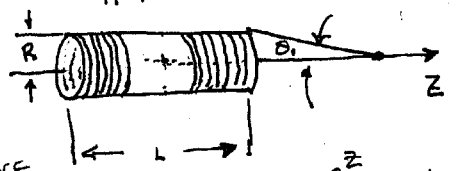
* MAGNETIC FIELD ON AXIS OF A SOLENOID

FOR ONE LOOP $B(z) = \dfrac{\mu_0 I R^2}{2(R^2+z^2)^{3/2}}$ SO FOR LOTS OF LOOPS – ADD!

FOR THE SOLENOID

n TURNS PER UNIT LENGTH

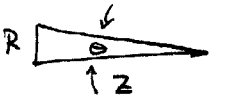


WE HAVE

$$B_{\text{LOTS OF LOOPS}} = \frac{\mu_0 I R^2}{2}\int_{z+L}^{z} \frac{n\,dz}{(R^2+z^2)^{3/2}}$$

• THIS IS NICE WITH ANGLES SO NOTE THAT

$z = R\cot\theta$



$\Rightarrow dz = -\dfrac{R}{\sin^2\theta}\,d\theta$

FROM $(R^2+z^2)^{-3/2}$

$$\Rightarrow B = \frac{\mu_0 n I}{2}\int_{\theta_1}^{\theta_2} \frac{R^3}{\sin^3\theta}\left(\frac{\sin^3\theta}{R^3}\right)(-R\,d\theta)$$

$$= -\frac{\mu_0 n I}{2}\int_{\theta_1}^{\theta_2} \sin\theta\,d\theta = \frac{\mu_0 n I}{2}\left(\cos\theta_2 - \cos\theta_1\right)$$

– OFTEN A USEFUL FORM FOR B

$$\therefore B(z) = \frac{\mu_0 n I}{2}\left[\frac{z}{(z^2+R^2)^{1/2}} - \frac{(z+L)}{((z+L)^2+R^2)^{1/2}}\right]$$

THE EXACT RELATION