Electric Potential Energy

Electric potential energy is analogous to gravitational potential energy. It is the amount of energy a charged object has by virtue of being in an electric field, that energy can be converted into Kinetic energy if the object is left to accelerate.

Recall the formula for gravitational potential energy in a non uniform field was

$$E_p = \frac{-Gm_1 m_2}{r}$$

The formula for electric potential energy in a non uniform field is

$$E_p = \frac{kq_1 q_2}{r}$$

* Use signs of charges in this equation

The zero point is when the two objects are infinitely far apart.

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?

$$W = \Delta E = E_f - E_i$$

$$= \frac{kq_1 q_2}{1} - 0 = 0.22\text{ J}$$

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

Example: How much work must be done to bring a -7.0 μC charged object to within 0.50 m of a 5.0 μC charged object from a long way away?

$$W = \Delta E = E_{pf} - E_{pi}$$

$$= \frac{kq_1q_2}{r} - 0 = -0.63\ J$$

In this case, bringing a negative charge near a positive charge lost energy therefore work is negative.

Example: A 0.025 kg ball with a charge of 15.6 μC is 0.062 metres from a 73.6 μC charge. What will be the speed of the ball when it is 1.5 metres from the charge?

$$W = \Delta E = E_f - E_i$$

$$= \frac{8.988\times10^9 \times 15.6\times10^{-6} \times 73.6\times10^{-6}}{1.5} - \frac{8.988\times10^9\times15.6\times10^{-6}\times73.6\times10^{-6}}{0.062}$$

$$= 6.880\ J - 166.45\ J = -159.57\ J$$

$$E_K \text{ gained} = E_p \text{ lost}$$

$$v = \sqrt{\frac{2E_K}{m}} = 113\ m/s$$

$$\approx 110\ m/s$$