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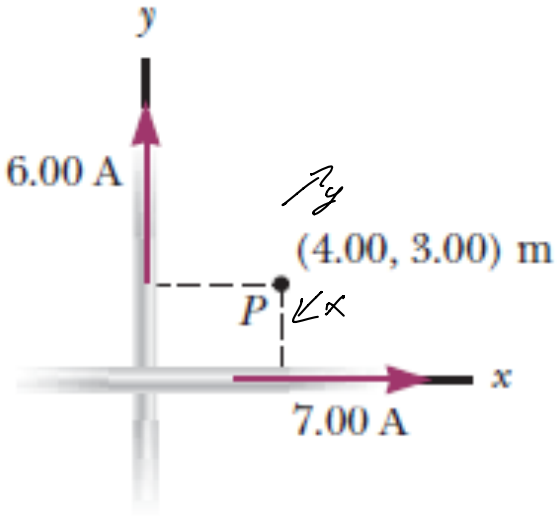
Electric and Magnetic Fields Test – Take Home Part

For each of the following problems, show all work including all equations used, numbers entered into the equations, and then circle your final answer complete with units. **You are expected to do your own work!**

1. A wire carries a 7.00 A current along the x-axis, and another wire carries a 6.00 A current along the y-axis as shown below. What is the magnetic field (in vector notation) at point *P*, located at $x = 4.00$ m, $y = 3.00$ m?



$$\vec{B}_x = \frac{(4\pi \times 10^{-17})(7.00A)}{2\pi(3m)}$$

$$= \frac{28 \times 10^{-17}}{6}$$

$$\vec{B}_x = 4.66 \times 10^{-17}$$

$$\vec{B}_y = \frac{\mu I}{2\pi r}$$

$$= \frac{(4\pi \times 10^{-17})(6.00A)}{2\pi(4m)}$$

$$= \frac{(1 \times 10^{-17})(6)}{2}$$

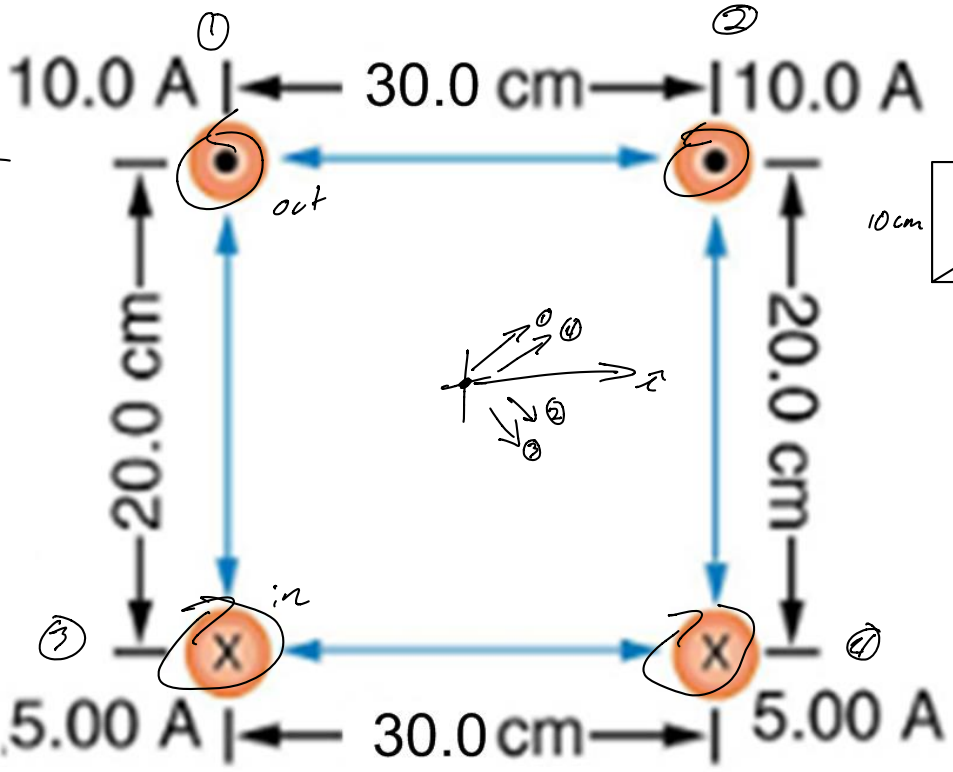
$$\vec{B}_y = 3 \times 10^{-17}$$

$$\vec{B} = \vec{B}_x - \vec{B}_y$$

$$= (4.66 \times 10^{-17}) - (3.0 \times 10^{-17})$$

$$\vec{B} = 1.66 \times 10^{-17}\ T\ \hat{k}$$

2. For the configuration shown below, determine
   a) the magnetic field (in vector format) at the center of the rectangle.
   b) The net force (in vector form) on a doubly ionized Oxygen atom traveling with a velocity, **v** = 1 km/s $\hat{j}$ through the center of the rectangle.



$B_1 = \frac{(4\pi \times 10^{-7})(10.0A)}{2\pi(0.18m)}$

$= \frac{20 \times 10^{-7}}{0.18}$

$B_1 = 1.11 \times 10^{-5} T$

$B_2 = \frac{(4\pi \times 10^{-7})(10.0A)}{2\pi(0.18m)}$

$B_2 = B_1$

$B_2 = 1.11 \times 10^{-5}$

$B_3 = \frac{(4\pi \times 10^{-7})(5.00A)}{2\pi(0.18m)}$

$= \frac{10 \times 10^{-7}}{0.18}$

$B_3 = 5.55 \times 10^{-6}$

$B_4 = \frac{(4\pi \times 10^{-7})(5.00A)}{2\pi(0.18m)}$

$B_4 = B_3$

$B_4 = 5.55 \times 10^{-6}$

15 cm, 10 cm, x, θ

$x = \sqrt{15^2 + 10^2}$

$= \sqrt{225 + 100}$

$= \sqrt{325}$

$x = 18.03$ cm

$\theta = \tan^{-1}\left(\frac{10}{15}\right)$

$\theta = 33.7°$

$(B_1 + B_4)\cos(\theta) + (B_2 + B_3)\cos(\theta)\ \hat{i}$

$(1.67 \times 10^{-5})\cos(\theta) + (1.67 \times 10^{-5})\cos(\theta)\ \hat{i}$

$2\cos\theta\,(1.67 \times 10^{-5})\ \hat{i}$

$(B_1 + B_4)\sin(\theta) - (B_2 + B_3)\sin(\theta)\ \hat{j}$

$0\ \hat{j}$

a) $\vec{B} = 2(1.67 \times 10^{-5})\cos(33.7°)\ \hat{i} + 0\ \hat{j}$

$\vec{B} = 2.78 \times 10^{-5} T\ \hat{i} + 0\ \hat{j}$

$q = 2 \times (\text{charge of } e^-)$
$= -3.204 \times 10^{-19} C$

b) $\vec{F} = |q| v_\perp B$

$= (-3.204 \times 10^{-19} C)(1{,}000 \text{ m/s})(7.78 \times 10^{-5} T)$

$\vec{F} = -8.91 \times 10^{-21} N$ ⊗

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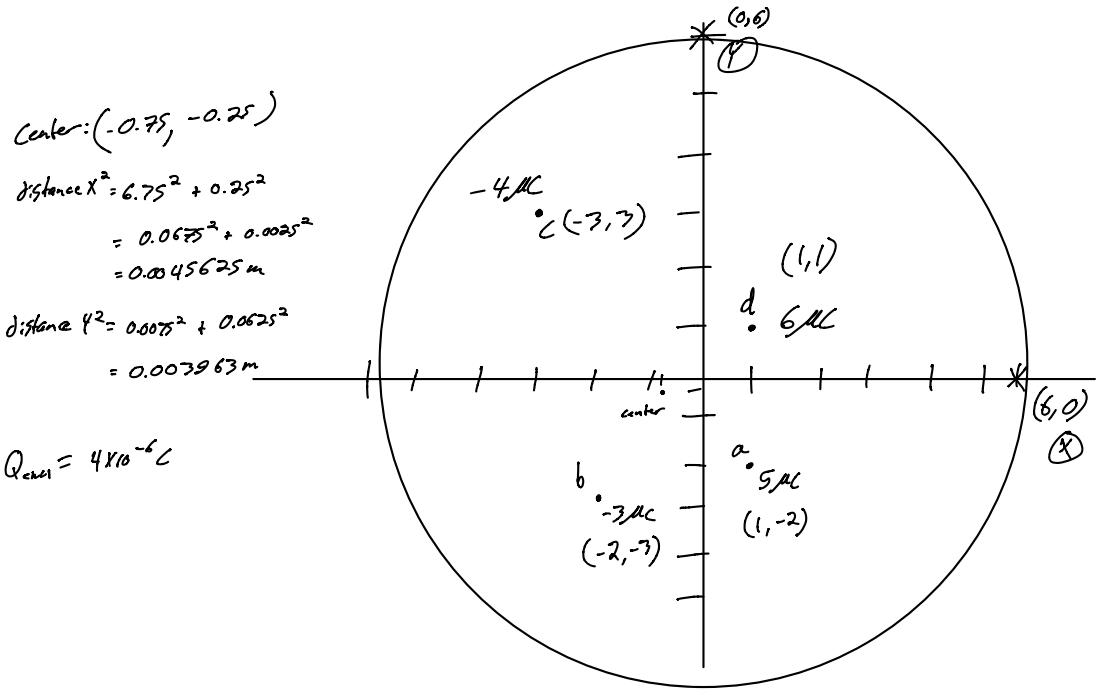
3. The following charges are located at the points indicate where is the positions are given in centimeters.
   5 μC at (1, -2) -3 μC at (-2, -3)
   -4 μC at (-3, 3) 6 μC at (1, 1)
   Determine the magnitude of the Electric Field at the points (6, 0) and (0, 6).



$\Phi = EA = \frac{Q_{encl}}{\epsilon_0}$

$E = \frac{Q_{encl}}{A \epsilon_0}$

$E_x = \frac{4 \times 10^{-6} C}{4\pi (0.00456) \epsilon_0}$

$E_y = \frac{4 \times 10^{-6} C}{4\pi (0.00396) \epsilon_0}$

at (6,0): $E_x = 7.98 \times 10^6$ N/C

at (0,6): $E_y = 9.08 \times 10^6$ N/C