PHYS 102 Midterm Exam **02/08/2023**

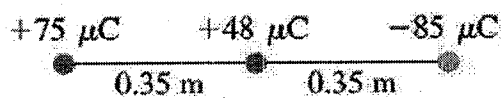
İzmir University of Economics

Name_____ **Student No**_____

Please write section number and select day, time and lecturer of the course.

Each question is 20 point. Exam duration is 60 minutes.

1. Particles of charge +75, +48, and -85 μC are placed in a line (figure). The center one is 0.35 m from each of the others. Calculate the net force on +48 μC charge due to the other two. ($k = 8.988 \times 10^9$ N.m^2/C^2)



$$F = k \frac{Q_1 Q_2}{r^2}$$

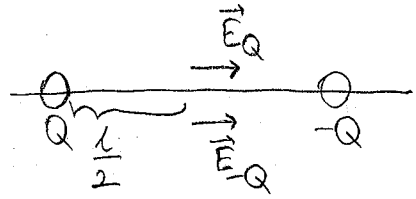
$$\vec{F} = k \frac{(75\times10^{-6}C)(48\times10^{-6}C)}{(0.35m)^2}\hat{i} + k \frac{(48\times10^{-6}C)(85\times10^{-6}C)}{(0.35m)^2}\hat{i}$$

$$\vec{F} = \frac{8.988\times10^{9}\,Nm^2/c^2}{(0.35m)^2}\left(3.6\times10^{-9}C^2 + 4.08\times10^{-9}C^2\right)\hat{i}$$

$$\vec{F} = \hat{i}\,\frac{8.988\times10^{9}\,Nm^2/c^2}{(0.35m)^2} \times 7.68\times10^{-9}C^2$$

$$\vec{F} = 563.49\,N\,\hat{i}$$

2. The electric field midway between two equal but opposite point charges is 586 N/C, and the distance between the charges is 0.160 m. What is the magnitude of the charge on each?
($k = 8.988 \times 10^9$ N.m^2/C^2)

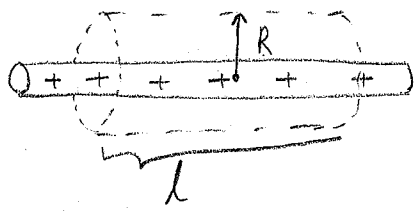


$$E_{net} = 2E_Q = 2k\frac{Q}{(\ell/2)^2} = \frac{8kQ}{\ell^2}$$

$$Q = \frac{E\ell^2}{8k}$$

$$Q = \frac{(586\ N/C) \times (0.160m)^2}{8 \times (8.988 \times 10^9\ N m^2/C^2)} = 2.086 \times 10^{-10}\ C$$

3. A very long straight wire possesses a uniform positive charge per unit length, λ. Calculate the electric field at points near (but outside) the wire, far from the ends.

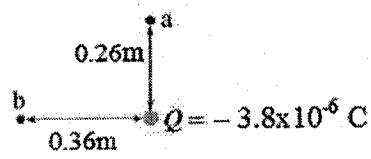


$$\oint \vec{E} \cdot d\vec{A} = \frac{Q_{encl}}{\varepsilon_0} \qquad Q_{encl} = \lambda l$$

$$E\, 2\pi R l = \frac{\lambda l}{\varepsilon_0}$$

$$E = \frac{1}{2\pi\varepsilon_0}\frac{\lambda}{R}$$

4. Point a is 0.26 m north of a $-3.8\text{x}10^{-6}$ C point charge, and point b is 0.36 m west of the charge (figure). Determine V_b-V_a. ($\varepsilon_0 = 8.85x10^{-12}C^2/Nm^2$)



$r_b = 0.36m$

$r_a = 0.26m$

$$V_{ba} = V_b - V_a = \frac{1}{4\pi\varepsilon_0}\frac{Q}{r_b} - \frac{1}{4\pi\varepsilon_0}\frac{Q}{r_a}$$

$$V_b - V_a = \frac{Q}{4\pi\varepsilon_0}\left(\frac{1}{r_b} - \frac{1}{r_a}\right)$$

$$V_b - V_a = \frac{(-3.8\times10^{-6}C)}{4\pi(8.85\times10^{-12}C^2/Nm^2)}\left(\frac{1}{0.36m} - \frac{1}{0.26m}\right)$$

$$V_b - V_a = \frac{-3.8\times10^{-6}C}{4\pi(8.85\times10^{-12}C^2/Nm^2)}\left(\frac{-0.1m}{0.0936m^2}\right)$$

$$V_b - V_a = 36523.7\,V$$

5. How much energy is stored by the electric field between two square plates, 0.080 m on a side, separated by a 0.0013 m air gap? The charges on the plates are equal and opposite and of magnitude 420×10^{-6} C. ($\varepsilon_0 = 8.85x10^{-12}C^2/Nm^2$)

$$U = \frac{1}{2}QV = \frac{1}{2}CV^2 = \frac{1}{2}\frac{Q^2}{C}$$

$$C = \varepsilon_0 \frac{A}{d}$$

$$U = \frac{1}{2}\frac{Q^2}{C} = \frac{1}{2}\frac{Q^2 d}{\varepsilon_0 A}$$

$$U = \frac{1}{2}\frac{(420\times10^{-6}C)^2 \times (0.0013m)}{(8.85\times10^{-12}C^2/Nm^2)(0.080m)^2} = 2024.36\,J$$