B})_x > 0$
E. Something else



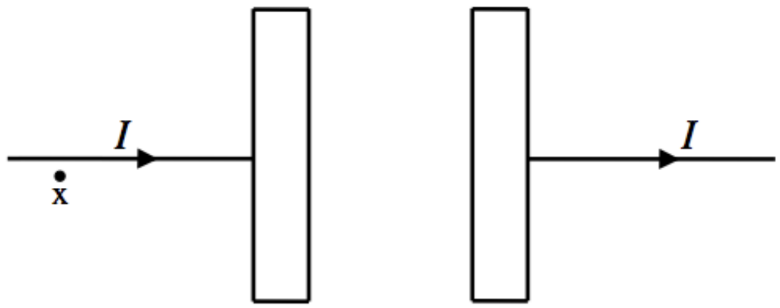
A pair of capacitor plates are charging up due to a current I. The plates have an area $A = \pi R^2$. Use the Maxwell-Ampere Law to find the magnetic field at the point "x" in the diagram as distance r from the wire.

A. $B = \frac{\mu_0 I}{4\pi r}$
B. $B = \frac{\mu_0 I}{2\pi r}$
C. $B = \frac{\mu_0 I}{4\pi r^2}$
D. $B = \frac{\mu_0 I}{2\pi r^2}$
E. Something much more complicated



The plates have an area $A = \pi R^2$. Use the Gauss' Law to find the electric field between the plates, answer in terms of σ the charge density on the plates.

A. $E = \sigma/\varepsilon_0$
B. $E = -\sigma/\varepsilon_0$
C. $E = \sigma/(\varepsilon_0 \pi R^2)$
D. $E = \sigma \pi R^2/\varepsilon_0$
E. Something much more complicated

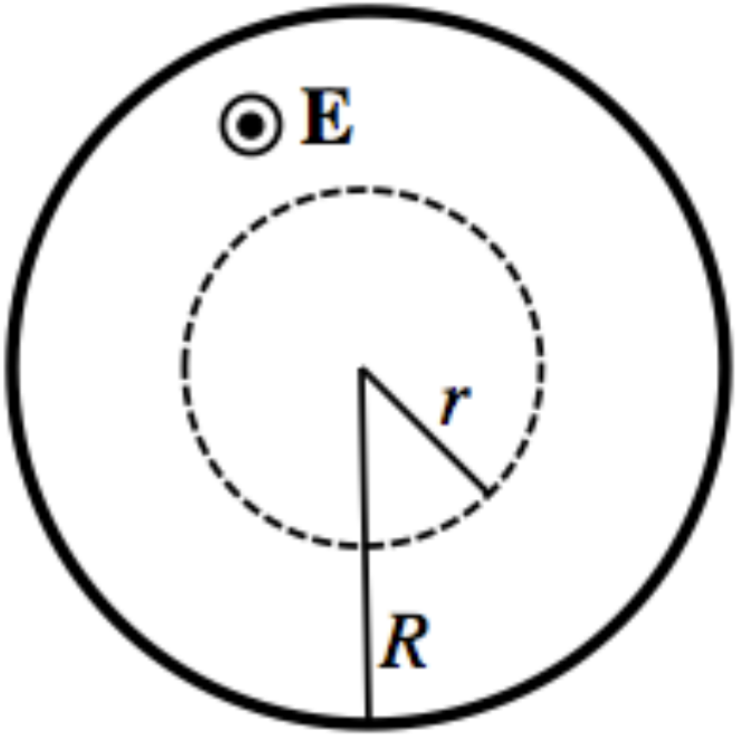


The plates have an area $A = \pi R^2$. Determine the relationship between the current flowing in the wires and the rate of change of the charge density on the plates.

A. $d\sigma/dt = I$
B. $\pi R^2 d\sigma/dt = I$
C. $d\sigma/dt = \pi R^2 I$
D. Something else

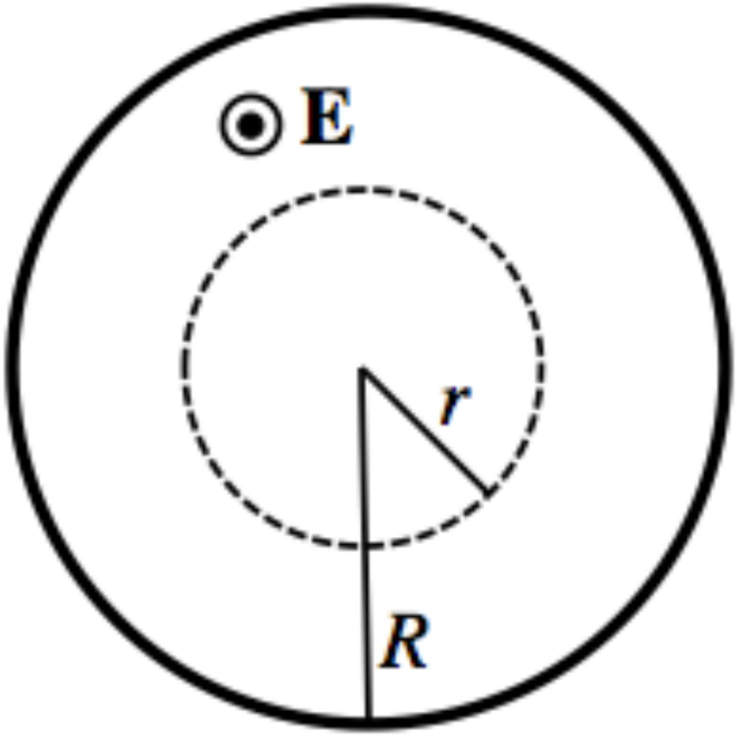
We found the relationship between the current and the change of the charge density was: $\pi R^2 d\sigma/dt = I$. Determine the rate of change of the electric field between the plates, $d\mathbf{E}/dt$.

A. $\sigma/\varepsilon_0\hat{x}$
B. $I/(\pi R^2\varepsilon_0)\hat{x}$
C. $-I/(\pi R^2\varepsilon_0)\hat{x}$
D. $I/(2\pi R\varepsilon_0)\hat{x}$
E. $-I/(2\pi R\varepsilon_0)\hat{x}$



Use the Maxwell-Ampere Law to derive a formula for the manetic at a distance $r < R$ from the center of the plate in terms of the current, I.

A. $B = \frac{\mu_0 I}{2\pi r}$
B. $B = \frac{\mu_0 I r}{2\pi R^2}$
C. $B = \frac{\mu_0 I}{4\pi r}$
D. $B = \frac{\mu_0 I r}{4\pi R^2}$
E. Something else entirely



Use the Maxwell-Ampere Law to derive a formula for the magnetic at a distance $r > R$ from the center of the plate in terms of the current, I.

A. $B = \frac{\mu_0 I}{2\pi r}$
B. $B = \frac{\mu_0 I r}{2\pi R^2}$
C. 0
D. Something else entirely