To determine the potential difference between any two points near the point charge q_1, first note that the electric potential at each point depends only on the distance from each point to the charge q_1. If the two distances are r_1 and r_2, then the potential difference between these two points can be written as follows:

$$\Delta V = k_C \frac{q_1}{r_2} - k_C \frac{q_1}{r_1} = k_C q_1 \left(\frac{1}{r_2} - \frac{1}{r_1} \right)$$

If the distance r_1 between the point and q_1 is large enough, it is assumed to be infinitely far from the charge q_1. In that case, the quantity $1/r_1$ is zero. The expression then simplifies to the following (dropping the subscripts):

POTENTIAL DIFFERENCE BETWEEN A POINT AT INFINITY AND A POINT NEAR A POINT CHARGE

$$\Delta V = k_C \frac{q}{r}$$

$$\text{potential difference} = \text{Coulomb constant} \times \frac{\text{value of the point charge}}{\text{distance to the point charge}}$$

This result for the potential difference associated with a point charge appears identical to the electric potential associated with a point charge. The two expressions look the same only because we have chosen a special reference point from which to measure the potential difference.

One common application of the concept of potential difference is in the operation of electric circuits. Recall that the reference point for determining the electric potential at some point is arbitrary and must be defined. Earth is frequently designated to have an electric potential of zero and makes a convenient reference point. Thus, *grounding* an electrical device (connecting it to Earth) creates a possible reference point, which is commonly used to measure the electric potential in an electric circuit.

The superposition principle can be used to calculate the electric potential for a group of charges

The electric potential at a point near two or more charges is obtained by applying a rule called the *superposition principle.* This rule states that the total electric potential at some point near several point charges is the algebraic sum of the electric potentials resulting from each of the individual charges. While this is similar to the method used previously to find the resultant electric field at a point in space, here the summation is much easier to evaluate because the electric potentials are scalar quantities, not vector quantities. There are no vector components to consider.

To evaluate the electric potential at a point near a group of point charges, you simply take the algebraic sum of the potentials resulting from all charges. Remember, you must keep track of signs. The electric potential at some point near a positive charge is positive, and the potential near a negative charge is negative.

Did you know?

The volt is named after the Italian physicist Alessandro Volta (1745–1827), who developed the first practical electric battery, known as a voltaic pile. Because potential difference is measured in units of volts, it is sometimes referred to as *voltage*.

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