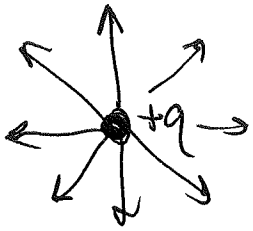
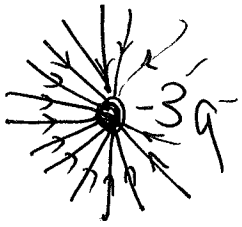
Name: Key

Practice - 18.5 Electric Field Lines: Multiple Charges

1. A. Sketch the electric field lines near a point charge +q.

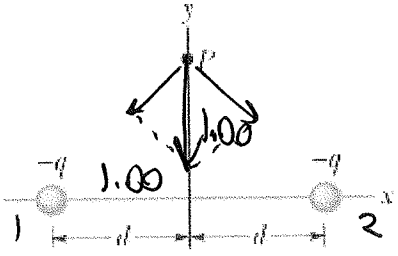


B. Do the same for a point charge -3.00q.



3X as many lines

2. A. In what direction does the electric field point at Point P? Downward



B. If d = 1.00 m, -q = -4.00 μC and the distance from Point P to the x-axis is 1.00 m, what is the magnitude of the electric field at Point P?

$E_{1y} = \frac{kq}{r^2}\cos 45^\circ \qquad r = \sqrt{1^2+1^2} = \sqrt{2}\ m$

$= \frac{\left(8.99\times10^{9}\frac{N m^2}{C^2}\right)\left(4.00\times10^{-6}\ C\right)}{\left(\sqrt{2}\ m\right)^2}\cos 45^\circ =$

$= 1.27\times10^{4}\frac{N}{C}$

X-components cancel

$E_{1y} = E_{2y}$

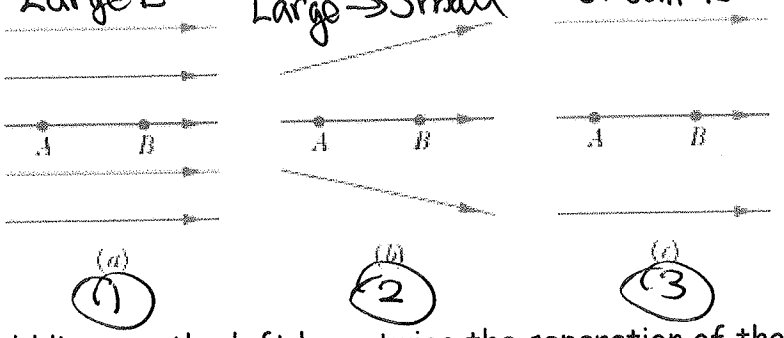
$E_{TOT} = E_{1y} + E_2 = 1.27\times10^{4} + 1.27\times10^{4}\frac{N}{C} = \boxed{2.54\times10^{4}\frac{N}{C}}$

3. Three arrangements of electric field lines are shown. In each arrangement, a proton is released from rest at point A and is then accelerated through point B by the electric field. Points A and B have equal separations in the three arrangements. Rank the arrangements according to the linear momentum of the proton at point B, greatest first. Large $\vec{E}$ Large → Small Small $\vec{E}$

$p = mv$

$v = v_0 + at$

$a = \frac{qE}{m}$



(a) 1 (b) 2 (c) 3

4. The electric field lines on the left have twice the separation of those on the right.

A. If the magnitude of the field at A is $40 \frac{N}{C}$, what is the magnitude of the force on a proton at A?

$$F = qE = (1.60 \times 10^{-19} C)\left(40 \frac{N}{C}\right) = \boxed{6.40 \times 10^{-18} N}$$

B. What is the magnitude of the field at B?

Field lines are twice as far apart $\Rightarrow$ E has $\frac{1}{2}$ the value

$$\boxed{20.0 \frac{N}{C}}$$

5. The nucleus of a plutonium-239 atom contains 94 protons. Assume that the nucleus is a sphere with radius 6.64 fm (1 fm = 10^{-15} m) and with the charge of the protons uniformly spread through the sphere. At the nucleus surface, what are the magnitude and direction (radially inward or outward) of the electric field produced by the protons?

$$E = \frac{kq}{r^2} = \frac{\left(8.99 \times 10^9 \frac{Nm^2}{C^2}\right)(94 \times 1.60 \times 10^{-19} C)}{(6.64 \times 10^{-15} m)^2} = \boxed{3.07 \times 10^{21} \frac{N}{C}}$$

radially outward

6. What is the magnitude of a point charge whose electric field 50.0 cm away has the magnitude 2.00 N/C?

$$E = \frac{kq}{r^2} \Rightarrow q = \frac{Er^2}{k} = \frac{\left(2.00\frac{N}{C}\right)(0.500\,m)^2}{\left(8.99\times10^9\frac{N m^2}{C^2}\right)}$$

$$= \boxed{5.56\times10^{-11}\,C} \quad 55.6\,pC$$