Physics 114 – March 2, 2010

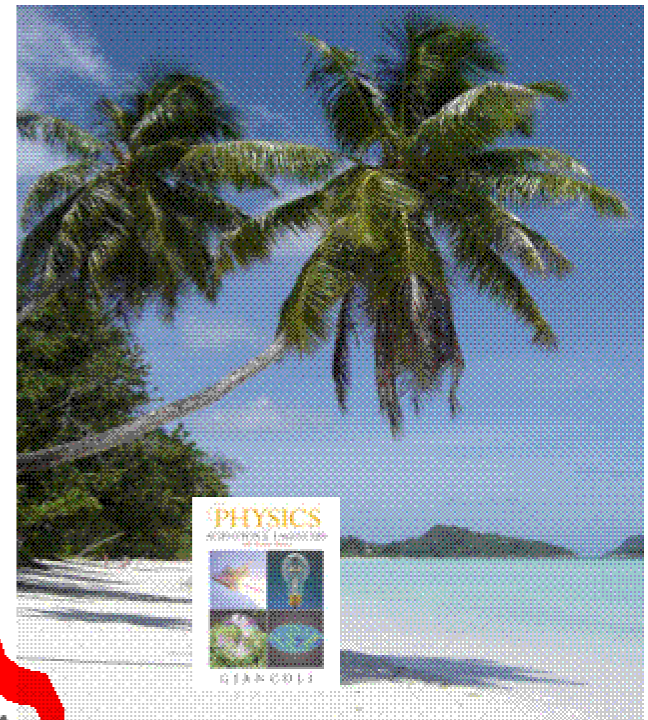
Spring Break Next week

EXAM 2 *NOT* the following week

But the week after

Tuesday, March 23

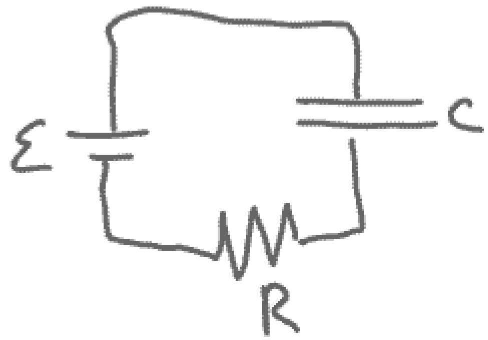
Hoyt 8–9:20 AM

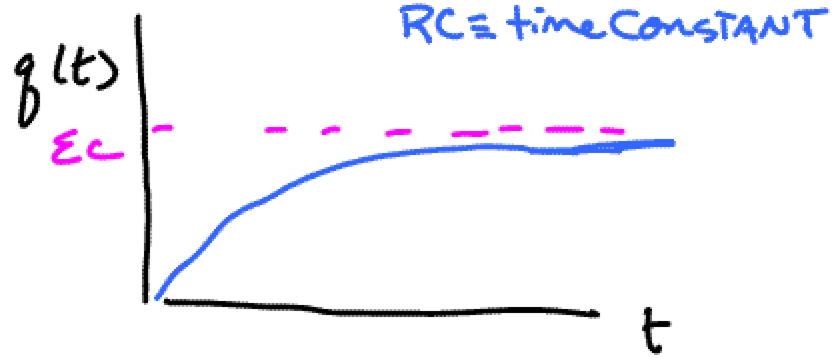


Last Time — RC Circuits

Charging

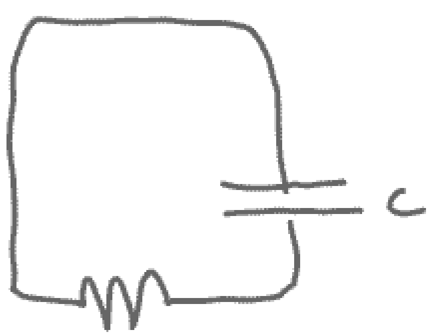
$$q(t) = \mathcal{E}C\left(1 - e^{-t/RC}\right)$$

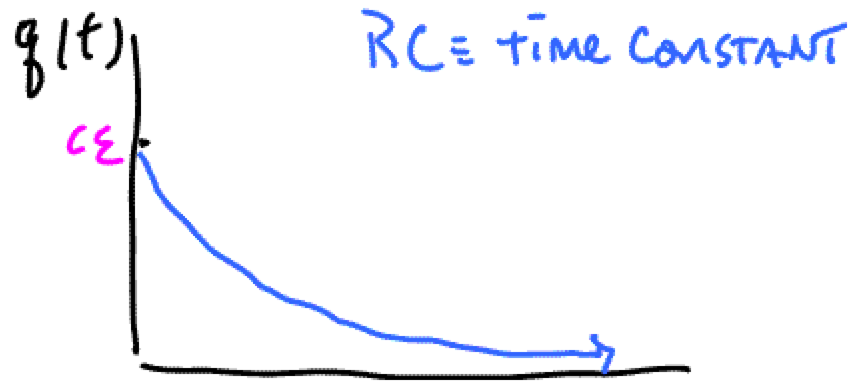




Discharging

$$q(t) = q_0 e^{-t/RC}$$





Magnetism

Let there be a magnetic field $\vec{B}$

units → Tesla (MKS)

gauss   1 Tesla = 10000 Gauss

$|\vec{B}_{earth}| \cong 0.5$ gauss

$|\vec{B}_{\text{typical bar magnet}}| \cong 100$ gauss

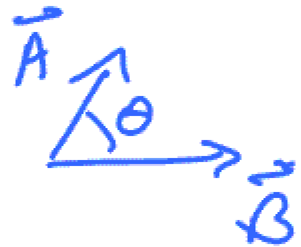
$|\vec{B}_{electromagnet}| \approx 2$ Tesla

$|\vec{B}_{\text{very strong lab magnet}}| \approx 10$ Tesla

$|\vec{B}_{\text{high fields for study}}| \approx 100$ Tesla

Lorentz Force law

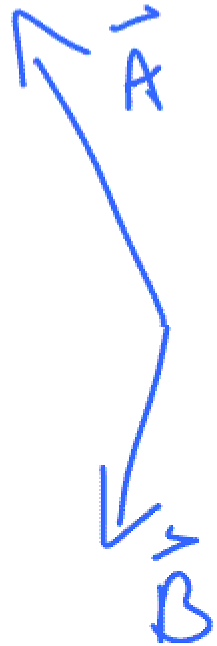
$$\vec{F} = q\vec{E} + q\vec{V}\times\vec{B}$$

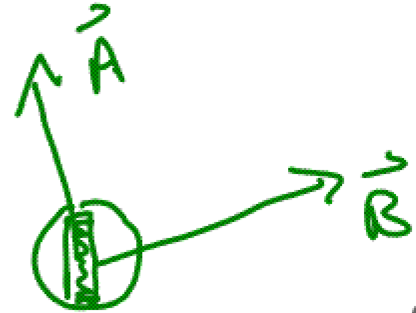


$$|\vec{A}\times\vec{B}| = |\vec{A}||\vec{B}|\sin\theta$$

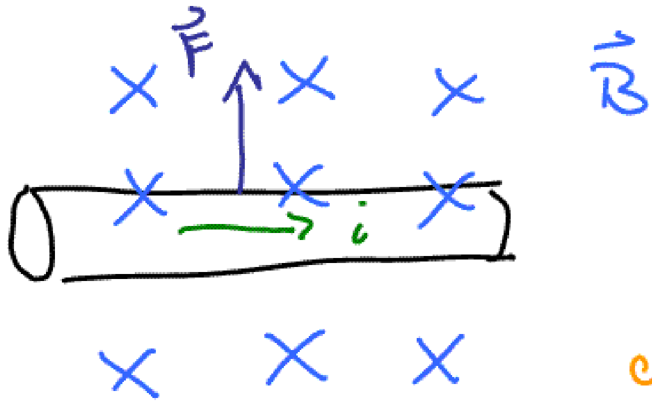
$$\vec{A}\times\vec{B} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ A_x & A_y & A_z \\ B_x & B_y & B_z \end{vmatrix}$$

$$= \hat{i}(A_y B_z - A_z B_y) - \hat{j}(A_x B_z - A_z B_x) + \hat{k}(A_x B_y - A_y B_x)$$





Imagine turning a screw head.
Screw bores into board in direction of
$\vec{A} \times \vec{B}$



charges/vol

$$\vec{F}_{wire} = (q\vec{V}_d \times \vec{B})\, n A L$$

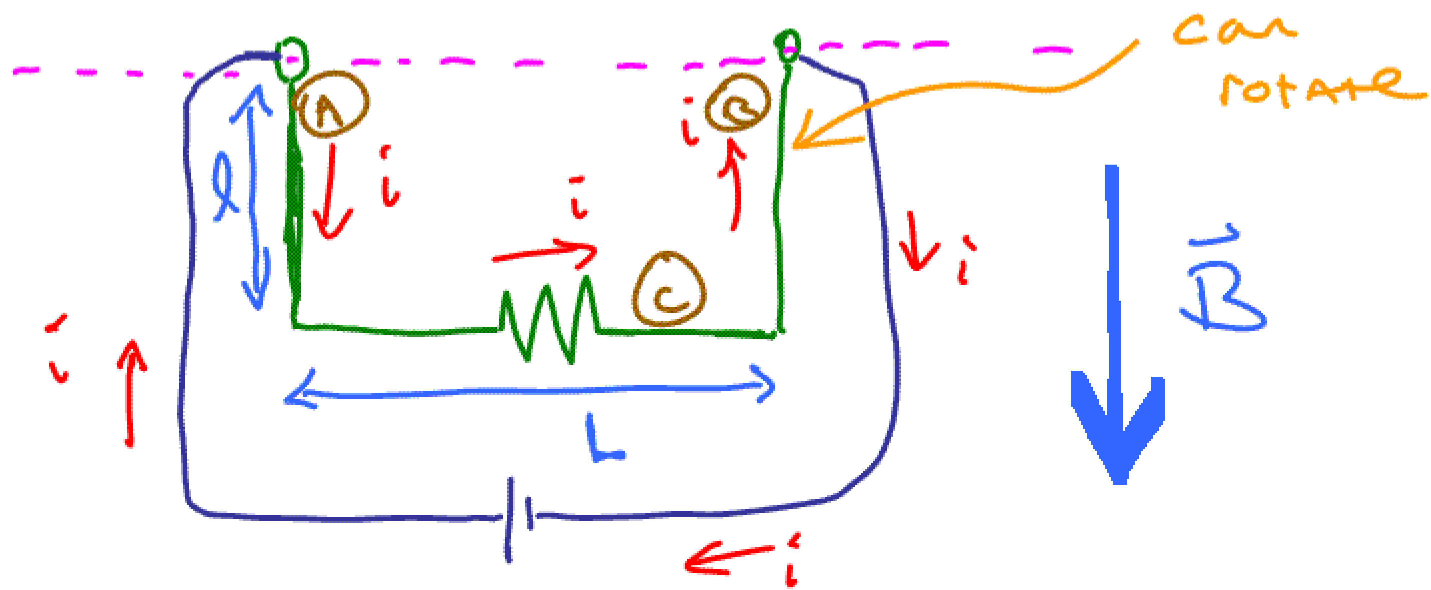
drift velocity

Volume

$$i = n q V_d A$$

$$\vec{F} = i \vec{L} \times \vec{B}$$

$$\vec{F} = L \vec{i} \times \vec{B}$$



what is the torque on hanging loop

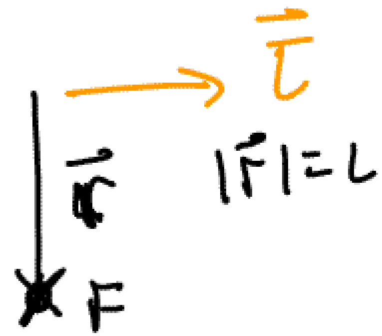
$$\vec{\tau} = \vec{r} \times \vec{F}$$

$$\vec{F}_{\text{wire } (A) + (B)} = l \underbrace{\vec{i} \times \vec{B}}_{0} = 0$$

$$\vec{F}_{\text{wire } (C)} = L \vec{i} \times \vec{B}$$

into Board

$\vec{\tau}$



$$\vec{\tau} = \vec{r} \times \vec{F}$$

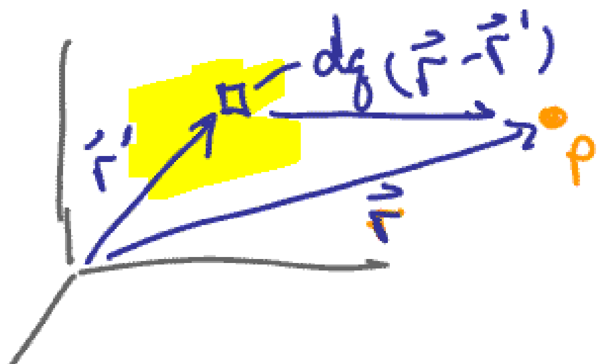
$$|\vec{\tau}| = l L i B$$

Electrostatics

Coulomb's law

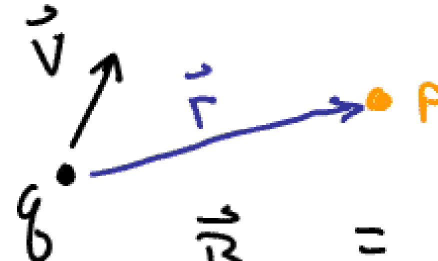
$$\vec{E} = \frac{kq}{r^2}\hat{r}$$

$$\vec{F} = q'\vec{E}$$



Magnetostatics

Law of Biot-Savart

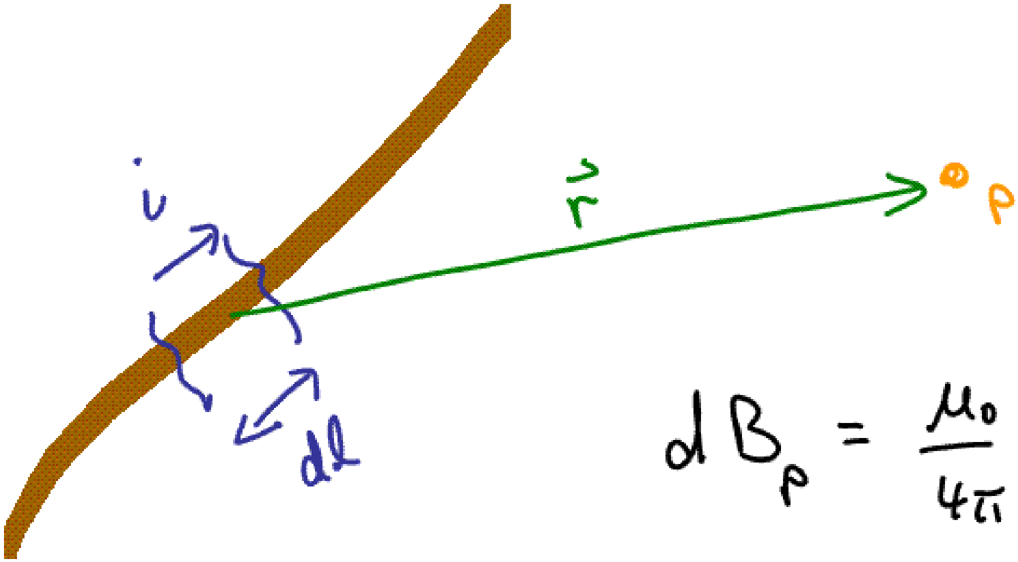


$$\vec{B}_{\text{at } P \text{ due to } q} = \frac{\mu_0}{4\pi}\,\frac{q\,\vec{v}\times\hat{r}}{r^2}$$

μ_0 = permeability of free space

$$= 4\pi \times 10^{-7}\ \frac{T \cdot M}{A}$$

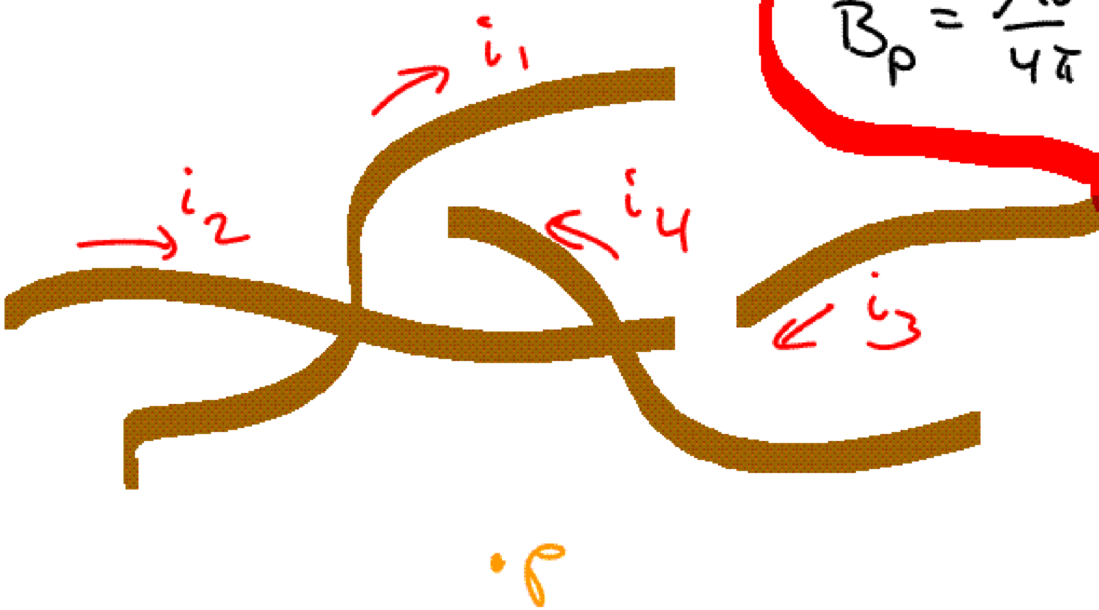
$$dE_P = \frac{k\,dq}{(\vec{r}-\vec{r}\,')^2}\,\widehat{(\vec{r}-\vec{r}\,')}$$

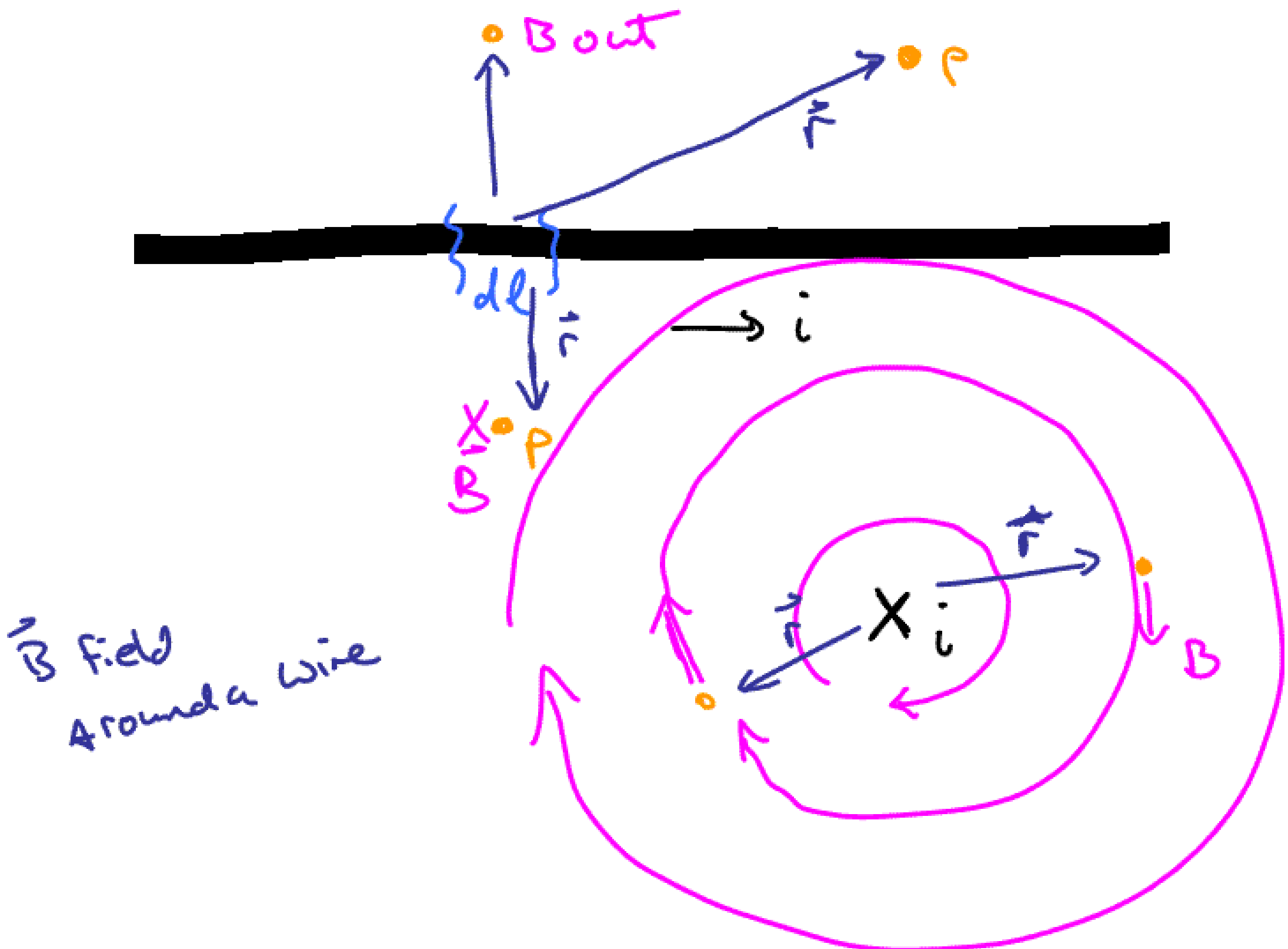


$$dB_P = \frac{\mu_0}{4\pi}\,\frac{i\,d\vec{l}\times\hat{r}}{r^2}$$

$$\vec{B}_P = \frac{\mu_0}{4\pi}\int\frac{i\,d\vec{l}\times\hat{r}}{r^2}$$

Distribution of currents

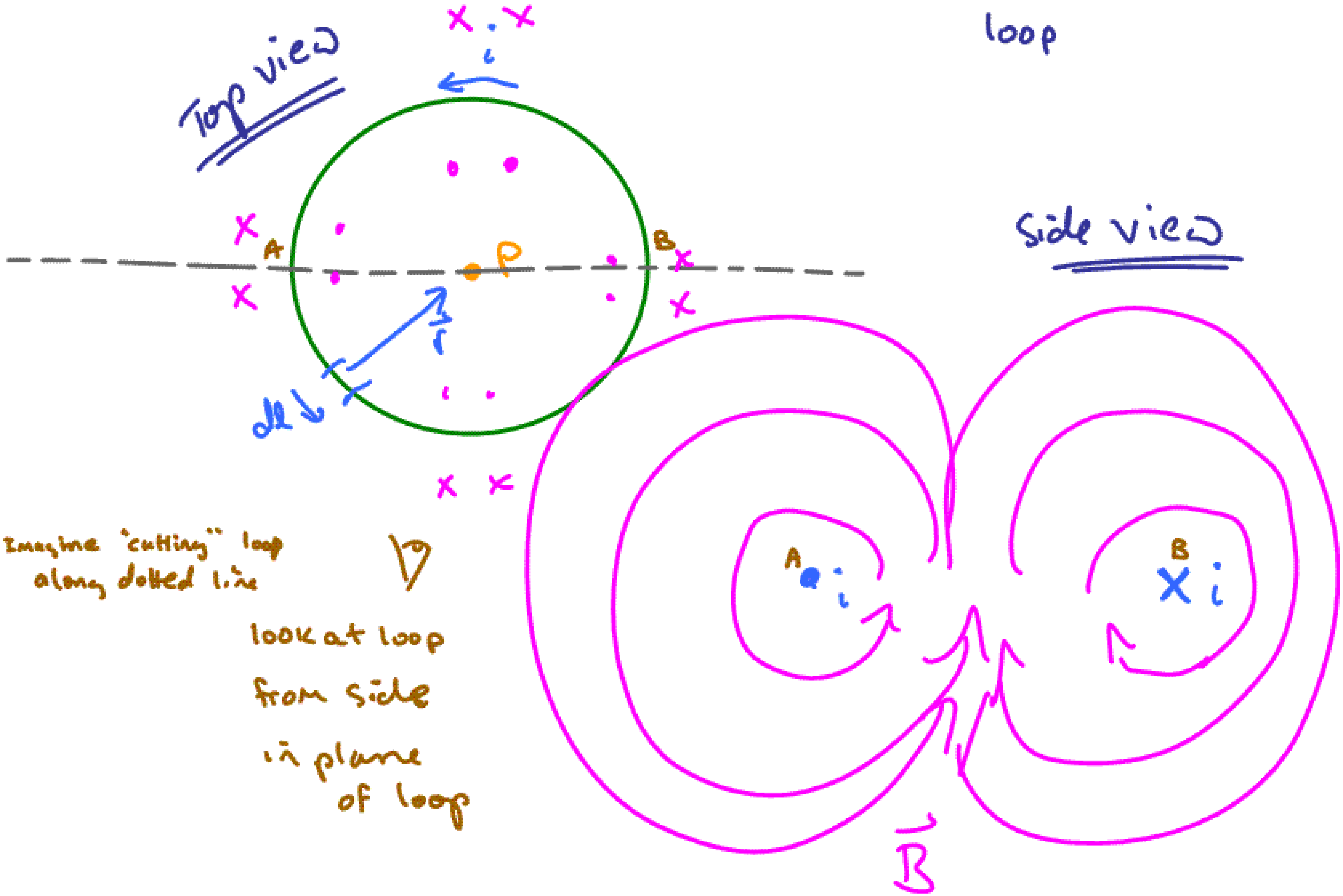




A new right-hand rule of thumb (useful):

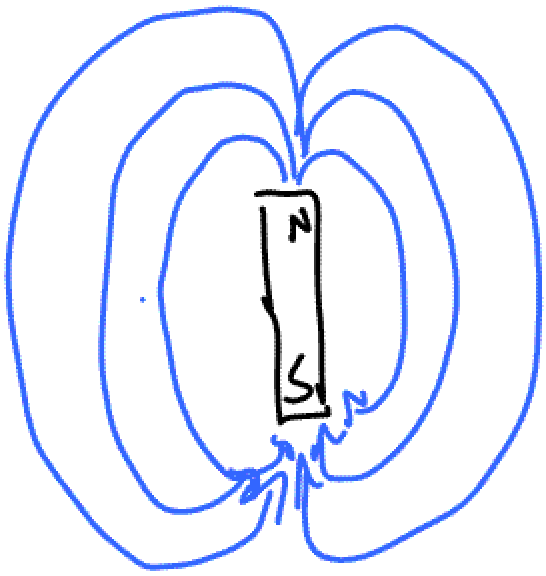
grasp wire w/ right hand with thumb going in direction of the current. Then fingers are wrapping around wire in the direction of $\vec{B}$

$\vec{B}$ field of a current loop



Another right-hand rule of thumb that is useful:

Curl fingers around closed loop in direction of the current and thumb points in direction of $\vec{B}$ in middle of loop.



Bar Magnet

$\vec{B}$ field of current loop is very similar to $\vec{B}$ field of Bar magnet.