IV. [20 Points Total]

A. Four point charges, one with charge +3q and the rest with charge +q, are fixed a distance s away from the origin, O, as shown. The top and bottom charges make angles α and β respectively with the horizontal x-axis.

1. [5 pts] On the diagram, indicate the direction of the net electric field at the origin, O, for the case that α = β. If the net electric field is zero, state so explicitly. Briefly explain.

The vertical, y, components of the fields from the upper and lower +q charges cancel. The remaining horizontal components are smaller than the full magnitude. Hence, the field to the left from the +3q charges exceeds the field to the right from the three +q charges. The net electric field is to the left.

2. [5 pts] Suppose the distance of all four charges from the origin, O, were reduced by half without changing the angles. Would the magnitude of the electric field change? If so, by what factor it would increase or decrease? Explain. If not, explain why not.

Each term in the sum that makes up the net electric field is increased by a factor of 4 since the electric field due to a point charge is proportional to 1/r². Hence, the net force increases 4x.

B. [10 pts.] A rectangular rubber sheet is held vertically near an infinitely long rod with positive charge density, +λ. The sheet is stretched into the orientations shown in the top view diagram below. The vertical sides of the sheet do not change.

Rank, from largest to smallest, the absolute value of the net electric flux through the sheet due to the rod. Explain.

The positively charged rod creates field lines radiating out from it in all directions regardless of height as shown. The net electric flux through the paper is proportional to the net number of field lines crossing the paper. As seen clearly from the diagram: |

|ΦA| > |ΦB| = |ΦC| = |ΦD| = |ΦE|