A wire with uniform current density $J$ is shown in cross section, with the current coming out of the page towards you. Four Amperian loops are shown. Choose from the list below the correct ranking of the magnitude of the value of line integral $\Sigma = \oint \mathbf{B} \cdot d\mathbf{s}$ around each loop.

\[
\Sigma_a = \Sigma_b = \Sigma_c = \Sigma_d
\]

\[
\Sigma_a = \Sigma_b > \Sigma_c > \Sigma_d
\]

\[
\Sigma_a > \Sigma_b > \Sigma_c > \Sigma_d
\]

\[
\Sigma = \oint \mathbf{B} \cdot d\mathbf{s} = \mathbf{\nabla} \times \mathbf{E}_{NC}
\]

C encloses more than d but a and b enclose the same.
Two identical wires carry currents of equal magnitude but opposite direction, as shown in the figure.

\[ i_A, \quad i_B \]
\[ \text{A} \quad \text{B} \]

Which way does the force on wire B due to wire A point?

(Circle One.)

\( \text{Antiparallel} \quad \text{repel} \)

To the right \( (\rightarrow) \)

To the left \( (\leftarrow) \)

Out of the page \( (\uparrow) \)
Alice, Bob, and Charlie have taken three identical wire loops and prepared a different magnetic field $B$ going through each loop. The direction and time rate of change for each loop is indicated in the figure. They can't figure out which way the current now flows in the loop. Help them out by circling one answer each below for clockwise (CW) counterclockwise (CCW) or no current flow (NONE).

(Circle One Each.)

A: CW  CCW  NONE
B: CW  CCW  NONE
C: CW  CCW  NONE

Use Lenz's Law:

A: Current produces $\vec{B}_{ind}$ to oppose decrease.
B: No change $\Rightarrow \frac{dI}{dt} = 0 \Rightarrow i = 0$
C: Current produces $\vec{B}_{ind}$ to boost decrease.
In the RL circuit the switch is closed at $t=0$ as shown.

(a) What is the current $i$ at $t=0$? At $t=0$, $L$ acts like an open circuit with no current. $i = 0$.

(b) What is the current $i$ after a very long time? $t = \infty$, $L$ acts like wire - short circuit. $V = iR$.

(c) If $R=1\Omega$, $V=1V$, and $L=1H$, what is the current after $t=1$ second?

For $LR$ charging, $\tau_{LR} = L/R = 1s$.

\[ i(t) = \frac{V}{R} \left( 1 - e^{-t/\tau_{LR}} \right) \]

\[ = \frac{1V}{1\Omega} \left( 1 - e^{-1} \right) \approx 0.63A \]

\[ \approx 0.63A \text{ ANS} \]