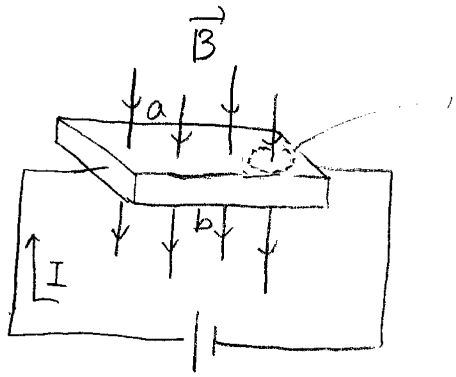
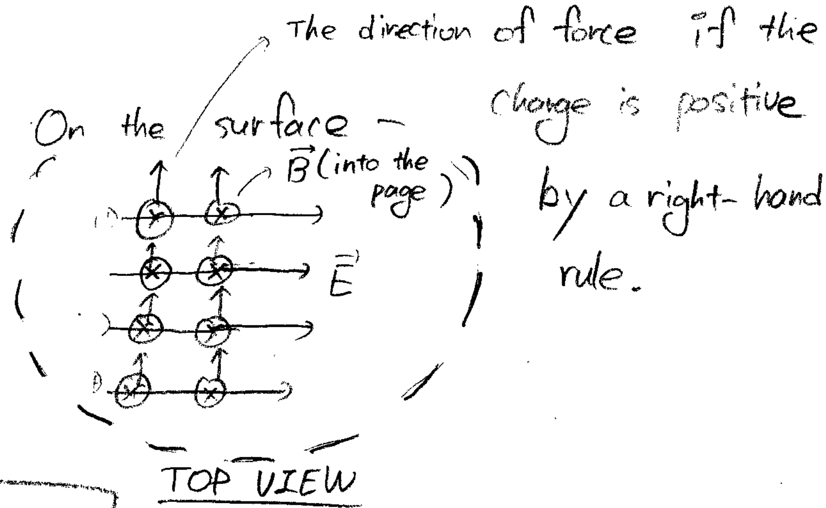
PHY 122 Workshop # 4

Ch 27.

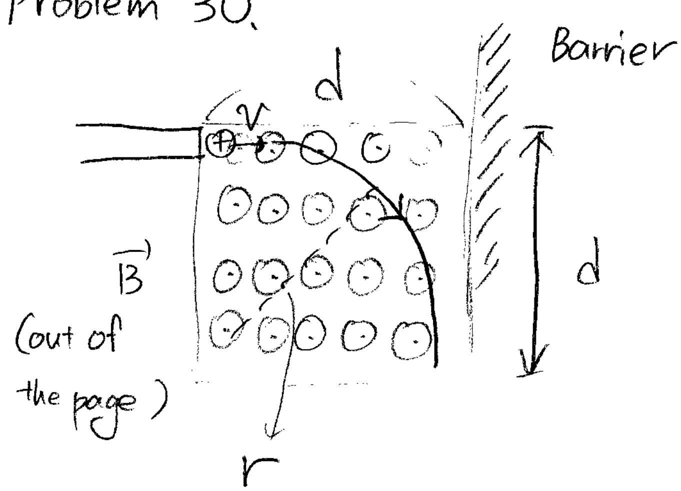
Question. 22





$\boxed{\text{The charge carriers are positive}}$. Positive particles moving to the right in the figure will experience a magnetic force into the page, or toward point a. Therefore, the positive charge carriers will tend to move toward the side containing a; this side will be at a higher potential than the side with point b.

Problem 30.



In order for the path to be bent by 90° within a distance d, the radius of curvature must be less than or equal to d. The

kinetic energy of the protons can be used to find their velocity.
The magnetic force produces centripetal acceleration, and from this, the magnetic field can be determined.

$$r \le d, \quad qvB = \frac{mv^2}{r} \Leftrightarrow r = \frac{mv}{qB} \underset{\uparrow}{=} \frac{mv}{eB}$$

$q = e$ for a proton

Therefore,

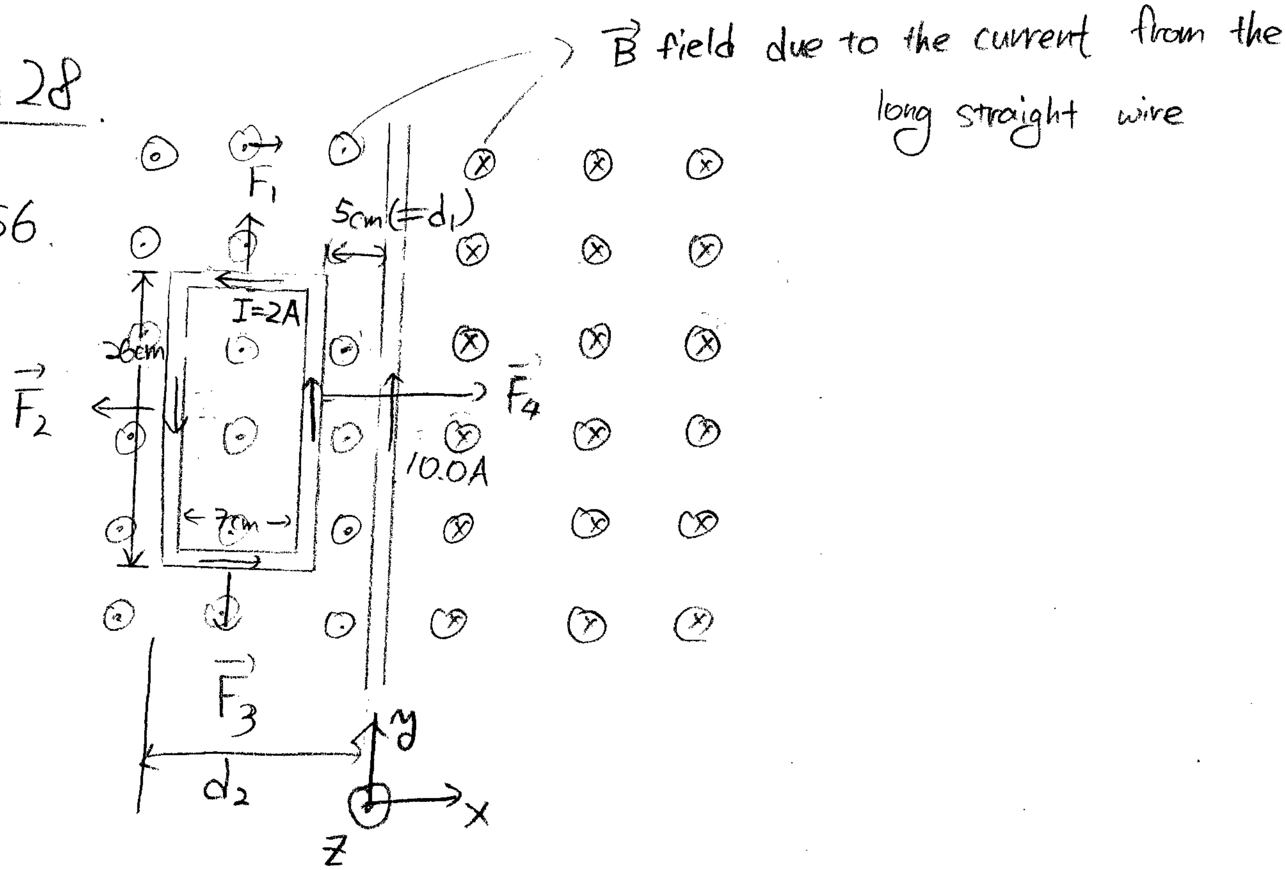
$$\frac{mv}{qB} \le d \Leftrightarrow B \ge \frac{mv}{ed} \quad \left(\text{Since } K = \frac{1}{2}mv^2 \Leftrightarrow v = \sqrt{\frac{2K}{m}}\right)$$

$$\Leftrightarrow B \ge \frac{m}{ed}\sqrt{\frac{2K}{m}}$$

$$\Leftrightarrow \boxed{B \ge \sqrt{\frac{2Km}{e^2 d^2}}}$$

Ch 28.

Prob 56.



(a) The magnetic field from the long straight wire will be out of the page in the region of the wire loop with its magnitude given by $B = \frac{\mu_0 I}{2\pi r}$ (Eq 28.1.) By symmetry, the forces from the two horizontal segments, $\vec{F}_1$ and $\vec{F}_3$, are equal and opposite, therefore they do not contribute to the net force.

We use Eq. 28-2, $F_2 = \frac{\mu_0}{2\pi}\frac{I_1 I_2}{d} l_2$, to find the force on the two vertical segments of the loop and sum the results to determine the net force. Note that the segment with the current parallel to the straight wire will be attracted to the wire, while the segment with the current flowing in the opposite direction will be repelled from the wire. Since $|\vec{F}_4|$ is greater than $|\vec{F}_2|$,

$$\vec{F}_{net} = \vec{F}_2 + \vec{F}_4 = -\frac{\mu_0 I_1 I_2}{2\pi d_2} l\,\hat{x} + \frac{\mu_0 I_1 I_2}{2\pi d_1} l\,\hat{x} = \frac{\mu_0 I_1 I_2 l}{2\pi}\left(\frac{1}{d_1} - \frac{1}{d_2}\right)\hat{x}$$

$$= \frac{(4\pi \times 10^{-7}\ T\cdot m/A)(2.0A)(10.0A)(0.26m)}{2\pi}\left(\frac{1}{0.05m} - \frac{1}{0.12m}\right)$$

$$= 1.2 \times 10^{-5} N\ \hat{x}$$

$\therefore$ $\boxed{1.2 \times 10^{-5} N}$ toward the wire

(b) $\vec{\tau}_{net} = \vec{r} \times \vec{F}_{net} = 0$ ($\because \vec{r} \parallel \vec{F}_{net}$, both in $\hat{x}$-direction)