phys 221

Lecture 13.

Assignment #6.

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

Ref. 15-1, 15-2.

#5.1, 5.4, 5.14, 5.17.

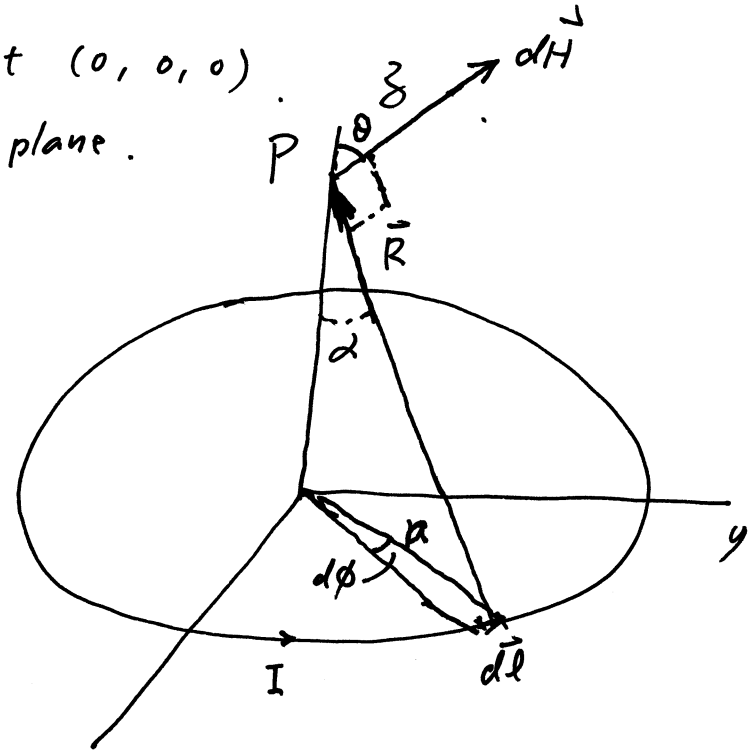
examples of the Biot-Savart law.

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 a component in any direction in the x-y plane.

(it's a circle!)

$$\therefore \vec{H} = \hat{z}\, dH_z = \hat{z} \int_0^{2\pi} \frac{I\,a\cos\theta \cdot d\phi}{4\pi R^2}$$

$$= \hat{z}\, \frac{I\,a\cos\theta}{2R^2} = \hat{z}\, \frac{I a^2}{2(a^2+z^2)^{3/2}}$$

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

- At the centre of the loop. ($\beta = 0$):

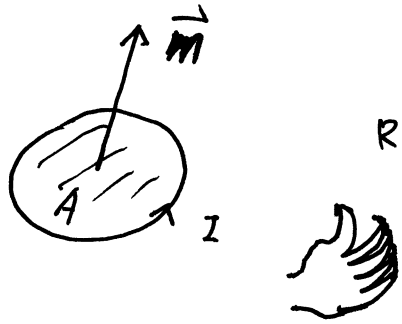
$$\vec{H} = \hat{\beta}\,\frac{I}{2a}$$

- Very far away: ($|\beta| \gg a$):

$$\vec{H} = \hat{\beta}\,\frac{Ia^2}{2|\beta|^3}$$

- magnetic dipole: $\vec{m}$

small current loop



magnitude: $m = AI$.

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

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