ELECTRIC FIELD LINES

A convenient aid for visualizing electric field patterns is to draw lines pointing in the direction of the electric field, called *electric field lines.* Although electric field lines do not really exist, they offer a useful means of analyzing fields by representing both the strength and the direction of the field at different points in space. This is useful because the field at each point is often the result of more than one charge, as seen in Sample Problem D. Field lines make it easier to visualize the net field at each point.

The number of field lines is proportional to the electric field strength

By convention, electric field lines are drawn so that the electric field vector, **E,** is tangent to the lines at each point. Further, 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. Thus, *E* is stronger where the field lines are close together and weaker where they are far apart.

Figure 9(a) shows some representative electric field lines for a positive point charge. Note that this two-dimensional drawing contains only the field lines that lie in the plane containing the point charge. The lines are actually directed outward radially from the charge in all directions, somewhat like quills radiate from the body of a porcupine. Because a positive test charge placed in this field would be repelled by the positive charge *q,* the lines are directed away from the positive charge, extending to infinity. Similarly, the electric field lines for a single negative point charge, which begin at infinity, are directed inward toward the charge, as shown in **Figure 9(b).** Note that the lines are closer together as they get near the charge, indicating that the strength of the field is increasing. This is consistent with our equation for electric field strength, which is inversely proportional to distance squared. **Figure 9(c)** shows grass seeds in an insulating liquid. When a small charged conductor is placed in the center, these seeds align with the electric field produced by the charged body.

The rules for drawing electric field lines are summarized in **Table 4.** Note that no two field lines from the same field can cross one another. The reason is that at every point in space, the electric field vector points in a single direction and any field line at that point must also point in that direction.

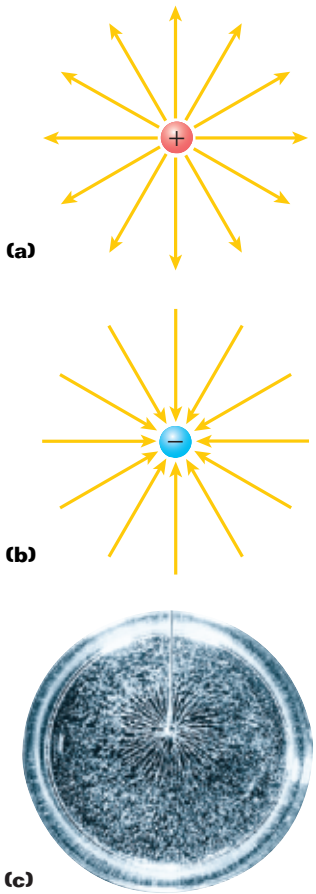

Figure 9
The diagrams **(a)** and **(b)** show some representative electric field lines for a positive and a negative point charge. In **(c),** grass seeds align with a similar field produced by a charged body.

Table 4 Rules for Drawing Electric Field Lines

The lines must begin on positive charges or at infinity and must terminate on negative charges or at infinity.
The number of lines drawn leaving a positive charge or approaching a negative charge is proportional to the magnitude of the charge.
No two field lines from the same field can cross each other.