**Question 25** (6 marks)

A pair of parallel metal plates, placed in a vacuum, are separated by a distance of $5.00 \times 10^{-3}$ 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**

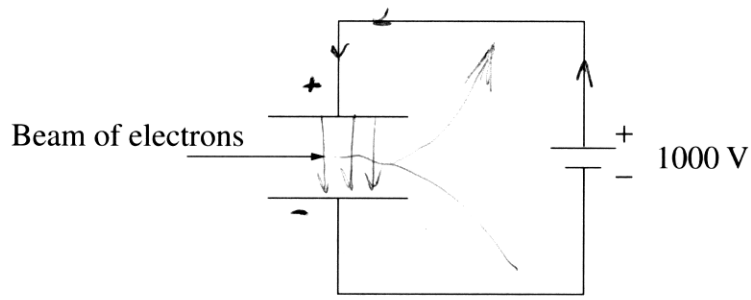
$E = \frac{V}{d} = \frac{1000}{5 \times 10^{-3}} = 200\,000$ J

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

$F = qE \quad F = 200\,000 \times 1.602 \times 10^{-19}$

$F = 3.204 \times 10^{-14}$ N

(c) A beam of electrons is fired with a velocity of $3.00 \times 10^{6}$ 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.

$v = 3.00 \times 10^{6}$ ms$^{-1}$ $\quad F = 3.204 \times 10^{-14}$

$F = qvB$

$3.204 \times 10^{-14} = 1.602 \times 10^{-19} \times 3 \times 10^{6} \times B$

$3.204 \times 10^{-14} = 4.806 \times 10^{-13} B$

$B = 0.0666$ T

$= 6.67 \times 10^{-2}$ T Up. out of page