Physics 12
Section 17-5
Electric Potential Due to Point Charges

1. The electric potential due to a single point charge can be calculated using the following equation:

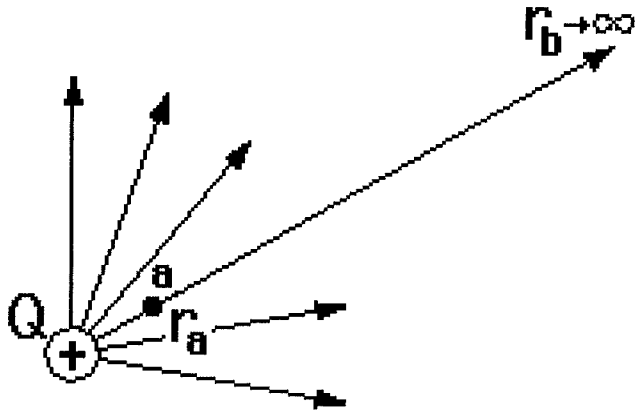
$$V = kQ/r$$

V is the electric potential at a certain distance r away from a single charge Q.

The electric potential is considered to be zero at an infinite distance from the charge Q.

The electric field is also considered to be zero at an infinite distance from the charge Q.

$$V_a - V_b = kQ\left[\frac{1}{r_a} - \frac{1}{r_b}\right]$$



$$\Delta Ep = q\Delta V$$

$$\Delta Ep = q(kQ/r_2 - kQ/r_1)$$

But r_2 is the current location and r_1 is at infinity so the electric potential at r_1 is zero.

To form:

$$Ep = \frac{KqQ}{r}$$

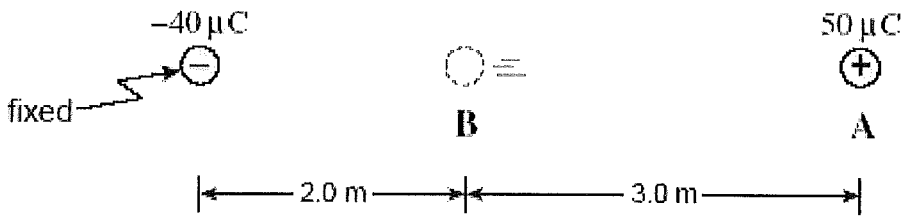
or

$$Ep = \frac{KQ_1Q_2}{r}$$

This is the electric potential energy between two charges and distance r apart

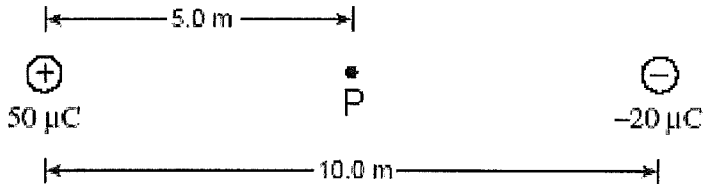
Example:

5. A 1.0×10^{-3} kg styrofoam ball carrying 50 μC of charge is released from rest from position A as shown in the diagram below. ($1\ \mu C = 1 \times 10^{-6}$ C)



a) Determine the change in electric potential energy, ΔE_p, of the ball as it moves from position A to position B. **(5 marks)**

5. a) Determine the electric potential, relative to zero at infinity, at point P, midway between the two charges, shown below. **(5 marks)**



$V = V_{50\mu C} + V_{-20\mu C}$ ← **1 mark**

$V = 9.0\times10^{9}\left(50\times10^{-6}\right)/5.0 \;+\; 9\times10^{9}\left(-20\times10^{-6}\right)/5.0$ ← **3 marks**

$V = 5.4\times10^{4}\ \text{V}$ ← **1 mark**

b) How much work would it take to move a $-15\ \mu C$ charge from point P to a position infinitely far away? **(2 marks)**

$W = \Delta E_p = E_{pf} - E_{pi}$ ($\Delta V \times q$)

$W = 0-\left(54\times10^{3}\right)\left(-15\times10^{-6}\right)$ ← **1 mark**

$W = 0.81\ \text{J}$ ← **1 mark**

2. The electric potential energy of an object can be calculated by combining the following:

$\Delta E_p = q\Delta V$ from 17-1

and

$V = kQ/r$ from 17-5

$$\Delta E_p = k\frac{Q_1Q_2}{r} - k\frac{Q_1Q_2}{r_0}$$ ← 1 mark

$$\Delta E_p = 9\times10^9\frac{\left(50\times10^{-6}\right)\left(-40\times10^{-6}\right)}{2} - 9\times10^9\frac{\left(50\times10^{-6}\right)\left(-40\times10^{-6}\right)}{5}$$

$$\Delta E_p = -9 - \left(-3.6\right)$$

$$\Delta E_p = -5.4\ \text{J}$$

← 4 marks