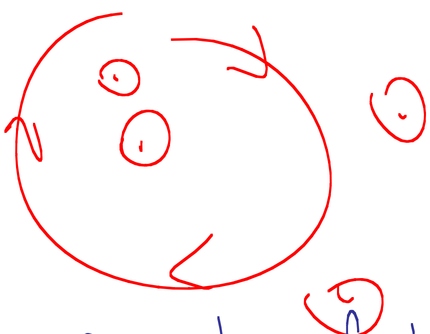
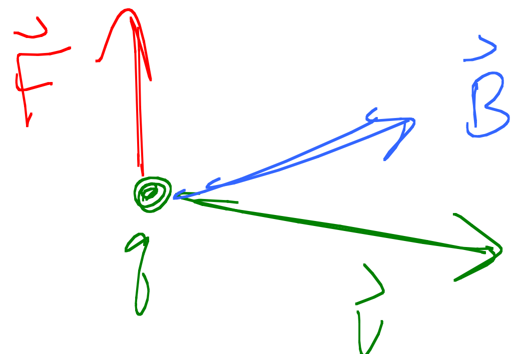
Phys 2120-4 10/8/12

Note Title 10/8/2012

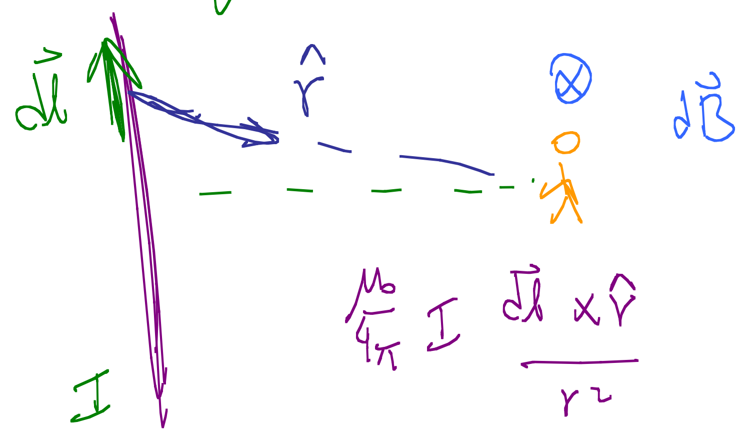
Magnetic fields



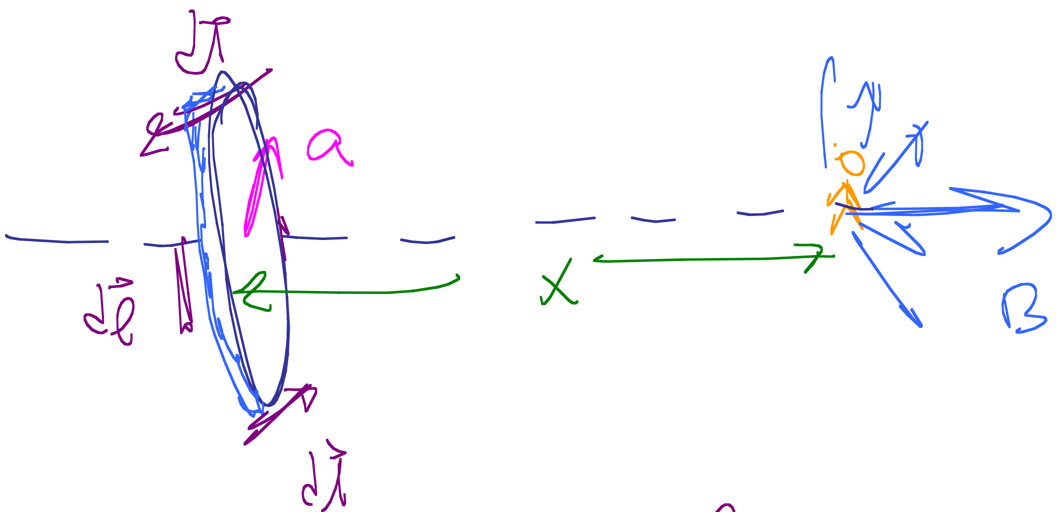


$(q\vec{v}\times\vec{B})$

How is magnetic field produced



$$\frac{\mu_0}{4\pi} I \frac{\vec{dl}\times\hat{r}}{r^2}$$



$$B = \frac{\mu_0 I a^2}{2(x^2+a^2)^{3/2}}$$

Middle of ring $x = 0$

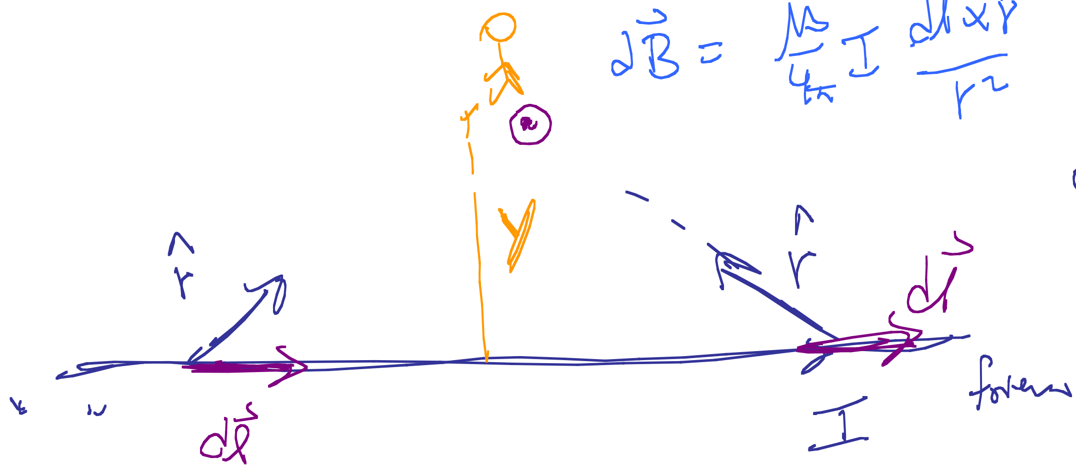
$$B_{\text{middle}} = \frac{\mu_0 I}{2a}$$

$x \gg a$

$$B = \frac{\mu_0 I a^2 \pi}{2\pi x^3}$$

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

$\odot$ out $\quad \otimes$ in



out of page

Integrate along the wire

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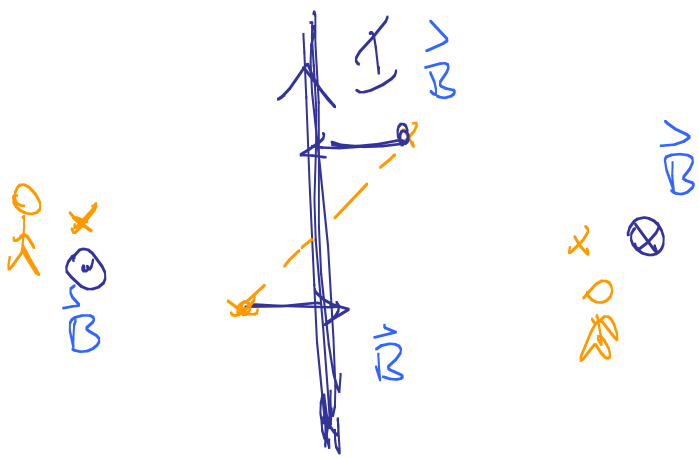
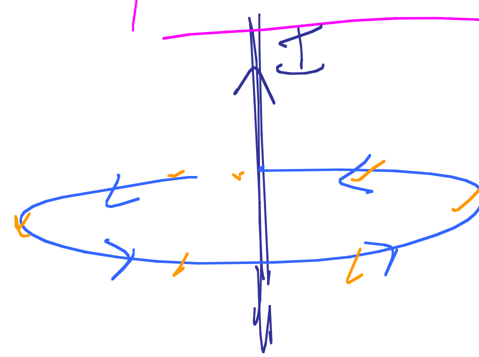
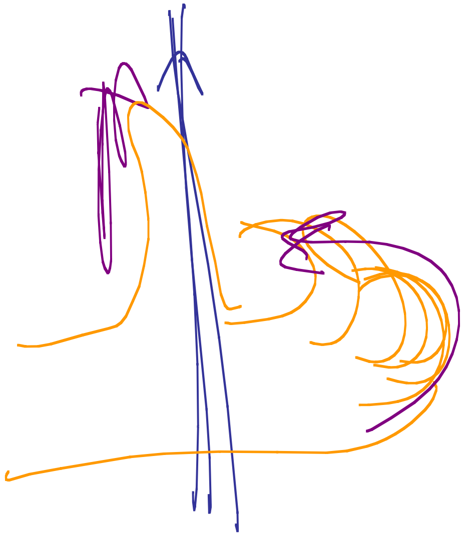
$$\boxed{B = \frac{\mu_0 I}{2\pi y}}$$

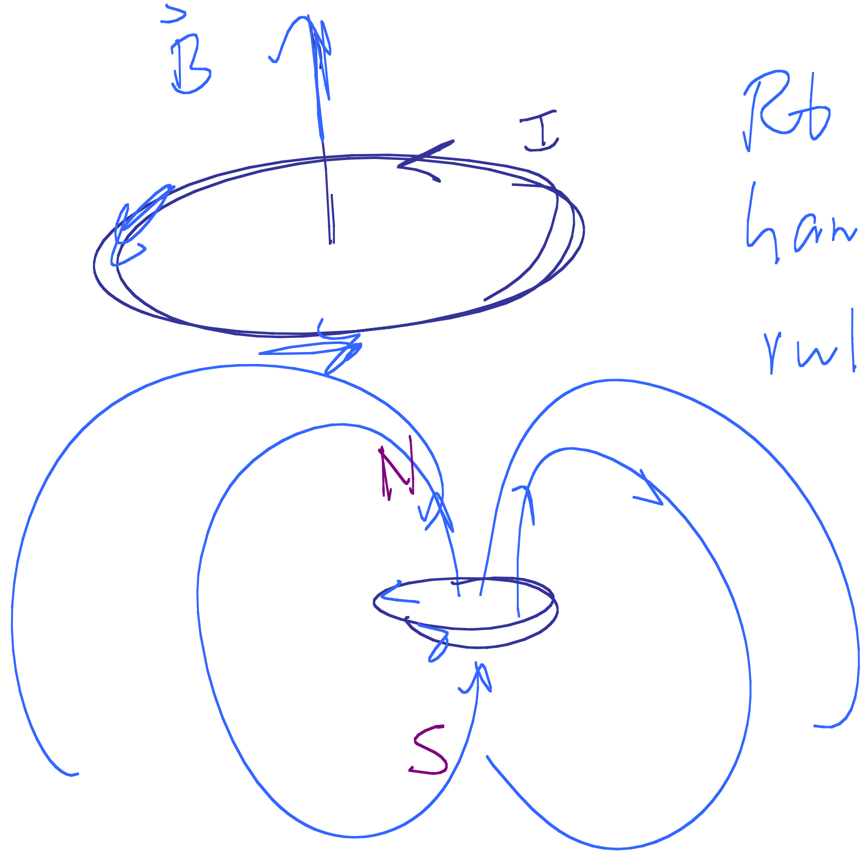




Magnetic field lines.

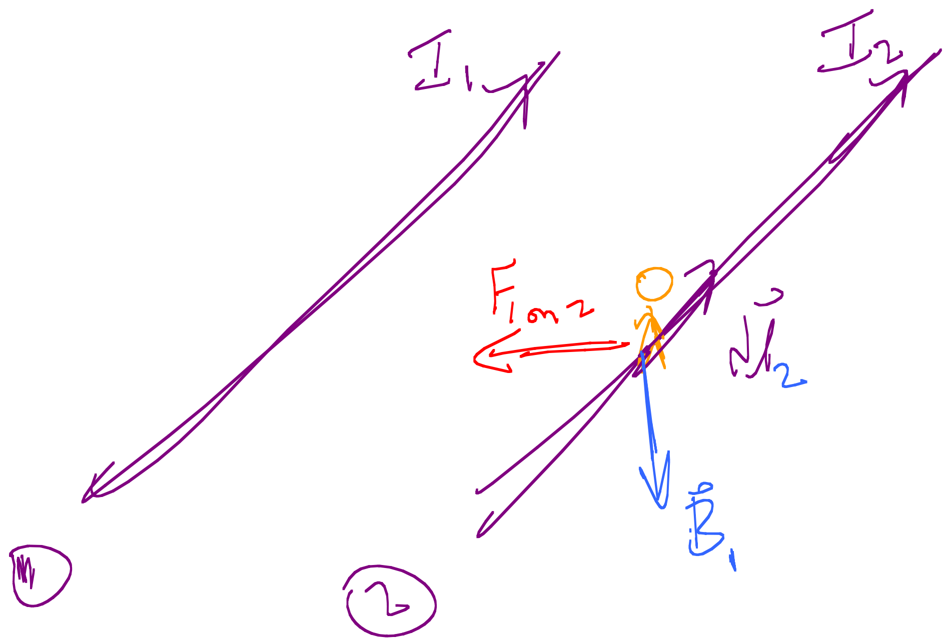


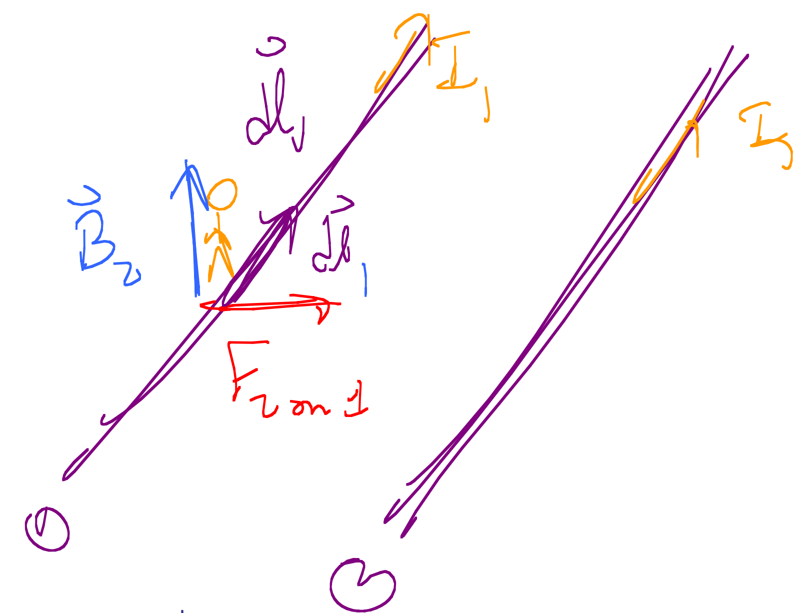
Dir of $\vec{B}$ field



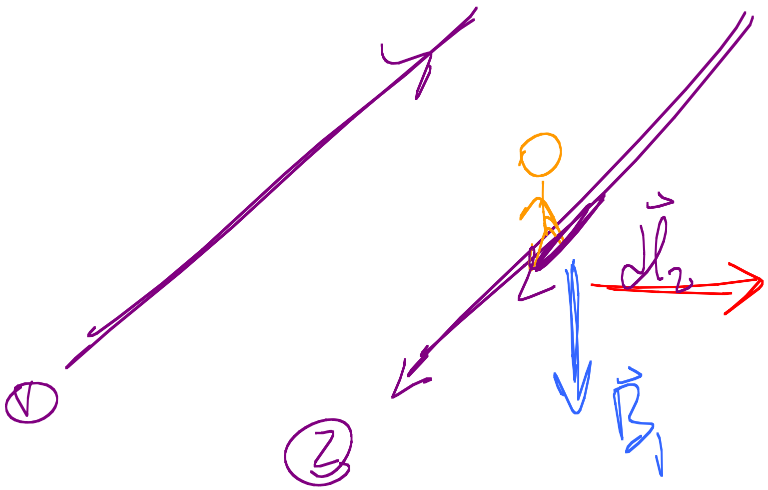
Rt hand rule.

Parallel Wires





Currents in same dir, attract.

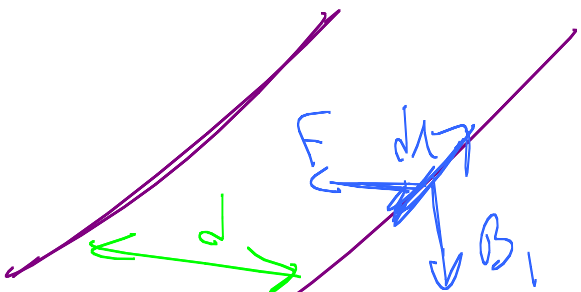


Currents opp dir's repel.

Calculate forces between (perp)

Force of 1 on 2

$$F_{1\to 2} = I_2 l_2 B_1 = \frac{\mu_0 I_1 I_2 l}{2\pi d}$$



$$B_1 = \frac{\mu_0 I_1}{2\pi d}$$

$$\frac{F}{l} = \frac{\mu_0 I_1 I_2}{2\pi d}$$

26.29 Wire carries 15 A You form it into single-turn circular loop w/ magnetic field 80 μT at center. What's the loop's radius?

$$B_{center} = \frac{\mu_0 I}{2r} \qquad r = \frac{\mu_0 I}{2B} = \frac{(4\pi \times 10^{-7})(15)}{2(80 \times 10^{-6})}$$

$$= 0.118 = 12 \text{ cm}$$

26.32 whats the current in a long wire if the magnetic field 1.2 cm from the wire's axis is 67 μT.

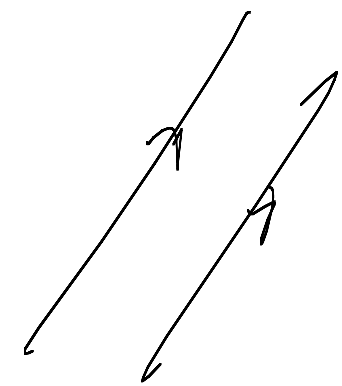
$$B = \frac{\mu_0 I}{2\pi r} \qquad I = \frac{2\pi r B}{\mu_0} = \frac{2\pi (0.012\,m)(6.7 \times 10^{-6})}{4\pi \times 10^{-7}}$$

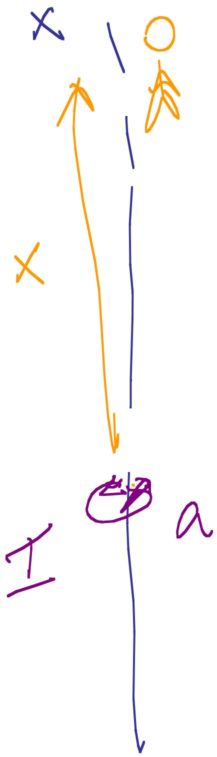
$$= 4.0\,A$$

26.33 Parallel wires about 1 cm apart. carry currents of about 15 A. What's force per unit length between wires

$$\frac{F}{l} = \frac{\mu_0 I_1 I_2}{2\pi d} = \frac{4\pi\times10^{-7}\,(15)^2}{2\pi\,(0.010)}$$

$$= 4.5\times10^{-2}\ \mathrm{N/m}$$





Special case: Small Current loop.

On axis

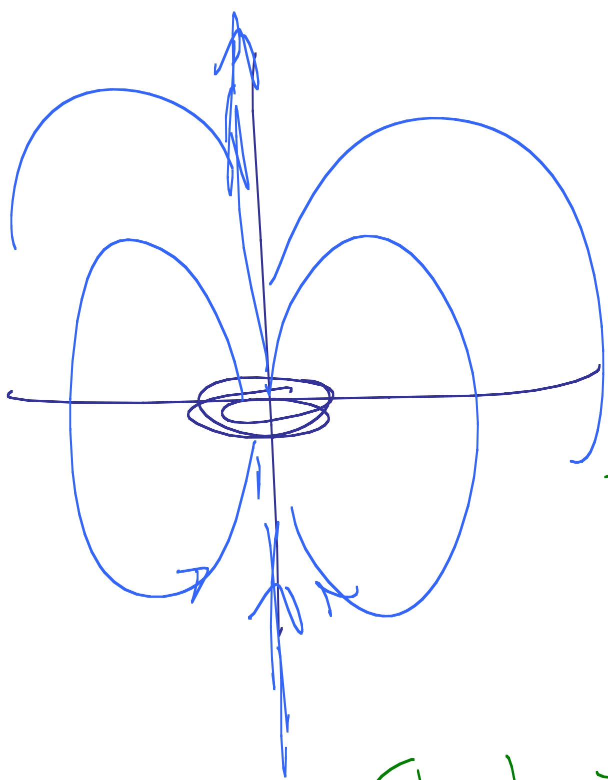
$$B_x \approx \frac{\mu_0 I a^2}{2x^3} = \frac{\mu_0 I \overbrace{\pi a^2}^{=A}}{2\pi\, x^3}$$

Magnetic moment

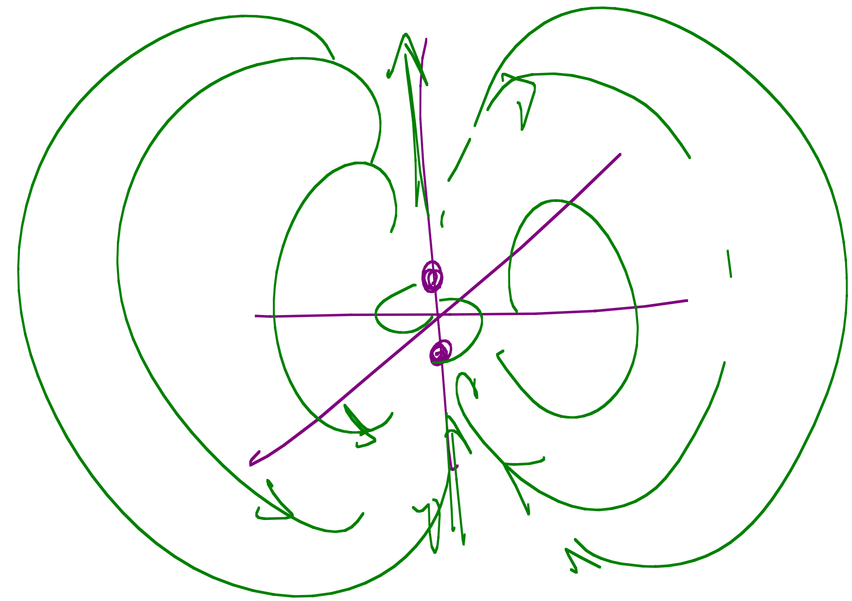
$$\mu = I \cdot (\text{Area})$$

Dipole moment

$$= \frac{\mu_0}{2\pi}\,\frac{\mu}{x^3}$$

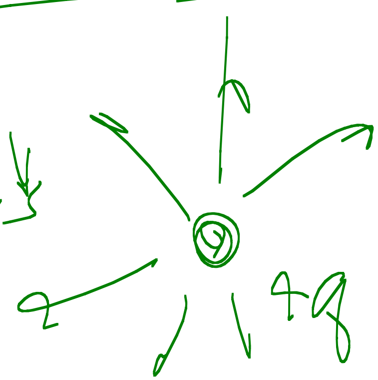


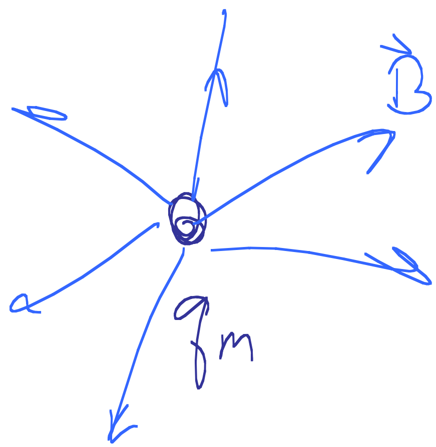
Magnetic Dipole



Dipoles

Electrostatic field





Magnetic monopole

In principle, possible.

Unobserved ...
so far.