unit charge (measured in units of volts), and potential difference describes a change in energy per unit charge.

The potential difference in a uniform field varies with the displacement from a reference point

The expression for potential difference can be combined with the expressions for electrical potential energy. The resulting equations are often simpler to apply in certain situations. For example, consider the electrical potential energy of a charge in a uniform electric field.

$$PE_{electric} = -qEd$$

This expression can be substituted into the equation for potential difference.

$$\Delta V = \frac{\Delta(-qEd)}{q}$$

As the charge moves in a uniform electric field, the quantity in the parentheses does not change from the reference point. Thus, the potential difference in this case can be rewritten as follows:

POTENTIAL DIFFERENCE IN A UNIFORM ELECTRIC FIELD

$$\Delta V = -Ed$$

potential difference = −(magnitude of the electric field × displacement)

Keep in mind that d is the displacement *parallel* to the field and that motion perpendicular to the field does not change the electrical potential energy.

The reference point for potential difference near a point charge is often at infinity

To determine the potential difference between two points in the field of a point charge, first calculate the electric potential associated with each point. Imagine a point charge q_2 at point A in the electric field of a point charge q_1 at point B some distance, r, away as shown in **Figure 4.** The electric potential at point A due to q_1 can be expressed as follows:

$$V_A = \frac{PE_{electric}}{q_2} = k_C\frac{q_1q_2}{rq_2} = k_C\frac{q_1}{r}$$

Do not confuse the two charges in this example. The charge q_1 is responsible for the electric potential at point A. Therefore, *an electric potential exists at some point in an electric field regardless of whether there is a charge at that point.* In this case, the electric potential at a point depends on only two quantities: the charge responsible for the electric potential (in this case q_1) and the distance r from this charge to the point in question.

Did you know?

A unit of energy commonly used in atomic and nuclear physics that is convenient because of its small size is the *electron volt,* eV. It is defined as the energy that an electron (or proton) gains when accelerated through a potential difference of 1 V. One electron volt is equal to 1.60×10^{-19} J.

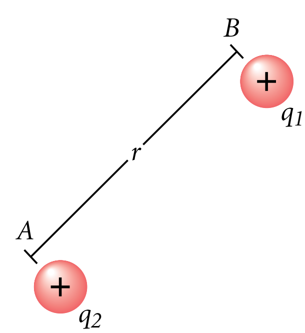

Figure 4
The electric potential at point A depends on the charge at point B and the distance r.