15.4 Electric Field Lines
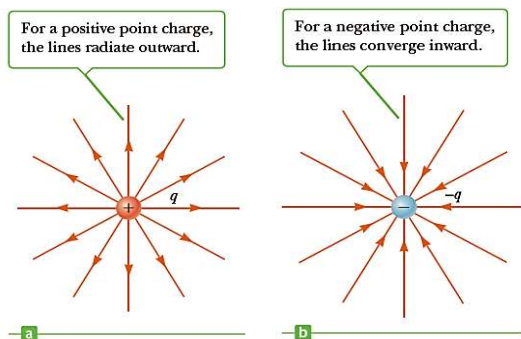
The electric field lines are related to the electric field in any region of space in the following way:

1. The electric field vector $\vec{E}$ is tangent to the electric field lines at each point.

2. The number of lines per unit area through a surface perpendicular to the lines is proportional to the strength of the electric field in a given region.

Note that $\vec{E}$ is large when the field lines are close together and small when the lines are far apart.
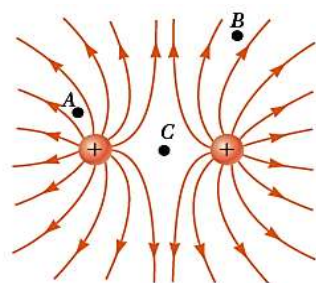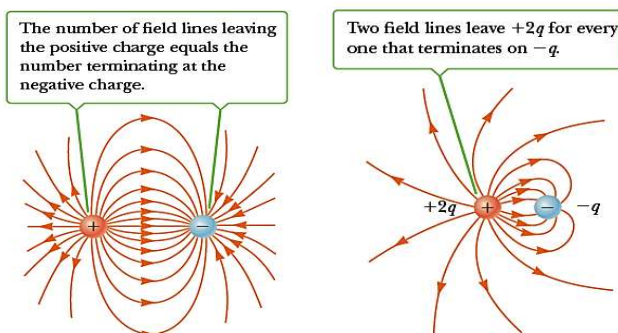
The rules for drawing electric field lines for any charge distribution follow directly from the relationship between electric field lines and electric field vectors:

1. The lines for a group of point charges must begin on positive charges and end on negative charges. In the case of an excess of charge, some lines will begin or end infinitely far away.
2. The number of lines drawn leaving a positive charge or ending on a negative charge is proportional to the magnitude of the charge.
3.   No two field lines can cross each other

For a positive point charge, the lines radiate outward.

For a negative point charge, the lines converge inward.

The electric field lines for a point charge

The electric field lines for two equal and opposite point charges (an electric dipole). And the electric field lines for a point charge of +2q and a second point charge of -q.

The number of field lines leaving the positive charge equals the number terminating at the negative charge.

Two field lines leave $+2q$ for every one that terminates on $-q$.

The electric field lines for two positive point charges. The points A, B, and C are discussed in Quick Quiz 15.6.

Note – At points very near either charge, the lines are nearly radial. The high density of lines between the charges indicates a strong electric field in this region.

Quick Quiz 15.6 Rank the magnitudes of the electric field at points A, B, and C in Figure with the largest magnitude first. (a) A, B, C (b) A, C, B (c) C, A, B (d) The answer can't be determined by visual inspection.

Solution: The correct answer is (a). The field is greatest at point A because this is where the field lines are closest together. The absence of lines at point C indicates that the electric field there is zero.

Problems

Problem 18.6 Figure shows the electric field lines for two point-charges separated by a small distance. (a) Determine the ratio q_1/q_2. (b) What are the signs of q_1 and q_2?