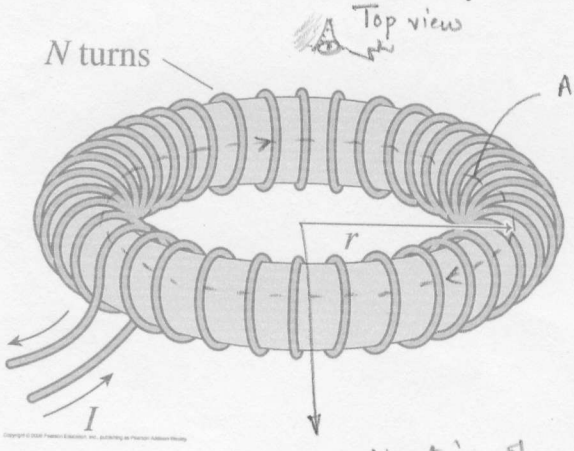
SOLUTION

NAME:	Quiz #1c: Phys270
	0104

1. A toroid is a coil of wire wrapped around a doughnut-shaped ring (a torus) made of nonconducting material.
   a. [8 pts] Use Ampere's law to derive an expression of the magnetic field strength at a distance r from the axis of the toroid (within the coil windings) with a current I through N closely spaced turns. Make sure you draw your Amperian loop on the diagram.
   b. [2 pts] Is the magnetic field you found in part (a) uniform? Explain.



a) from the top one can see that the current enclosed by the loop is $NI = I_{net}$ coming out of the loop plane.

∴ Assuming clockwise direction to be +ve we have

$$I_{net} = -NI$$

Lets assume using symmetry that B is uniform at a given r and is in clockwise direction

Then $\oint B \cdot ds = \mu_0(-NI)$

$$\Rightarrow B 2\pi r = -NI\mu_0$$

$$\therefore B = -\frac{\mu_0 NI}{2\pi r}$$ in clockwise direction

$$\therefore B(r) = \frac{\mu_0 NI}{2\pi r}$$ in anticlockwise direction.

b) from the expression obtained in a. we observe that $|\vec{B}|$ is not uniform but varies as $\frac{1}{r}$ inside the toroid