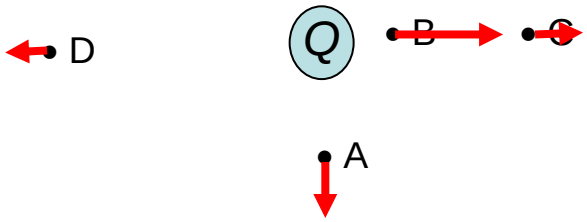
Discussion Question 2A
P212, Week 2
Electric Field Lines

Electric fields are force fields produced by electric charges. They can extend throughout space, and influence other charges (and currents and magnetic fields, as you will discover later in the course). *Electric Field Lines* graphically represent electric fields. They show you the direction and relative magnitude of force that a test charge would feel in the field region.

(a) The configuration at right shows some points around a positive charge *Q*. If a positive test charge *q* is placed at point A, at a distance r_A from *Q*, calculate the magnitude of the force on the test charge in terms the given variables.



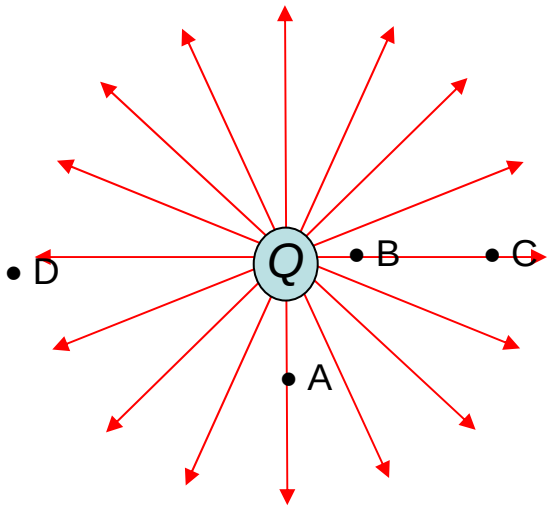
$|F_A| = kqQ/r_A^2$

Draw the direction of the force with an arrow on the diagram.

(b) Would the magnitude of the force be bigger or smaller if the charge was placed at points B,C, or D?
Force would be bigger at B, smaller at C or D

Draw the direction of these forces on the diagram with arrows, using the length of the arrows to indicate the relative magnitude of the forces.

(c) On the diagram at right, draw extended electric field lines for Q. What feature of these lines indicates the relative magnitude of the fields at A and B?



Electric fields—and hence magnitudes of forces on test charges—are strongest where field lines are most dense. So, it is clear from the field lines that for test charges placed at the different points, $|F_B| > |F_A| > |F_C| > |F_D|$.

(d) Calculate the magnitude of the *electric field* at point A, in terms of given variables.
$\vec{E}_A = kQ / r_A^2 \hat{r}$

If Q is doubled, what is the new value of the electric field at A? If q is doubled instead, what is the new value of the field at A?
If *Q* is doubled, $\vec{E}' = 2\vec{E}$
If q is doubled $\vec{E}' = \vec{E}$

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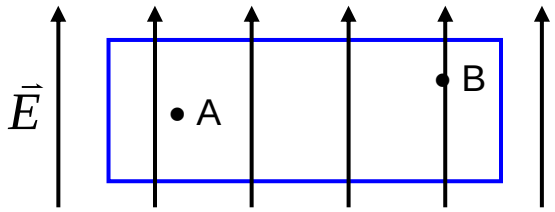
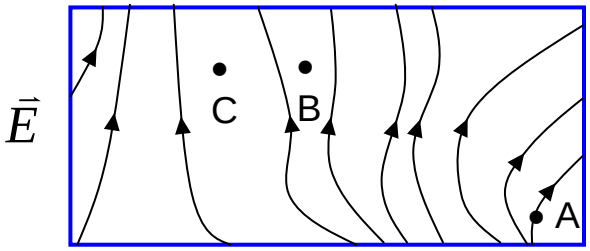
(e) The region in the box at right contains a uniform electric field, *E*. A test charge *q* is placed in the box. Compare the magnitude of the field at points A and B. Write an expression for the force the test charge feels at point A.



$\vec{E}_A = \vec{E}_B$

$\vec{F}_A = q\vec{E}$

(f) The region in the box at right contains a non-uniform electric field. Compare the magnitudes of the field at A,B, and C. If identical test charges are placed at B and C, which one is pushed out of the box first?



$\vec{E}_A > \vec{E}_B > \vec{E}_C$

The charge at B is pushed out of the box first.