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General Physics II, Quiz 6
PHYS10000AA, Class year 99
3-10-2011

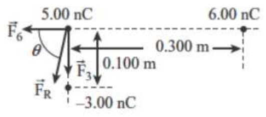
SN:_______________, Name:________________

Chapter 23-24, Serway; ABSOLUTELY NO CHEATING!

Please write the answers on the blank space or on the back of this paper to save resources.

1.

P23.9 In the sketch at the right, F_R is the resultant of the forces F_6 and F_3 that are exerted on the point charge at the origin by the 6.00 nC and the –3.00 nC point charges, respectively.



ANS FIG. P23.9

The components of the resultant force are

$$F_x = -F_6 = -\left(8.99\times10^9\ \frac{\text{N}\cdot\text{m}^2}{\text{C}^2}\right)\frac{\left(6.00\times10^{-9}\ \text{C}\right)\left(5.00\times10^{-9}\ \text{C}\right)}{(0.300\ \text{m})^2}$$

$$= -3.00\times10^{-6}\ \text{N}\quad(\text{to the left})$$

$$F_x = -F_3 = -\left(8.99\times10^9\ \frac{\text{N}\cdot\text{m}^2}{\text{C}^2}\right)\frac{\left(3.00\times10^{-9}\ \text{C}\right)\left(5.00\times10^{-9}\ \text{C}\right)}{(0.100\ \text{m})^2}$$

$$= -1.35\times10^{-5}\ \text{N}\quad(\text{downward})$$

(a) The forces are perpendicular, so the magnitude of the resultant is

$$F_R = \sqrt{(F_6)^2 + (F_3)^2} = \boxed{1.38\times10^{-5}\ \text{N}}$$

(b) The magnitude of the angle of the resultant is $\theta = \tan^{-1}\left(\frac{F_3}{F_6}\right) = 77.5°$. The resultant force is in the third quadrant, so the direction is $\boxed{77.5°\ \text{below}\ -x\ \text{axis}}$.

2.

P23.25 The field is due to the other three charges: $\vec{\mathbf{E}} = \frac{k_e q_1}{r_1^2}\hat{\mathbf{r}}_1 + \frac{k_e q_2}{r_2^2}\hat{\mathbf{r}}_2 + \frac{k_e q_3}{r_3^2}\hat{\mathbf{r}}_3$

$$\vec{\mathbf{E}} = \frac{k_e(2q)}{a^2}\hat{\mathbf{i}} + \frac{k_e(3q)}{2a^2}\left(\hat{\mathbf{i}}\cos 45.0° + \hat{\mathbf{j}}\sin 45.0°\right) + \frac{k_e(4q)}{a^2}\hat{\mathbf{j}}$$

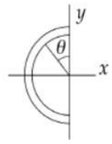
$$\vec{\mathbf{E}} = \frac{k_e q}{a^2}\left[\left(2 + \frac{3}{2}\cos 45.0°\right)\hat{\mathbf{i}} + \left(\frac{3}{2}\sin 45.0° + 4\right)\hat{\mathbf{j}}\right] = \frac{k_e q}{a^2}\left(3.06\hat{\mathbf{i}} + 5.06\hat{\mathbf{j}}\right)$$

(a) $\vec{\mathbf{E}} = \frac{k_e q}{a^2}\left(3.06\hat{\mathbf{i}} + 5.06\hat{\mathbf{j}}\right) \quad\rightarrow\quad \vec{\mathbf{E}} = \boxed{5.91\frac{k_e q}{a^2}\ \text{at } 58.8°\ \text{above the horizontal}}$

(b) $\vec{\mathbf{F}} = q\vec{\mathbf{E}} = \frac{k_e q^2}{a^2}\left(3.06\hat{\mathbf{i}} + 5.06\hat{\mathbf{j}}\right) = \boxed{5.91\frac{k_e q^2}{a^2}\ \text{at } 58.8°\ \text{above the horizontal}}$

3.

P23.35 Due to symmetry $E_y = \int dE_y = 0$, and $E_x = -\int dE \sin\theta = -k_e \int \frac{dq \sin\theta}{r^2}$ where $dq = \lambda ds = \lambda r d\theta$; the component E_x is negative because charge $q = -7.50\ \mu$C, causing the net electric field to be directed to the left.



ANS FIG. P23.35

$$E_x = -\frac{k_e\lambda}{r}\int_0^{\pi} \sin\theta\, d\theta = -\frac{k_e\lambda}{r}(-\cos\theta)\Big|_0^{\pi} = -\frac{2k_e\lambda}{r}$$

where $\lambda = \frac{|q|}{L}$ and $r = \frac{L}{\pi}$.

Thus,

$$E_x = -\frac{2k_e|q|\pi}{L^2} = -\frac{2\left(8.99\times 10^{9}\ \text{N}\cdot\text{m}^2/\text{C}^2\right)\left(7.50\times 10^{-6}\ \text{C}\right)\pi}{(0.140\ \text{m})^2}$$

$$E_x = -2.16\times 10^{7}\ \text{N/C}$$

(a) magnitude $E = \boxed{2.16\times 10^{7}\ \text{N/C}}$

(b) to the left