**Answer on question #61562, Physics, Electromagnetism**

As the electrons are accelerated through the second anode, the gain in kinetic energy is $1.98X10^{-15}$ J, and the speed of the electrons as they enter the region between the electric field plates is $6.60X10^{7}$ m/s. The electrons are moving to the right as they pass between the electric field plates. The plates are 2.00 cm long, 2.00 mm apart, and as the electrons pass between the plates, the potential difference is $4.50X10^{2}$ V. The top plate of the electric field is positive charged.

**a)** Determine the acceleration of the electron in the region between the deflection plates. Include both magnitude and direction in your answer.

**b)** Determine the vertical component of the velocity of the electrons when they emerge from the region between the plates. Include both magnitude and direction in your answer

**c)** Determine the vertical displacement of the electrons as they are deflected. Include both magnitude and direction in your answer.

**Solution:**

**a)**

To determine the acceleration on the electrons as they pass between the plates we use:

$$F = qE$$

and

$$F = ma$$

Where, *F* is the force (N); *q* is the electronic charge ($1.6 \times 10^{-19}$ C), *m* is the mass of the electron ($9{,}1\times10^{-31}$ kg) and *a* is the acceleration of the electron ($ms^{-2}$)

Equating the two expressions gives us:

$$ma = qE$$

The electric field between the plates is given by:

$$E = \frac{U}{d}$$

Where: *U* is the voltage applied between the plates and *d* is the plate separation.

Hence:

$$a = \frac{qU}{dm}$$

Finally,

$$a = \frac{1.6 \cdot 10^{-19} C \times 4.5 \cdot 10^{2} V}{9.1 \cdot 10^{-31} kg \times 2 \cdot 10^{-3} m} = 3.96 \cdot 10^{16}\ ms^{-2}$$

**b)**

Use

$$v = u + at$$

Since the electron beam enters horizontally between the plates then there is no initial vertical component of velocity: *u* = 0.

$$v = at$$

The time it takes for the electrons to pass between the plates is obtained by using:

$$s = Vt$$

Where: *S* is plate length of 2.00 cm, and *V* is the velocity of the electrons as they enter the region between the plates.

$$t = \frac{s}{V}$$

$$t = \frac{2 \cdot 10^{-2} m}{6.6 \cdot 10^{7} ms^{-1}} = 3.03 \cdot 10^{-10}\ s$$

Finally,

$$v = 3.96 \cdot 10^{16}\ ms^{-2} \times 3.03 \cdot 10^{-10}\ s = 1.2 \cdot 10^{7}\ ms^{-1}$$

**c)**

The vertical displacement of the electrons as they leave the plate deflected is derived by making use of:

$$s = ut + \frac{at^2}{2}$$

But, u = 0.

$$s = \frac{at^2}{2}$$

Where: S, is the deflection on emerging from the plates t = 3.03 x $10^{-10}$ s later.

$$s = \frac{3.96 \cdot 10^{16}\ ms^{-2} \times (3.03 \cdot 10^{-10}\ s)^2}{2} = 1.82 \cdot 10^{-3} m = 1.82\ mm$$

**Answer:** a) $3.96 \cdot 10^{16}\ ms^{-2}$ b) $1.2 \cdot 10^{7}\ ms^{-1}$ c) $1.82\ mm$