Answer on Question 76018, Physics, Other

Question:

An electron is projected horizontally into the space between two oppositely charged metal plates. The electric field between the plates is $500\,N/C$, directed up.

(a) While in the field, what is the force on the electron?

(b) If the vertical deflection of the electron as it leaves the plates is $3.0\,mm$, how much has its kinetic energy increased due to the electric field?

Solution:

(a) We can find the electric force acting on the electron from the formula:

$$F_e = qE,$$

here, $q = -1.6 \cdot 10^{-19}\,C$ is the charge of the electron, $E = 500\,N/C$ is the strength of the electric field.

Then, we get:

$$F_e = qE = -1.6 \cdot 10^{-19}\,C \cdot 500\,\frac{N}{C} = -8.0 \cdot 10^{-17}\,N.$$

The sign minus indicates that the force acting on the electron directed downward (it directed opposite to the direction of the electric field).

(b) We can find the change in the kinetic energy of the electron due to the electric field from the work – kinetic energy theorem (the change in the kinetic energy is equal to the work done by the electric force on the electron):

$$\Delta KE = W,$$

here, ΔKE is the change in the kinetic energy of the electron due to the electric field, W is the work done by the electric force on the electron.

By the definition of the work done, we get:

$$W = F_e \Delta d = qE\Delta d,$$

here, $\Delta d = -3.0 \cdot 10^{-3}\,m$ is the vertical deflection of the electron as it leaves the plates.

Finally, we get:

$$\Delta KE = W = -1.6 \cdot 10^{-19}\,C \cdot 500\,\frac{N}{C} \cdot (-3.0 \cdot 10^{-3}\,m) =$$

$$= 2.4 \cdot 10^{-19}\,J \cdot \frac{1\,eV}{1.6 \cdot 10^{-19}\,J} = 1.5\,eV.$$

Answer:

(a) $F_e = 8.0 \cdot 10^{-17}\,N$, downward.

(b) $\Delta KE = 2.4 \cdot 10^{-19}\, J = 1.5\ eV$.