HW Solution Chapter 32 Phys 201 Term 211

32.2

$$\phi_{Top} + \phi_{bottom} + \phi_{sides} = 0$$ Gauss's law for magnetism.

$\rightarrow \phi_{outward} > 0$

$\rightarrow \phi_{inward} < 0$

$$\phi_{Top} = BA = 0.3 \times \pi (0.02)^2 = 3.77 \times 10^{-4}\ Wb$$
$$= 0.377\ mWb \text{ (outward)}$$

$$\phi_{bottom} = 0.7\ mWb \text{ (outward)}$$

$$\phi_{sides} = -(\phi_{Top} + \phi_{bottom}) = -0.377 - 0.7\ mWb$$
$$= \underline{-1.077\ mWb}$$

32.6

$$\oint \vec{B} \cdot d\vec{s} = \mu_0 i_{encl,d}$$

Current density is constant $\Rightarrow i_{d,encl}/A_{encl} = i_d/A \Rightarrow i_{d,encl} = i_d \frac{HW}{L^2}$

($A_{encl} = HW$, $A = L^2$)

$$\oint \vec{B} \cdot d\vec{s} = \mu_0 i_d \frac{HW}{L^2} = 8.85 \times 10^{-12} \times 0.75 \times \frac{8}{144}$$
$$= \underline{3.7 \times 10^{-13}\ T.m}$$

32.9

$$\phi_E = 3t \times 10^{-3} \quad R = 3\ cm$$

$r_1 = 2\ cm$ (inside) $\quad B_{in} = \frac{\mu_0 i_d r_1}{2\pi R^2} \quad i_d = \varepsilon_0 \frac{d\phi_E}{dt} = 3\varepsilon_0 \times 10^{-3}$

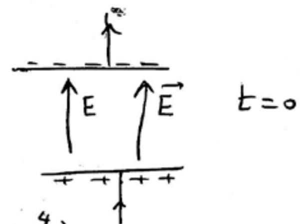
$$B_{in} = \frac{4\pi \times 10^{-7} \times 3 \times 8.85 \times 10^{-12} \times 10^{-3} \times 0.02}{2\pi \times (0.03)^2} = \underline{1.18 \times 10^{-18}\ T}$$

$r_2 = 5\text{ cm}$ (outside) $\quad B_{out} = \dfrac{\mu_0 i_d}{2\pi r_2} \quad i_d = 3\varepsilon_0 \times 10^{-3}$

$$B_{out} = \frac{4\pi\times10^{-7} \times 3\times 8.85\times10^{-12}\times 10^{-3}}{2\pi\times(0.05)^2} = \underline{\underline{1.06\times10^{-19}\,T}}$$

32.18

a) $|\vec{E}| = 4\times10^5 - 6\times10^4 t$



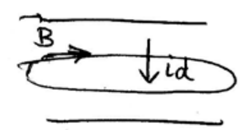
$A = 4\times10^{-2}\ m^2$

$$i_d = \varepsilon_0 \frac{d\Phi_E}{dt} = \varepsilon_0 A \frac{dE}{dt} = \varepsilon_0 A\,(-6\times10^4)$$

$$= -8.85\times10^{-12}\times 4\times10^{-2}\times 6\times10^4 = \underline{\underline{-2.1\times10^{-8}\,A}}$$

b) (–) sign means current is downward.

c) $\vec{B}$ is clockwise



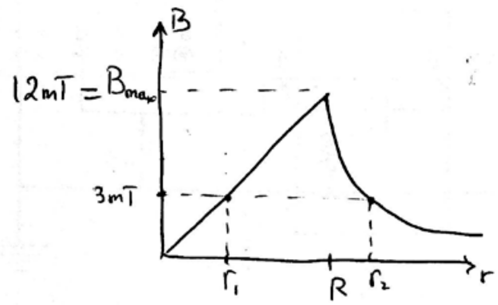
32.20

$R = 1.2\text{ cm} \quad i = 12A = i_d$

a) $r_1 = \dfrac{R}{3}$ inside. $\quad \dfrac{i_{d,encl}}{A_{encl}} = \dfrac{i_d}{A}$

$$i_{d,encl} = i_d \frac{A_{encl}}{A} = i_d \frac{\pi (R/3)^2}{\pi R^2} = \frac{i_d}{9} = \frac{12}{9} = \underline{\underline{1.33A}}$$

b)



There are two values for r at which B = 3 mT
r_1 inside and r_2 outside

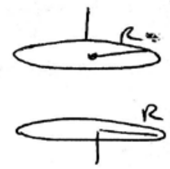
$B_{max} = \dfrac{\mu_0 i_d}{2\pi R}$

$B_{in} = \dfrac{\mu_0 i_d\, r_1}{2\pi R^2} \qquad \dfrac{B_{max}}{B_{in}} = \dfrac{R}{r_1} = \dfrac{12}{3} \Rightarrow r_1 = \dfrac{3R}{12} = \dfrac{R}{4} = \underline{\underline{0.3\text{ cm}}}$

$$B_{out} = \frac{\mu_0 i_d}{2\pi r_2} \qquad \frac{B_{max}}{B_{out}} = \frac{r_2}{R} = \frac{12}{3} \Rightarrow r_2 = 4R = \underline{\underline{4.8\text{ cm}}}$$

32.26

$R = 3$ cm $\qquad i_d = 0.5$ A



$r_1 = 2$ cm (inside)

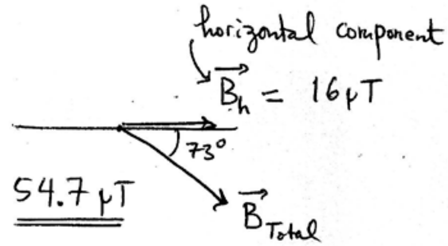
$$B_{in} = \frac{\mu_0 i_d r_1}{2\pi R^2} = \frac{4\pi\times10^{-7}\times 0.5\times 0.02}{2\pi\times 0.03} = ---$$

$r_2 = 5$ cm (outside)

$$B_{out} = \frac{\mu_0 i_d}{2\pi r_2} = \frac{4\pi\times10^{-7}\times 0.5}{2\pi\times 0.05} = ---$$

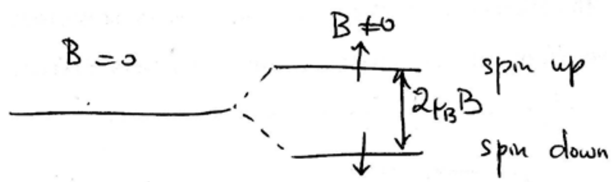
32.31

From the figure $\cos 73^\circ = \frac{B_h}{B_{Total}}$



$$B_{Total} = \frac{B_h}{\cos 73^\circ} = \frac{16\,\mu T}{\cos 73^\circ} = \underline{\underline{54.7\,\mu T}}$$

32.34

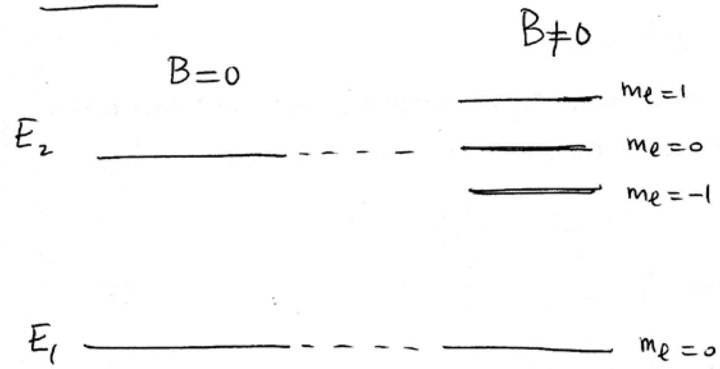


$$\Delta U = 2\mu_B B = 6\times10^{-25} \Rightarrow B = \frac{6\times10^{-25}}{2\mu_B}$$

μ_B: Bohr magneton $= 9.3\times10^{-24}$ J/T

$$B = \frac{6\times10^{-25}}{2\times 9.3\times10^{-24}} = \underline{\underline{0.032\text{ T}}}$$

32.36



We neglect $\vec{\mu}_s$ in this problem to make things easy!

a) $E_1 \quad m_\ell = 0$

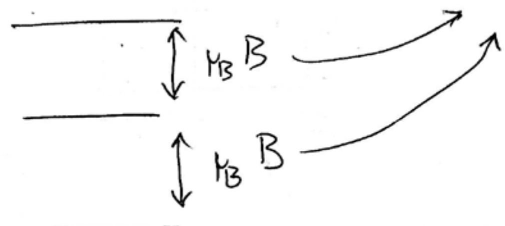
b) $E_2 \quad m_\ell = -1, 0, 1$

remember $U_{orb} = - \vec{\mu}_{orb} \cdot \vec{B} = - \mu_{orb\,z} B$

very important $\Longrightarrow U_{orb} = - m_\ell \mu_B B$

c) spacing is $\Delta U = \mu_B B = 9.3 \times 10^{-24} \times 0.5$

$= 4.65 \times 10^{-24}\,J$



32.39

$\mu = M\,\text{Volume} = M A \ell$ (M: magnetization)

$\Rightarrow \mu = 5.3 \times 10^{3} \times \pi \left(\frac{0.01}{2}\right)^2 \times 0.05 = 2.08 \times 10^{-2}\ J/T$

32.46

a) $\mu_{Total} = N \mu = \frac{m N_A}{M} \mu = \rho \frac{V N_A}{M} \mu = 8.9\ A \cdot m^2$ or J/T

b) $\vec{\tau} = \vec{\mu} \times \vec{B} \qquad |\tau| = \mu B \sin 90^\circ = 8.9 \times 1.5 = 13\ N \cdot m$