First let’s examine **electric potential energy**. If a charged object is in an electric field it has electric potential energy - that is it has the potential to move in that field. Note that the potential energy it has could be used to…

A non-uniform field, such as that provided by a point, is one which has a different…

In this case we can derive a formula for the electric potential energy in a NON-UNIFORM FIELD:

\[ W = E_p = F_e \cdot d = \left(\frac{Kq_1q_2}{r^2}\right) \cdot d = \frac{Kq_1q_2}{r} \]

Again note the similarities between…

**Example:**
How much work must be done to bring a 4.0 uC charged object to within 1.0 m of a 6.0 uC charged object from a long way away?

\[ U = E_p = \frac{Kq_1q_2}{r} \]

\[ = \frac{(9.0 \times 10^9)(6.0 \times 10^{-9})(4.0 \times 10^{-10})}{1.0} \]

\[ = 0.216 \text{ J} \]

In this case, bringing a positive charge near another positive charge requires ______ therefore the work is ______.

**Example:**
How much work must be done to bring a -7.0 uC charged object to within 0.5 m of a 5.0 uC charged object from a long way away?

\[ E_p = \frac{Kq_1q_2}{r} \]

\[ = \frac{(9.0 \times 10^9)(5.0 \times 10^{-9})(-7.0 \times 10^{-9})}{0.5} \]

\[ = -0.63 \text{ J} \]

In this case, bringing a negative charge near a positive charge ______ energy therefore work is ______.
Electric Potential

Now we need to consider a new quantity, electric potential (V). Electric potential is defined as the electric potential energy per unit charge.

\[ V = \frac{E_p}{q} \]

Which becomes,

\[ V = \frac{kq}{r} \]

NOTE:

1. The electric potential is defined in terms of the moving of a positive charge. Therefore...
   - + charges... move towards low potential
   - - charges... move towards high potential

2. The unit for potential is...

Example:
Calculate the potential at point P as shown in the diagram.

\[ V_T = V_1 + V_2 + V_3 \]

\[ V_1 = \frac{kq_1}{r_1} = \frac{(9.0 \times 10^9)(3.0 \times 10^{-4})}{0.05} = 540,000 \text{ V} \]

\[ V_2 = \frac{kq_2}{r_2} = \frac{(9.0 \times 10^9)(4.0 \times 10^{-6})}{0.070} = 51,400 \text{ V} \]

\[ V_3 = \frac{kq_3}{r_3} = \frac{(9.0 \times 10^9)(-2.0 \times 10^{-6})}{0.050} = -360,000 \text{ V} \]

\[ V_T = 540,000 + 51,400 - 360,000 = 694,000 \text{ V} \]

NOTE:

1. Potentials are... scalar quantities

2. We WILL use... + and - signs of charges
Potential Difference

We sometimes want to determine the electric potential between two points. This is known as the potential difference.

For example, given two points A and B, the potential difference between A and B is:

\[ V_{AB} = V_B - V_A \]

NOTE: When we talk about potential at a point we are talking about the potential difference between that point and infinity, where the potential at infinity is ZERO.

**Example:** What is the potential difference between points A and B due to the charge shown?

\[ V_{AB} = V_B - V_A = \frac{kq_1}{r_b} - \frac{kq_2}{r_A} = \frac{(9.0 \times 10^9)(8.00 \times 10^{-6})}{0.50} - \frac{(9.0 \times 10^9)(8.00 \times 10^{-6})}{1.00} = 72,000 \, V \]