PHYSICS 12

ELECTRIC POTENTIAL ENERGY (EPE)

Electric potential energy (EPE or E_p) is the energy of an electrically charged particle that is associated with this particle's distance from another electrically charged particle. The electric potential energy is the result of the particle's ability to overcome the effect of attractive or repulsive electric force.

- Units – Joule [J]
- Formula:

$$EPE = \frac{kq_1q_2}{r}$$

where k is Coulomb's constant $9.00 \times 10^9 Nm^2/C^2$
q_1 and q_2 stand for the magnitude of two charges in Coulombs [C]
r is the distance between the charges measured in meters [m]

WORK (W)

Work done within an electric field: When a positive test charge moves from point A to point B in an electric field, work W_{AB} is done by the electric force. The work is equal to the difference in the electric potential energy.

$$W = EPE_A - EPE_B$$

ELECTRIC POTENTIAL (V)

Electric Potential at a given pint is the electric potential energy of a small test charge situated at that point divided by the charge itself.

- Units: [J/C] = **Volt [V]**

$$V = \frac{EPE}{q}$$

Electric potential difference created by a point charge:

$$V = \frac{kq}{r}$$

The total potential at a given location due to two or more charges is the **algebraic sum** of the potentials due to each charge.

ELECTRIC POTENTIAL DIFFERENCE = VOLTAGE (ΔV)

The potential difference between two points A and B is often called voltage.

$$V_B - V_A = \frac{EPE_B}{q} - \frac{EPE_A}{q} = \frac{-W_{AB}}{q}$$

Recall: The Law of Conservation of Energy: Energy cannot be created nor can it be destroyed, it can only be transformed from one form to another.

$$KE_i + EPE_i = KE_f + EPE_f$$

Example 1:

Which of the following is equal to the work required per coulomb to move a positive charge from one position to another in an electric field?

A. E_p, electric potential energy

B. ΔE_p, change in electric potential energy

C. V, electric potential

D. ΔV, electric potential difference

Example 2:

An electric charge accelerated from rest through a potential difference of 250 V reaches a speed of 9.4×10^6 m/s. What speed will this same charge reach if it is accelerated by a potential difference of 125 V?

A. 4.7×10^6 m/s

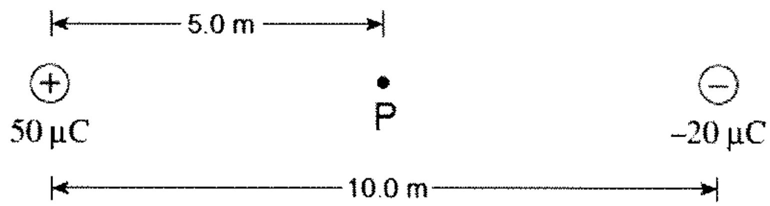
B. 6.6×10^6 m/s

C. 9.4×10^6 m/s

D. 1.3×10^7 m/s

Example 3:

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

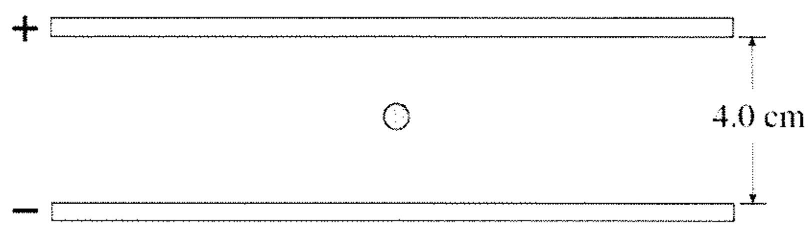


b) How much work would it take to move a −15 μC charge from point P to a position infinitely far away? **(2 marks)**

Example 4:

a)

A small negatively charged sphere with a mass of 4.5×10^{-6} kg is suspended electrostatically between oppositely charged horizontal parallel plates as shown in the diagram. A potential difference of 360 V is required across the plates to hold the charged sphere stationary.



Calculate the magnitude of the charge on the sphere.

b)

A sphere with a smaller mass carrying an equal but opposite charge is now placed between the plates. Using physics principles, explain the changes that must be made to the plates to keep the new sphere stationary.