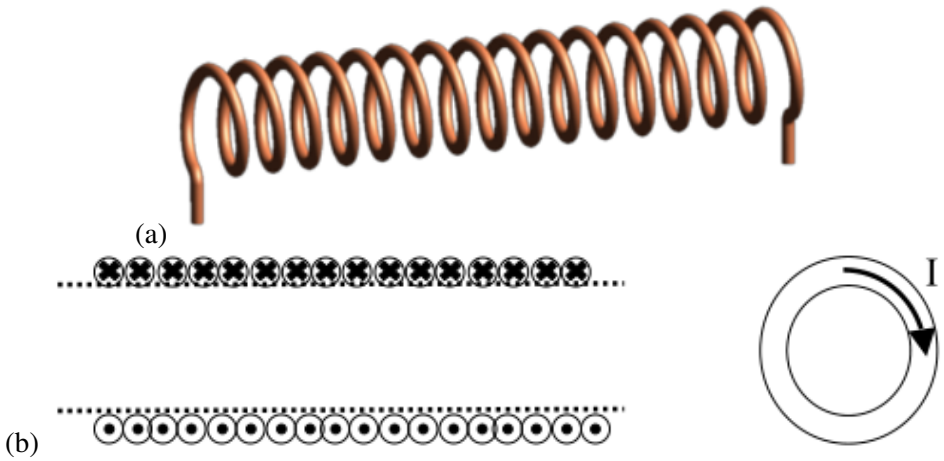
Goal: Determine the magnetic flux density inside an infinitely long solenoid in free space having n closely wounds turns per unit length and carrying a current I.



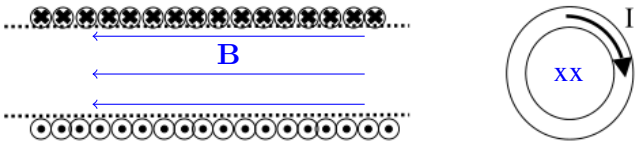
Steps:

1. State Ampère's law.
   Solution: The integral form of the Ampère's circuit law is

$$\oint_C \mathbf{B} \cdot d\mathbf{l} = \mu_0 I_{\text{enc}}$$

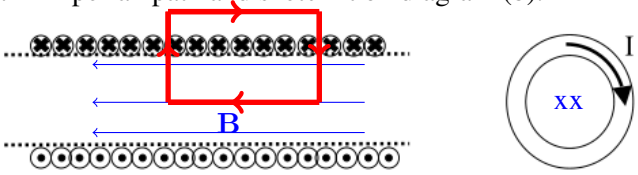
   where C is the contour of the boundary points of a surface S and I_{enc} is the total current passing through surface S.

2. Sketch the magnetic field inside the solenoid in diagram (b) above.



   Solution: **B** field is into the page

3. Determine an Amperian path and sketch it on diagram (b).



   Solution: **B** field is into the page

4. Applying Ampère's law, determine the magnetic field inside the solenoid.
   Solution:

$$\begin{aligned} BL &= \mu_0 nLI \\ B &= \mu_0 nI \end{aligned}$$

Answer:

$$B = \mu_0 n I$$