EE 381 Electric and Magnetic Fields Quiz #7 (Fall 2026)

Name KEY A

Instructions: **Open** book & notes. Place answers in indicated spaces and show all work for credit.

Point charges +1 μC and –2 μC are located at (1.24, 2.46, 3.69) and (-1.06, -2.54, -3.31) in Cartesian coordinates in **cm**, respectively. First, find the distance vector $\bar{r}-\bar{r}'$ and distance $|\bar{r}-\bar{r}'|$ from the positive charge to the negative charge as well as the electric field due to the positive charge at the location of the negative charge. Then, find the force $\bar{F}$ exerted by the positive charge on the negative charge.

The positive charge is the source of the electric field and force on the negative charge. Locate it using the source position vector $\bar{r}'=1.24\hat{a}_x+2.46\hat{a}_y+3.69\hat{a}_z$ (cm).

The location of the negative charge is where we want to find the electric field. Locate it using the field position vector $\bar{r}=-1.06\hat{a}_x-2.54\hat{a}_y-3.31\hat{a}_z$ (cm).

The distance vector is then

$$\bar{r}-\bar{r}'=(-1.06\hat{a}_x-2.54\hat{a}_y-3.31\hat{a}_z)-(1.24\hat{a}_x+2.46\hat{a}_y+3.69\hat{a}_z)$$
$$=-2.3\hat{a}_x-5\hat{a}_y-7\hat{a}_z \text{ (cm)} = -0.023\hat{a}_x-0.05\hat{a}_y-0.07\hat{a}_z \text{ (m)}$$

& distance is $|\bar{r}-\bar{r}'|=\sqrt{(-2.3)^2+(-5)^2+(-7)^2}=\sqrt{79.29}=8.90449 \text{ (cm)}=0.08904 \text{ (m)}$.

To find electric field due to **positive charge** at location of the negative charge, use

$$\bar{E}_{\text{pos@neg}}=\frac{Q\,(\bar{r}-\bar{r}')}{4\pi\varepsilon_0|\bar{r}-\bar{r}'|^3}=\frac{1\times10^{-6}\,(-0.023\hat{a}_x-0.05\hat{a}_y-0.07\hat{a}_z)}{4\pi(8.8541878\times10^{-12})\,0.089045^3}$$
$$=1.27295714\times10^{7}\,(-0.023\hat{a}_x-0.05\hat{a}_y-0.07\hat{a}_z)$$
$$=-292780.14\hat{a}_x-636478.568\hat{a}_y-891069.995\hat{a}_z \text{ (V/m)}$$

To find the force on **negative charge** due to positive charge, use

$$\bar{F}_{\text{pos-neg}}=q\,\bar{E}=-2\times10^{-6}\,(-292780.14\hat{a}_x-636478.568\hat{a}_y-891069.995\hat{a}_z)$$
$$=0.58556\hat{a}_x+1.272957\hat{a}_y+1.78214\hat{a}_z \text{ (N)}$$

Note: Use **MKS units** for equation calculations. Do NOT put units with prefixes in denominator.

$\bar{r}-\bar{r}' = -2.3\hat{a}_x-5\hat{a}_y-7\hat{a}_z$ (cm) $\quad |\bar{r}-\bar{r}'| =$ **8.9045 cm**

$\bar{E}_{\text{pos@neg}} = -292{,}780.14\hat{a}_x-636{,}478.57\hat{a}_y-891{,}070.00\hat{a}_z$ (V/m)

$\bar{F}_{\text{pos-neg}} = 0.5856\hat{a}_x+1.2730\hat{a}_y+1.7821\hat{a}_z$ (N)

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Name KEY B

Instructions: **Open** book & notes. Place answers in indicated spaces and show all work for credit.

Point charges +2 μC and –1 μC are located at (1.76, 2.55, 3.79) and (-1.24, -2.45, -3.21) in Cartesian coordinates in **cm**, respectively. First, find the distance vector $\bar{r}-\bar{r}'$ & distance $|\bar{r}-\bar{r}'|$ from the negative charge to the positive charge as well as the electric field due to the negative charge at the location of the positive charge. Then, find the force $\bar{F}$ exerted by the negative charge on the positive charge.

The negative charge is the source of the electric field and force on the positive charge. Locate it using the source position vector $\bar{r}' = -1.24\hat{a}_x - 2.45\hat{a}_y - 3.21\hat{a}_z$ (cm).

The location of the positive charge is where we want to find the electric field. Locate it using the field position vector $\bar{r} = 1.76\hat{a}_x + 2.55\hat{a}_y + 3.79\hat{a}_z$ (cm).

The distance vector is then

$$\bar{r}-\bar{r}' = (1.76\hat{a}_x + 2.55\hat{a}_y + 3.79\hat{a}_z) - (-1.24\hat{a}_x - 2.45\hat{a}_y - 3.21\hat{a}_z)$$
$$= 3\hat{a}_x + 5\hat{a}_y + 7\hat{a}_z \text{ (cm)} = 0.03\hat{a}_x + 0.05\hat{a}_y + 0.07\hat{a}_z \text{ (m)}$$

and the distance is $|\bar{r}-\bar{r}'| = \sqrt{3^2+5^2+7^2} = \sqrt{83} = 9.11043 \text{ (cm)} = 0.091104 \text{ (m)}$.

To find electric field due to **negative** charge at location of positive charge, use

$$\bar{E}_{\text{neg@pos}} = \frac{Q(\bar{r}-\bar{r}')}{4\pi\varepsilon_0|\bar{r}-\bar{r}'|^3} = \frac{-1\times10^{-6}\ (0.03\hat{a}_x + 0.05\hat{a}_y + 0.07\hat{a}_z)}{4\pi(8.8541878\times10^{-12})\,0.0911043^3}$$
$$= -1.18856864\times10^{7}\ (0.03\hat{a}_x + 0.05\hat{a}_y + 0.07\hat{a}_z)$$
$$= -356570.59\hat{a}_x - 594284.32\hat{a}_y - 831998.05\hat{a}_z \text{ (V/m)}$$

To find the force on **positive** charge due to negative charge, use

$$\bar{F} = q\bar{E} = 2\times10^{-6}\ (-356570.59\hat{a}_x - 594284.32\hat{a}_y - 831998.05\hat{a})$$
$$= -0.71314\hat{a}_x - 1.18857\hat{a}_y - 1.6640\hat{a}_z \text{ (N)}$$

Note: Use **MKS units** for equation calculations. Do NOT put units with prefixes in denominator.

$\bar{r}-\bar{r}' = 3\hat{a}_x + 5\hat{a}_y + 7\hat{a}_z$ (cm) $\quad |\bar{r}-\bar{r}'| =$ **9.1104 cm**

$\bar{E}_{\text{neg@pos}} = -356{,}570.59\hat{a}_x - 594{,}284.32\hat{a}_y - 831{,}998.05\hat{a}_z$ (V/m)

$\bar{F}_{\text{neg-pos}} = -0.7131\hat{a}_x - 1.1886\hat{a}_y - 1.6640\hat{a}_z$ (N)