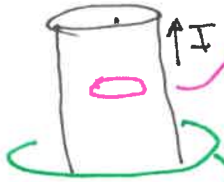
341 – class 27 – B2.pdf #1 & #4

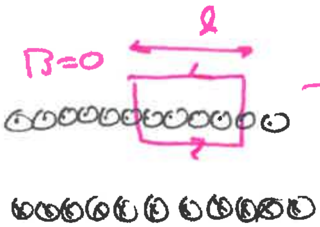
1 a)



loop inside cylinder: zero enclosed current
$\oint \vec{B}\cdot d\vec{l} = 2\pi r B = 0 \Rightarrow B = 0$

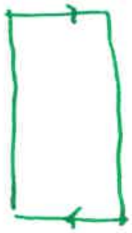
loop outside cylinder: enclosed current $= I$
$\oint B\cdot dl = 2\pi r B = \mu_0 I \Rightarrow B = \frac{\mu_0 I}{2\pi r}$

(b)



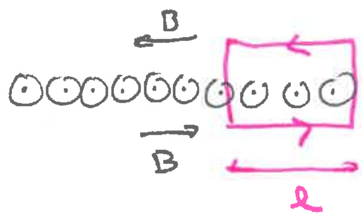
→ enclosed current $= \underbrace{N}_{\#\text{ wires}} l I$

$\oint \vec{B}\cdot d\vec{l} = Bl = \mu_0 N l I \Rightarrow B = \mu_0 N I$



→ you can't rule out a uniform B but if B depended on distance from solenoid this loop would be non zero but it encloses zero current

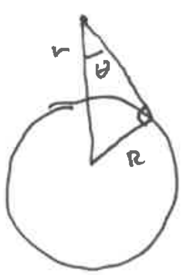
(c)



if I were to flip the plane 180° so the top becomes the bottom so the magnetic fields must be the same (and in opposite direction due to the flip)

enclosed current $= Kl$
$\oint \vec{B}\cdot d\vec{l} = 2Bl = \mu_0 K l \Rightarrow B = \frac{1}{2}\mu_0 K$

#4



$\theta = \sin^{-1}\left(\frac{R}{r}\right)$ $\quad \Omega = 2\pi(1-\cos\theta) = 2\pi\left(1 - \frac{\sqrt{r^2-R^2}}{r}\right)$

checks: if $r \gg R$ expect $\Omega = \frac{\pi R^2}{r^2}$; $\frac{\sqrt{r^2-R^2}}{r} = \sqrt{1-(R/r)^2} \approx 1 - \frac{1}{2}\left(\frac{R}{r}\right)^2$

So $\Omega = 2\pi\left(1-\left(1-\frac{1}{2}\left(\frac{R}{r}\right)^2\right)\right) = \frac{\pi R^2}{r^2}$ ✓

If you are h above the surface of Earth how far can you see?

$\cos\phi = \frac{R}{R+h} \approx 1 - \frac{h}{R} \approx 1 - \frac{\theta^2}{2}$

So $\theta \approx \sqrt{\frac{2h}{R}}$ & $S = R\theta = \sqrt{2Rh}$

Eg: if at top of a "tall ship" $h \sim 150$ ft $\Rightarrow S = 25$ km

Eg: if on ISS ($h = 400$ km) what angle is it to Earth edge → 70°
you can see a radius of nearly 2000 km