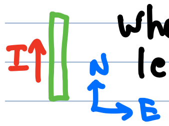
Q: A horizontal rod of mass m and length L is aligned in a N-S direction, carrying current I in the N direction. When a uniform $\vec{B}$ is applied to the entire rod, the $\vec{B}$ force levitates the rod.



a) Find the minimum $\vec{B}$ necessary

→ need a force to balance gravity
→ $\vec{B}$ must have component that points to the West
→ For the <u>minimum</u> $\vec{B}$, should exclusively point West

$F_g = mg \quad F_B = ILB \quad \rightarrow B_{min} = \frac{mg}{IL}$

numbers: 2 mm diameter copper, 1 m long, current 1 A

$\rightarrow B_{min} = \frac{\rho_{cu} \cancel{\ell} \pi r^2 g}{I \cancel{\ell}} = \frac{(8.9 \cdot 10^3 \, kg/m^3)\, \pi \, (10^{-3} m)^2 \; 9.8 \, m/s^2}{1A} = \boxed{0.27T}$ or 2700 Gauss

Please work on tutorials for ch 11: p119, p120, p145

EM 120 *Magnetic interactions*

3. The north pole of the magnet is held near the wire but the battery is not connected.

Prediction: no force (no I)

Observation:

4. The north pole of the magnet is held: (a) closer to the wire and (b) farther from the wire.

Prediction: closer → stronger

Observation: farther → weaker

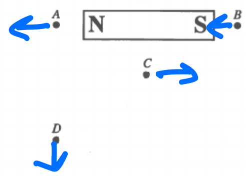
5. The magnet is turned so that it is parallel to the wire while the battery is connected.

Prediction: $\vec{I}$ parallel to $\vec{B}$ → sin0° or sin180° → no force

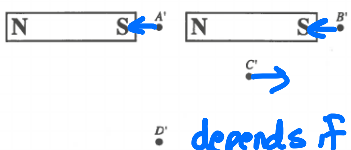
Observation:

Pretest: Magnets and magnetic fields Name ____________

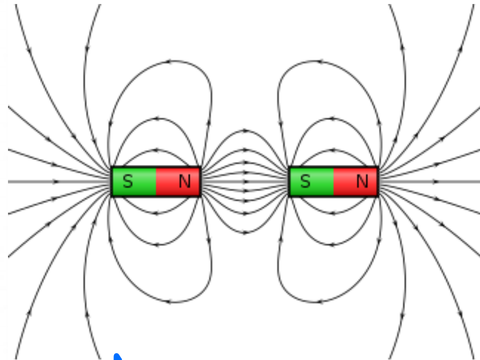
1. At each of the four labeled points (*A–D*), sketch a vector representing the magnetic field around the bar magnet.



2. A second bar magnet identical to the first one is placed to the left of point *A*. (See figure below.) At each of the four labeled points (*A'–D'*), sketch a vector representing the net magnetic field.



depends if close or far from the two magnets

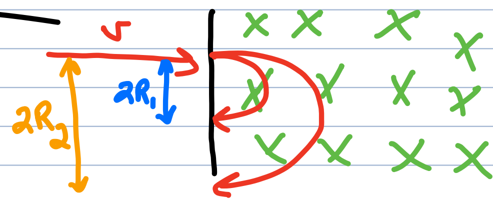


3. Rank the magnitude of the magnetic field at points *A*, *B*, *A'*, and *B'*. If the magnitude of the magnetic field at any point is zero, state that explicitly. Explain your reasoning. (If you do not have enough information to determine the ranking, explain what information you would need.)

$$|B(A')| > |B(B')| > |B(A)| = |B(B)|$$

Practice problems

 # 11.57



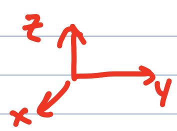
We want $2R_2 - 2R_1$

$$= \frac{2m_2 v_2}{q_2 B_2} - \frac{2m_1 v_1}{q_1 B_1}$$

$$= \frac{2v\,(m_2 - m_1)}{|3e^-|\,B}$$

#11.60

$$\vec{F} = q(\vec{v}\times\vec{B}) = q[(3.0\hat{i} + 4.0\hat{j}) \times (0.5\hat{i} + 0.8\hat{k})]\ 10^6\ m/s\ T$$



$$= q[2.4(-\hat{j}) + 2.0(-\hat{k}) + 3.2(\hat{i})]\,10^6\ m/s\ T$$

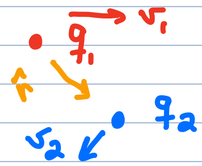
$$= [3.84(+\hat{j}) + 3.20(\hat{k}) - 5.12(\hat{i})]\ 10^{-13}\ N$$

 # 11.69 $R = \frac{mv}{qB} \Rightarrow R_{proton}$ is 1836 times larger than R_{e^-}

$$T = \frac{2\pi r}{v} = \frac{2\pi r}{qBr/m} = \frac{2\pi m}{qB} \Rightarrow T_{proton}\ 1836\times \text{ longer}$$

Ch 12 Sources of $\vec{B}$

electric



$$\vec{E}_1 = \frac{1}{4\pi\epsilon_0}\frac{q_1}{r^2}\hat{r}$$

$$\vec{F}_{1\,on\,2} = q_2\vec{E}_1 = \frac{1}{4\pi\epsilon_0}\frac{q_1 q_2}{r^2}\hat{r}$$

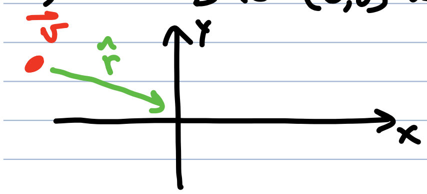
magnetic

$$\vec{B}_1 = \frac{\mu_0}{4\pi} q_1 \frac{\vec{v}_1 \times \hat{r}}{r^2}$$

$$\vec{F}_{1\,on\,2} = q_2\vec{v}_2 \times \vec{B}_1 = q_2\vec{v}_2 \times \left[\frac{\mu_0}{4\pi}\frac{q_1\vec{v}_1 \times \hat{r}}{r^2}\right]$$

example A proton is moving with $\vec{v} = 3.6\cdot 10^7\ m/s\,(\hat{\imath})$ along the line $y = +0.30\,\mu m$.

a) Find $\vec{B}$ @ $(0,0)$ when proton's at $x = -0.40\,\mu m$



$$\vec{r} = 0.40\,\mu m\,\hat{\imath} - 0.30\,\mu m\,\hat{\jmath}$$