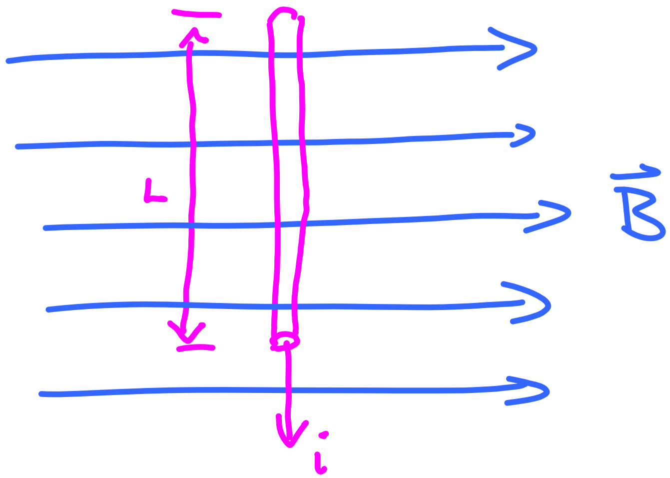
Physics 142 - October 21, 2010

Presentation preference sheets
to me today

... or you will be assigned by me
to smallest group at the end

Last Time



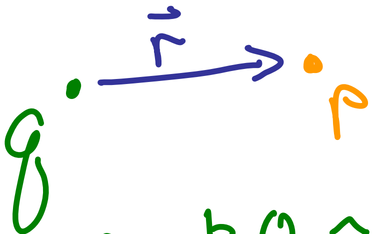
$$\vec{F}_{wire} = L\,\vec{i} \times \vec{B}$$

or

$$\vec{F}_{wire} = i\,\vec{L} \times \vec{B}$$

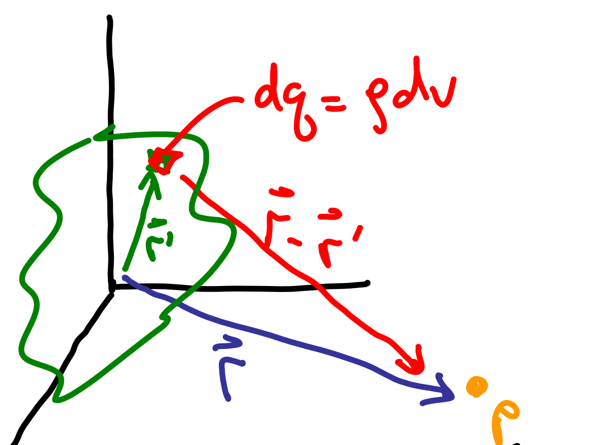
Electrostatics

Coulomb's law



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

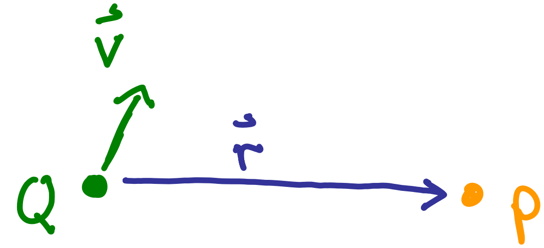
$$\vec{F} = q\vec{E}$$



$$d\vec{E}_P = \frac{k\,dq}{|r-r'|^2}\,\widehat{(\vec{r}-\vec{r}')}$$

Magnetostatics

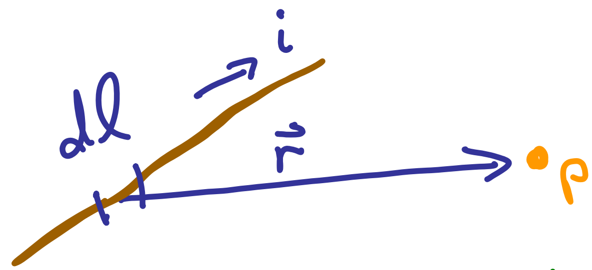
Law of Biot-Savart



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

$\mu_0 \equiv$ Const $\equiv$ permeability of Free Space

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



differential form of Biot Savart

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

↑ due to differential length dl of current i

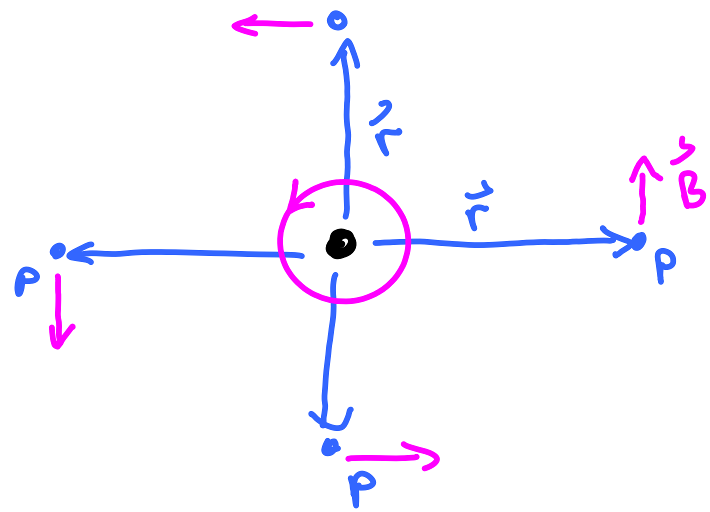
integrate over current distribution to get $\vec{B}_P$

Biot-Savart

determines $\vec{B}$ at point P due to current distribution

$$\vec{B}_P = \frac{\mu_0}{4\pi} \int_{\text{current distr.}} \frac{i\, d\vec{l} \times \hat{r}}{r^2}$$


RHR
i


r⃗
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B⃗
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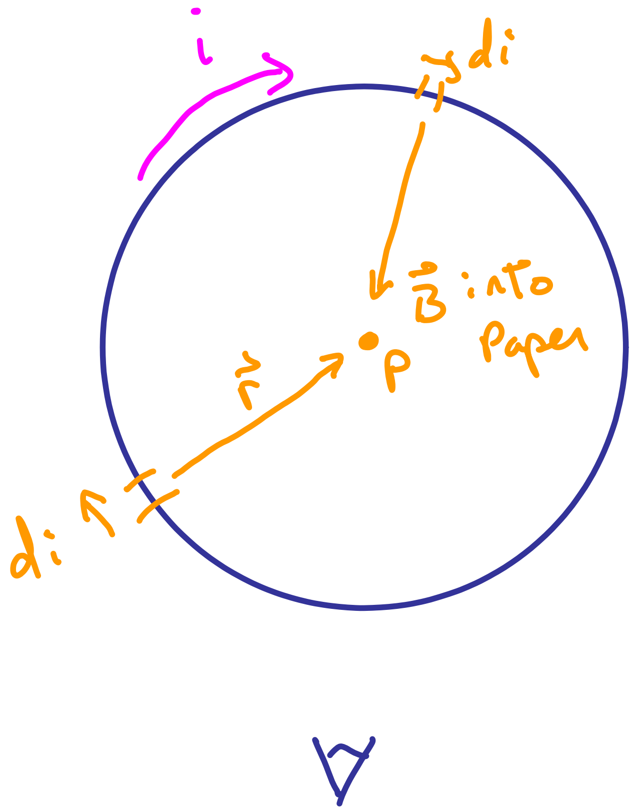
P


i
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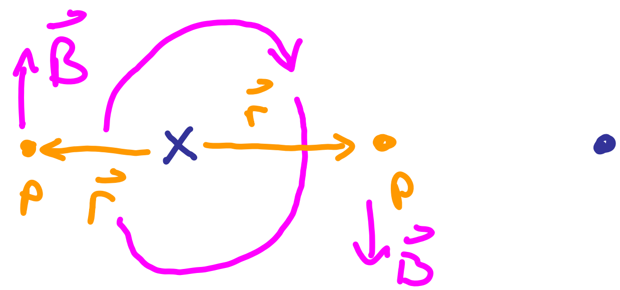
B⃗
r⃗
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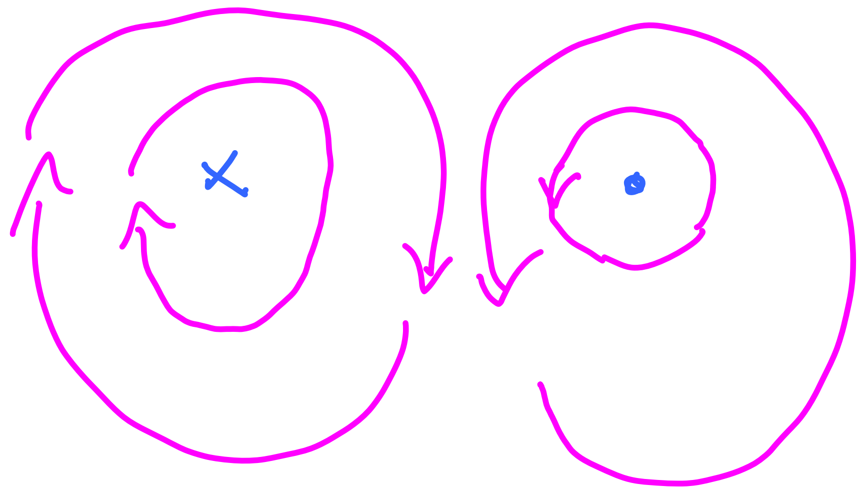
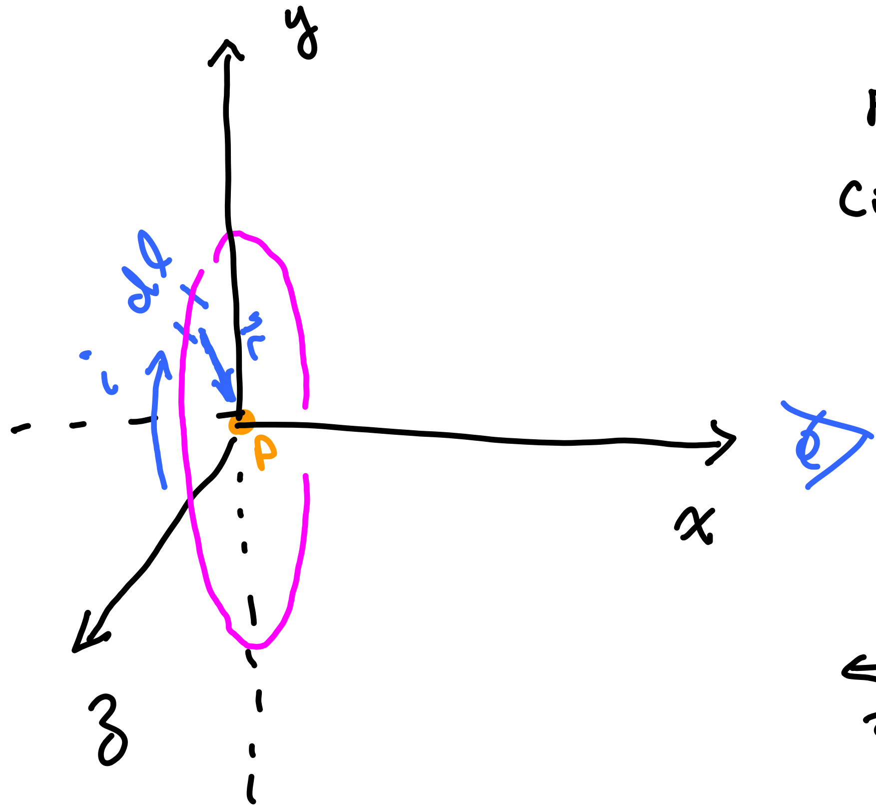
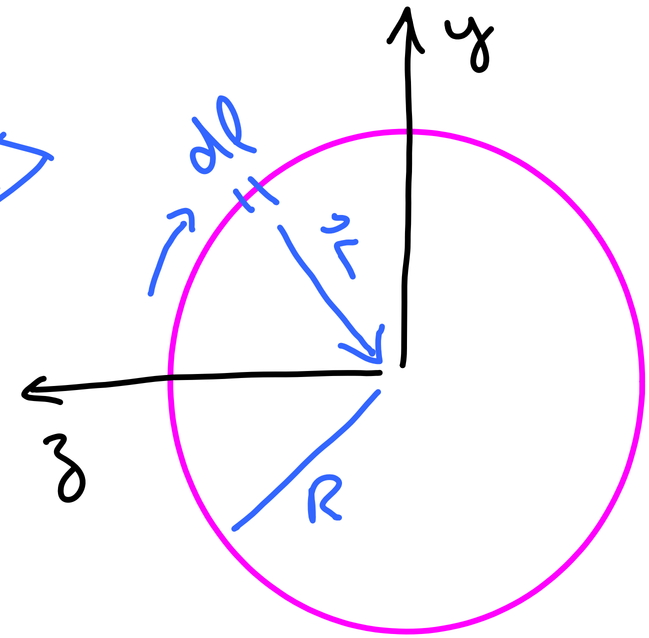
P
P
B⃗



Find $\vec{B}$ at origin

Circle has radius R





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

$i\,d\vec{l}\times\hat{r} \rightarrow B$ in $-\hat{x}$

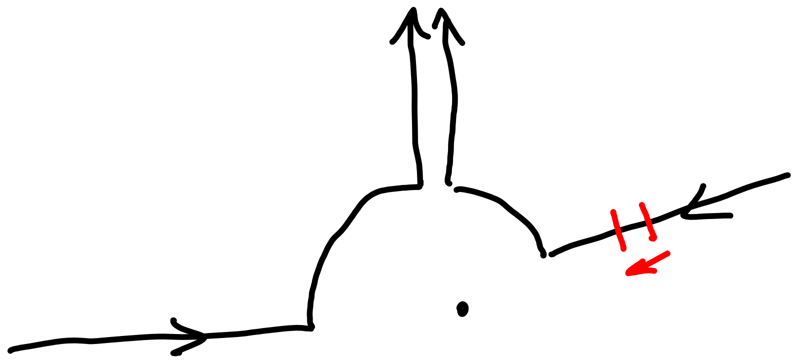
↳ $i\,dl \rightarrow i\,ds$

arc length

$$d\vec{B} = \frac{\mu_0}{4\pi}\frac{i\,dl}{R^2}(-\hat{x})$$

$$\vec{B} = \frac{\mu_0}{4\pi}\frac{i}{R^2}(-\hat{x})\int_0^{2\pi R} ds$$

$$\vec{B}_{origin} = \frac{\mu_0 i (-\hat{x}) 2\pi R}{4\pi R^2} = \frac{\mu_0 i}{2R} \cdot -\hat{x}$$



Electrostatics

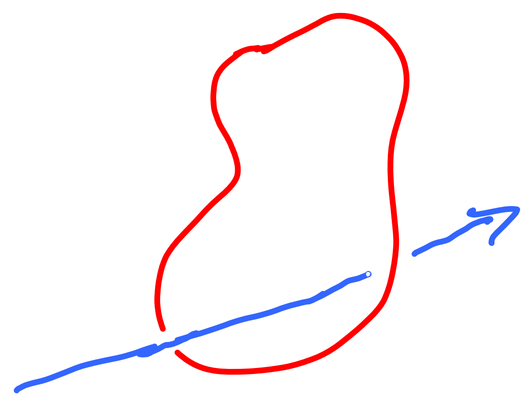
Gauss' law

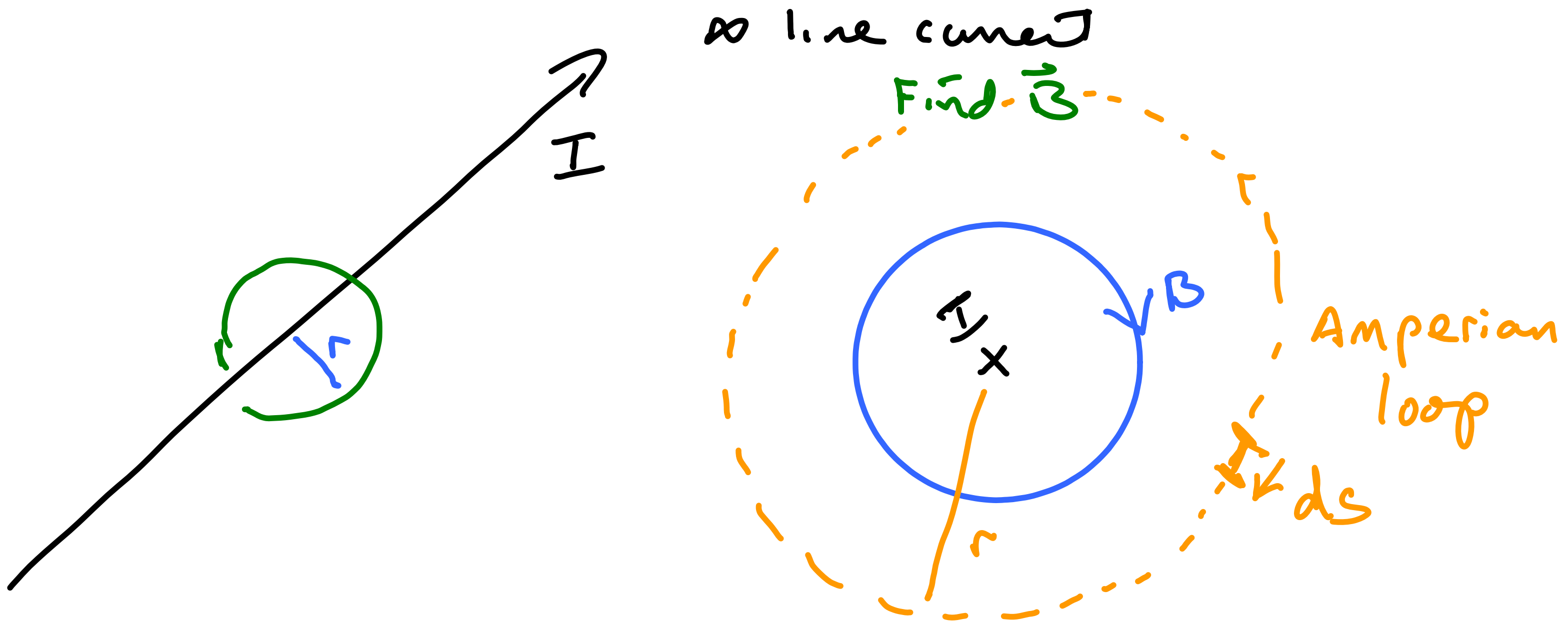
$$\oint \vec{E} \cdot d\vec{A} = \frac{Q_{encl}}{\epsilon_0}$$

Magnetostatics

Ampere's law

$$\int_{\text{closed curve}} \vec{B} \cdot d\vec{s} = \mu_0 I_{enclosed}$$



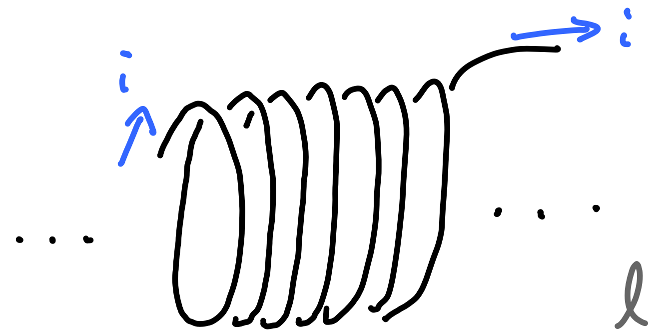


$$\oint_{loop} \vec{B}\cdot d\vec{s} = \mu_0 I_{encl}$$

$$|\vec{B}|\int_0^{2\pi r} ds = \mu_0 I_{encl}$$

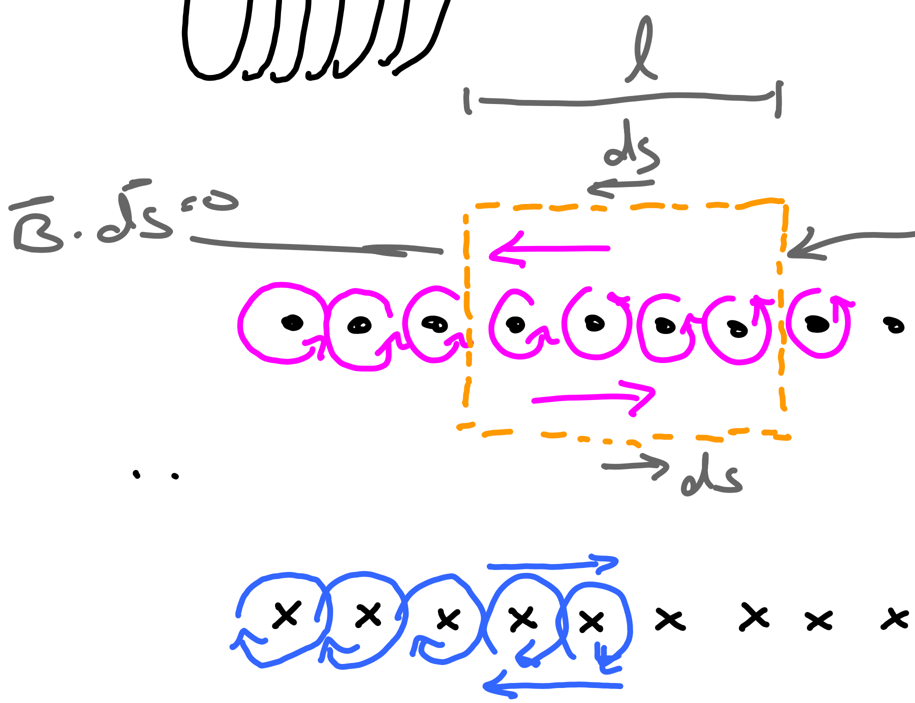
$$|\vec{B}(r)| = \frac{\mu_0 I}{2\pi r}$$

Solenoid



Field of ∞ solenoid

n loops/unit length



$\Rightarrow \int \vec{B}\cdot d\vec{s} = \mu_0 I_{encl}$

$2B\ell = \mu_0 n \ell i$

$B = \dfrac{\mu_0 n}{2} i$

outside solenoid $\vec{B} = 0$

inside solenoid $|B| = 2\dfrac{\mu_0 n}{2} = \mu_0 n i$