

## Lab 1 HOME SHEET

1. Convert the following vectors to spherical coordinates and write down their directions (12 pts)

(1) Vector  $(0,0,1)$  at point  $(0,0,1)$

(2) Vector  $(1,0,0)$  at point  $(0,1,0)$

(3) Vector  $(3, 4, -5)$  at point  $(3, 4, 5)$

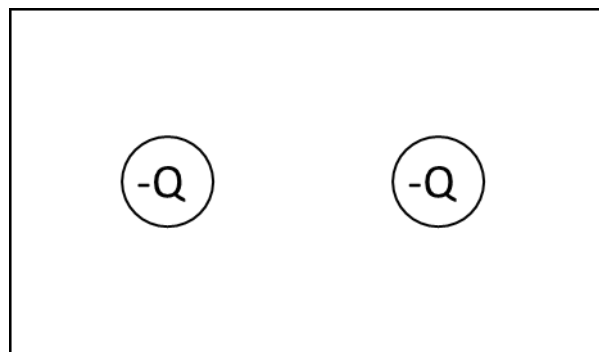
(4) Vector  $(2, 2, -2)$  at point  $(1, 1, 2)$

(5) Vector  $(1/3, 2/3, 2/3)$  at point  $(1/3, 2/3, 2/3)$

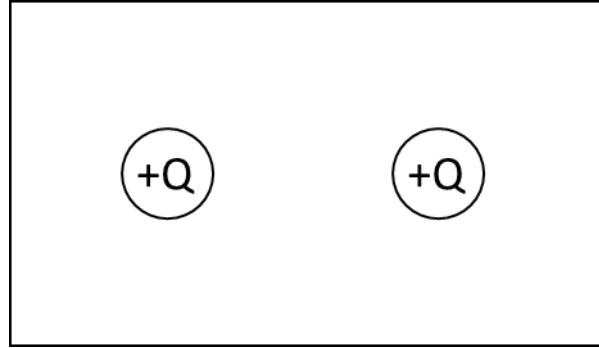
(6) At a point on the z-axis other than the origin, a vector has no z component. What component(s) does it have in spherical coordinates?

2. Plot the electrical field lines and equipotential surfaces with different colors. (9pts)

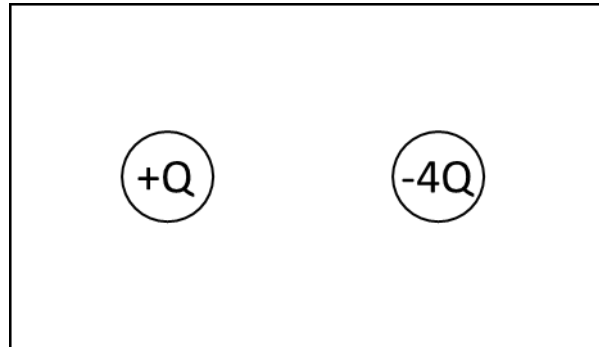
(1) Double negative charge



(2) Double positive charge



(3) One charge with +Q and one charge with -4Q



3. Assume  $Q_1$  is the positive charge at  $(-1,0)$  and  $Q_2$  is the negative charge at  $(1,0)$ . Let  $k$  be the ratio of the  $|Q_1|$  to  $|Q_2|$  and  $k > 1$ . Prove that the potential along the  $x$ -axis has a maximum in the range of  $(1, +\infty)$  and the coordinate at the maximum can be expressed as  $x = \frac{\sqrt{k+1}}{\sqrt{k-1}}$ . (4pts)