

Lecture 13.

Assignment #6.

Ref. 15-1, 15-2.

Due. Friday June 12, 2009
10:20 am.

examples of the Biot-Savart law.

#5.1, 5.4, 5.14, 5.17.

e.g. 5-2, 5-3. (you read).

e.g. 5-4. Magnetic field of a circular loop.

radius a , centred at $(0, 0, 0)$.
current I , on x - y plane.

Find $\vec{H}$ at $P(0, 0, z)$

$$\vec{dl} \perp \vec{R}$$

$$d\vec{H} = \frac{I}{4\pi} \frac{\vec{dl} \times \hat{R}}{R^2}$$

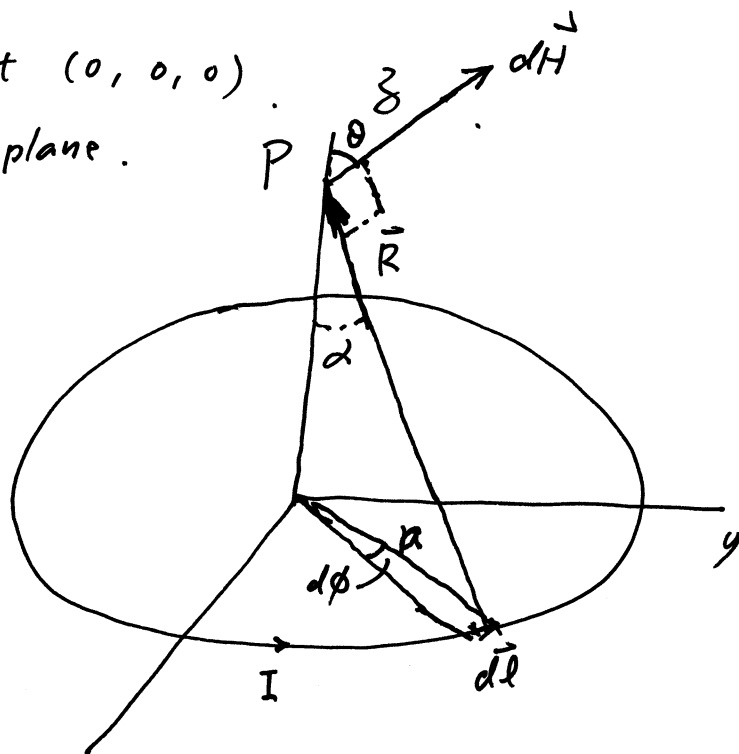
$$dH = \frac{I dl}{4\pi R^2} = \frac{I a d\phi}{4\pi R^2}$$

by symmetry, $\vec{H} = \hat{z} H$

(No special direction in x - y plane. $\Rightarrow \vec{H}$ can't have ~~any~~ a component in any direction in the x - y plane.)

$$\begin{aligned} \vec{H} &= \hat{z} dH_z = \hat{z} \int_0^{2\pi} \frac{I a \cos\theta \cdot d\phi}{4\pi R^2} \\ &= \hat{z} \frac{I a \cos\theta}{2 R^2} = \hat{z} \frac{I a^2}{2 (a^2 + z^2)^{3/2}} \end{aligned}$$

$$\left(\begin{aligned} \cos\theta &= \cos(90^\circ - \alpha) \\ &= \sin\alpha = \frac{a}{R} \\ R &= \sqrt{a^2 + z^2} \end{aligned} \right)$$



- At the centre of the loop. ($|\vec{r}| = 0$):

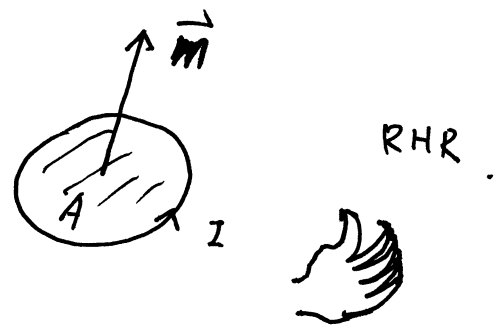
$$\vec{H} = \hat{\vec{z}} \frac{I}{2a}$$

- Very far away : ($|\vec{r}| \gg a$):

$$\vec{H} = \hat{\vec{z}} \frac{Ia^2}{2|\vec{r}|^3}$$

• magnetic dipole : $\vec{m}$

small current loop



magnitude : $m = AI$

direction : $\hat{\vec{A}}$ (RHR)

- compared to electric dipole $\vec{p}$:

