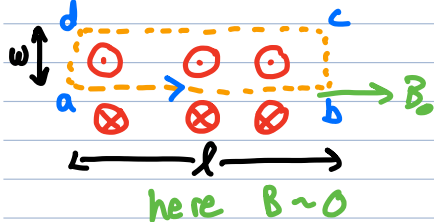# Ampere's Law example

A long solenoid has $n = 100$ turns per cm and current I. An e^- moves within along a circular path of $R = 2.30$ cm and speed $v = 1.4 \cdot 10^7$ m/s. What is B inside?

side view

end view

cross-section view

d c

w

a b

ℓ

here $B \sim 0$

$$\oint \vec{B} \cdot \vec{d\ell} = \mu_0 I_{enclosed}$$

r.h.s. $\mu_0 I n \ell$

l.h.s. $B_{ab} \ell \cos 0° + B_{bc} w \cos 90° +$

$B_{cd} \cos 0° + B_{da} w \cos 90° = B_0 \ell$

$\rightarrow B_0 \ell = \mu_0 I n \ell \rightarrow \boxed{B_0 = \mu_0 I n}$

From previous results: $B_0 = \dfrac{mv}{qR} \Rightarrow \mu_0 I n = \dfrac{mv}{qR} \Rightarrow I = \dfrac{mv}{qR\mu_0 n}$

$\wedge 0.3 A$