Last Name: ~~Qianmeng~~ Chen First Name: Qianmeng
UID: 904629728

Homework Quiz #1 Version D

1. A circular loop with area, *A*, lies in the *xy*-plane. As viewed along the *z*-axis looking in the −*z* direction toward the origin, a current *I* is circulating counter-clockwise around the loop. The torque produced by an external magnetic field, $\vec{B}$, is given by $\vec{\tau} = D(2\hat{i} - 2\hat{j})$ where *D* is a positive constant. For this orientation of the loop, the value of its magnetic potential energy, $-\vec{\mu}\bullet\vec{B}$, is negative. The magnitude of the magnetic field is $B_0 = 3D/IA$.

a)[25 pts] What is the magnetic moment of the current loop? (Hint: the answer is a vector.)

$\vec{\mu} = I\vec{A}$

$\vec{\tau} = \langle 2D, -2D, 0\rangle$ $\vec{\mu} = \langle 0, 0, IA\rangle$

let $\vec{B} = \langle x, y, z\rangle$

$\langle 0\ 0\ IA\rangle$

$\langle x\ y\ z\rangle$

$\langle -yIA, xIA, 0\rangle = \langle 2D, -2D, 0\rangle$ $\therefore$

$2D = -yIA$ $\quad y = -\frac{2D}{IA}$

$x = -\frac{2D}{IA}$

b-d) [75 pts] Find the components of the magnetic field: B_x, B_y, B_z. (You can use the reverse side for more space.)

$\therefore B = \langle \frac{-2D}{IA}, \frac{-2D}{IA}, z\rangle$

$\therefore z = \frac{\sqrt{3^2-2^2-x^2}\,D}{IA}$

$z = \frac{\pm D}{IA}$

$\therefore B = \langle \frac{-2D}{IA}, \frac{-2D}{IA}, \frac{D}{IA}\rangle$

sorry I thought the (a) part was asking for the magnetic field, restate my answers below:

(a): $\vec{\mu} = I\vec{A} = \boxed{\langle 0, 0, IA\rangle}$ ✓

(b): $B_x = \frac{-2D}{IA}$ $B_y = \frac{-2D}{IA}$ $B_z = \frac{D}{IA}$ ✓

(B_z is positive since $-\vec{\mu}\cdot\vec{B} < 0 \Rightarrow -IA\cdot\frac{D}{IA} = -D < 0$)

100