Question 25

Marks

Question 25 (6 marks)

A pair of parallel metal plates, placed in a vacuum, are separated by a distance of 5.00×10^{-3} m and have a potential difference of 1000 V applied to them.

(a) Calculate the magnitude of the electric field strength between the plates. **1**

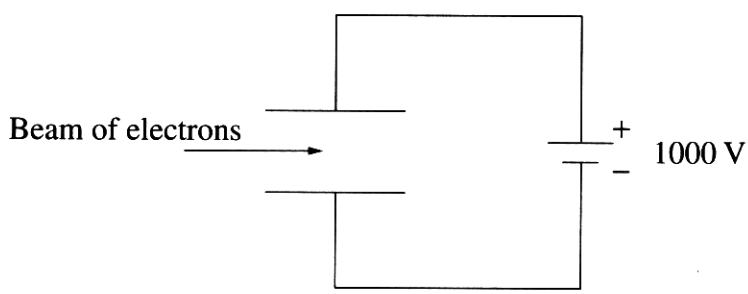
$d = 5\times10^{-3}$ $1000U = U$ $F = qvB$

$\mathcal{E} = \frac{1000}{5\times10^{-3}} = 2\times10^{5}$ T $\frac{-3.204\times10^{-14}}{1.602\times10^{-19}\times1000} = B$ $B = 200$

(b) Calculate the magnitude of the electrostatic force acting on an electron between the plates. **1**

$\mathcal{E} = \frac{F}{q}$ $2\times10^{5} = \frac{F}{-1.602\times10^{-19}}$ $F = -3.204\times10^{-14}$

(c) A beam of electrons is fired with a velocity of 3.00×10^{6} m s^{-1} between the plates as shown. A magnetic field is applied between the plates, sufficient to cancel the force on the electron beam due to the electric field. **4**



Calculate the magnitude and direction of the magnetic field required between the plates to stop the deflection of the electron beam.

$V = 1000$V $A = 3\times10^{6}$ ms^{-1} $q = -1.602\times10^{-19}$

$m = 9.109\times10^{-31}$

$F = qmA$ | $F = qvB$

$F = 9.109\times10^{-31} \times 3\times10^{6}$ | $2.7327\times10^{-24} = 1.602\times10^{-19} \cdot 1000.B$

$F = 2.7327\times10^{-24}$ | $\frac{2.7327\times10^{-24}}{-1.602\times10^{-19}\times1000} = B$

$B = -1.7\times10^{-8}$ T