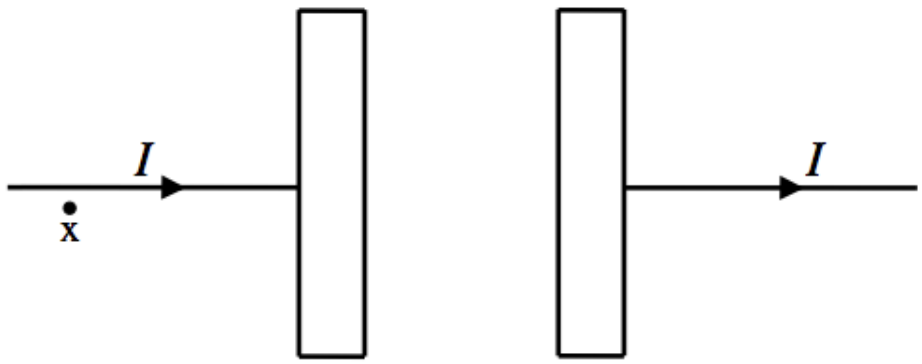
Maxwell-Ampere Part 2

A. Consider a capacitor in the process of charging up, shown edge-on in the diagram below. The circular plates have radius R, area $A = \pi R^2$, and are so close together that fringe effects can be ignored.
A current I is flowing in the long, straight wires.



Use the Maxwell-Ampere law to derive a formula for the magnetic field at the point "x" indicated in the diagram, a short distance r from the wire.

Use Gauss' law in integral form to derive a formula for the electric field between the capacitor plates. Be specific about the Gaussian surface used, and write the answer in terms of σ, the charge per unit area on the plates.

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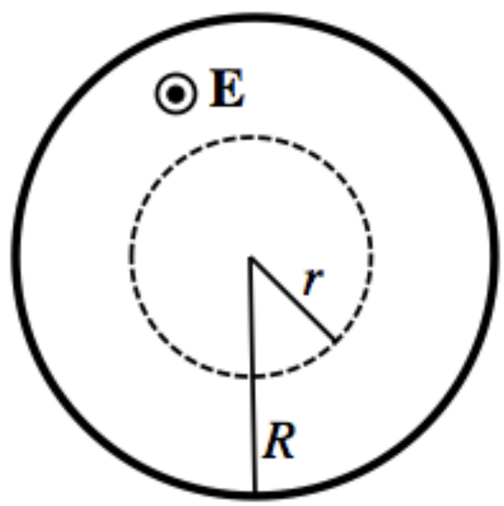
Write down a relationship between the current I flowing in the wires and the rate of change of the charge per unit area on the plates $\partial\sigma/\partial t$.

Use this information to find a relationship between the current I flowing in the wires and the rate of change of the electric field between the plates $\partial\mathbf{E}/\partial t$.

C. Use the diagram at right to indicate the direction of the magnetic field everywhere along the dashed loop, at a distance r from the center of the plates, shown here face-on.



Then, use the Maxwell-Ampere Law to derive a formula for the magnetic field at a distance $r < R$ from the center of the plates.
Express your final answer in terms of the current I flowing in the wires.

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Consider the two line integrals of the magnetic field $\oint_{L1} \vec{\mathbf{B}} \cdot d\vec{\ell}$ and $\oint_{L2} \vec{\mathbf{B}} \cdot d\vec{\ell}$ shown in the diagram below; both loops have the same radius r. How do the values of these two loop integrals compare? Is one larger than the other, or are they equal in magnitude? Explain your answer using the formulas you derived.