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Instructions: You have a total of 50 minutes to complete this test.
Answer each question completely showing complete details.
For complete credit you must include correct SI units with numerical answers.
Time start_____ Time finish _____pledged _____

Constants: $k=8.987\text{x}10^{9}\frac{Nm^2}{C^2}:\epsilon_0=8.854\text{x}10^{-12}\frac{C^2}{Nm^2}$

(1) A charge q is described by $q:[-4\mu C;-6m,3m]$.

(1:a) Find the **vector** electric field, $\vec{E}$ (with correct SI units) at the point p:x=-2m, y=5m.

(1:b) Find the magnitude of the vector electric field, $|\vec{E}|$, with correct SI units.

(1:c) If a charge $q_p=+5\mu C$ is placed at p, find the **vector** electric force on q_p.

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(2) An infinite plane is located in the x-y plane at z=0 and has a uniform surface charge density σ.
(2:a) Showing complete details, **with sketches and words**, find the **vector** electric field at z<0 and z>0.

(2:b) Now consider a second plane which is located (parallel to the first) at z=+d and has a surface charge density $-\sigma$. Showing complete details, **with sketches and words**, find the **vector** electric field between z=0 and z=d.

(2:c) Again, showing complete details, **with sketches and words**, find the **vector** electric field in the region z<0 and z>d.

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(3) Consider two charges: 1:[2μC;0m,3m] and 2:[-2μC;0m,-3m].
(3:a) Provide a sketch of the electric field map showing direction and relative strength . Note: one line here is completely insufficient.

(3:b) Find the **vector** electric field at the point given by p:[5m,0m].

(3:c) Find the **vector dipole moment** of the charge distribution with correct SI units.

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(4) A sphere of total charge Q of radius a has a volume charge density given by $\rho(r)=\left[\frac{Q}{\pi a^4}\right]r$ You will need to integrate $Q_{enc}=4\pi\int\rho(r)r^2dr$ with appropriate limits.

(4:a) Find the **vector** electric field **inside** the sphere (providing complete details with sketches). Express your answer in terms of Q, r and a, using the unit vector $\hat{r}$.

(4:b) Find the **vector** electric field **outside** the sphere (again, providing complete details with sketches). Express your answer in terms of Q and r using the unit vector $\hat{r}$.