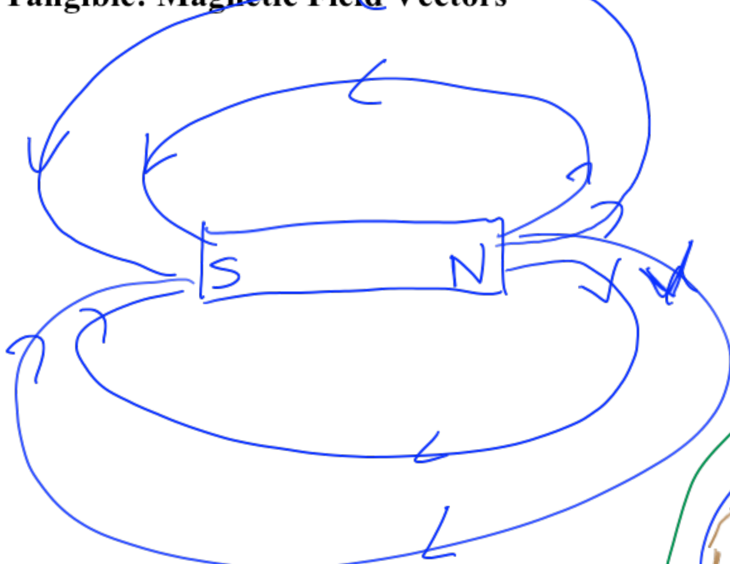
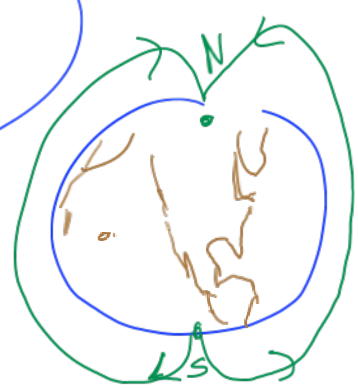
Feb 16

Tangible: Magnetic Field Vectors



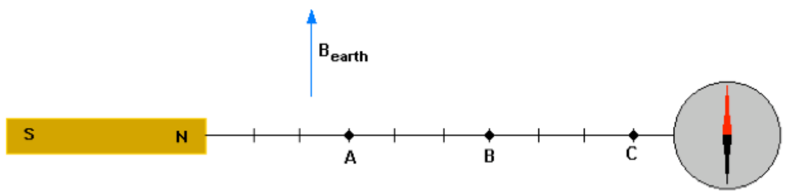
When far away (much farther than length of magnet) looks like a dipole



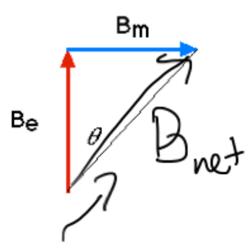
Tangible: Magnetic Field Vectors 2

Magnetic Personality

The figure shows a bar magnet, compass and a meter stick. The magnet is far enough from the compass that its magnetic field is too weak to have a noticeable effect on the direction the compass points.



Make sketches similar to the one below that shows the deflection of the compass needle when the magnet is moved to point A, point B, and point C.



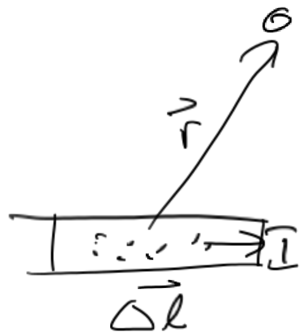
measure

$$\frac{B_m}{B_e} = \tan\theta$$

Discussion: Biot-Savart Law

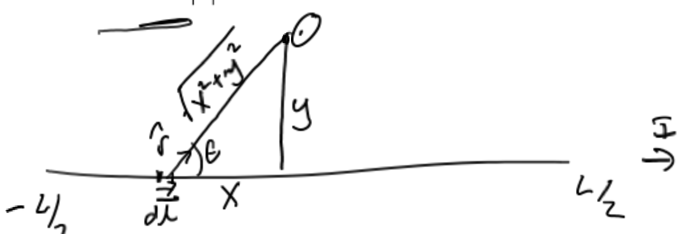
Single Charge

$$\vec{B} = \frac{\mu_0}{4\pi}\frac{q\vec{v}\times\hat{r}}{|\vec{r}|^2}, \text{ where } \frac{\mu_0}{4\pi} = 10^{-7}\,\frac{\text{tesla}\cdot\text{m}^2}{\text{coulomb}\cdot\text{m/s}}$$



Thin length of wire

$$\Delta\vec{B} = \frac{\mu_0}{4\pi}\frac{I\Delta\vec{l}\times\hat{r}}{|\vec{r}|^2}, \text{ where } \frac{\mu_0}{4\pi} = 10^{-7}\,\frac{\text{tesla}\cdot\text{m}^2}{\text{coulomb}\cdot\text{m/s}}$$



$\Delta\vec{l}$ point in dir of conventional current

$|\vec{dl}| = dx \qquad \vec{dl}\times\hat{r}$ is $\odot$

$|\vec{dl}\times\hat{r}| = |\vec{dl}|\,|\hat{r}|\sin\theta = dx\,\frac{y}{\sqrt{x^2+y^2}}$

$$\vec{B} = \frac{\mu_0 I}{4\pi} \int_{-L/2}^{L/2} dx \frac{y}{\sqrt{x^2+y^2}} \frac{1}{(x^2+y^2)} = \frac{\mu_0 I y}{4\pi} \int_{-L/2}^{L/2} \frac{dx}{(x^2+y^2)^{3/2}}$$

Straight wire

$$\left|\vec{B}_{\text{wire}}\right| = \frac{\mu_0}{4\pi} \frac{LI}{r\sqrt{r^2 + \left(L/2\right)^2}} \quad \text{if far away and } L >> r, \ \left|\vec{B}_{\text{wire}}\right| = \frac{\mu_0}{4\pi} \frac{2I}{r}$$

↑ distance r from center of wire

↑ drops like 1/r for really long wire

Quiz