Electric Potential

e=1.6E-19 C   k = 8.99E9 Nm^2/C^2

1. The potential energy, U, of a proton is 5E-18 J at a certain point in an electric field. What is the electric potential, V, at this point?

   $V = \frac{U}{q} = \frac{5E\text{-}18\,J}{1.6E\text{-}19} = 31.25$ volts

2. An object with charge q = +2E-16 C is located 1.0 cm from another object with charge Q = +2E-10 C.

   a. What is the electric potential, V, at the point occupied by q?

   $V = \frac{kQ}{r} = \frac{k(2E\text{-}10)}{1E\text{-}2} = 179.8\,V$

   b. What is the potential energy, U, of q?

   $V = \frac{U}{q}$ $U = qV = 3.6E\text{-}14\,J$

3. What is the final velocity of an electron that started from rest and was accelerated through a potential difference of 1000 V? (electron mass = 9.11E-31 kg)

   $K_i + U_i = K_f + U_f$

   $U_i - U_f = K_f$

   $-\Delta U = K_f$

   $+qV = \frac{1}{2}mv^2$

   $-(1.6E\text{-}19)(1000) = \frac{1}{2}(9.11E\text{-}31)v^2$

   $v = 1.87E7$ m/s

4. A proton is located 0.80 meters from a source charge, Q = +3C. How much work is required to move the proton to a point 0.50 meters from Q?

   $V = \frac{k(3)}{.8} = 3.37E10$

   $V_f = \frac{k(3)}{.5} = 5.34E10$

   $\Delta U = qV_f - qV_0$

   $(1.6E\text{-}19)(5.34E10 - 3.37E10)$

   $\Delta U = 3.152E\text{-}9$

   $W = -\Delta U = -3.2E\text{-}9\,J$

5. An electron starts from rest and is accelerated through a potential difference of 12V.

   a. How much work was done on the electron? (express answer in J and eV) $1.6E\text{-}19\,J = 1\,eV$

   $W = q\Delta V$

   $(1.6E\text{-}19)(12)$

   19.2E-18 J

   12 eV

   b. How much energy did the electron gain? (express answer in J and eV)

   1.92E-18 J

   12 eV

   c. What is the final speed of the electron?

   $1.92E\text{-}18 = \frac{1}{2}(9.11E\text{-}31)v^2$

   $v = 2.05E6$ m/s