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**

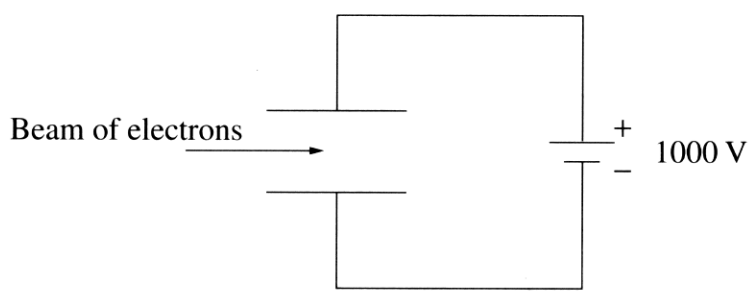
$E = \frac{V}{d} \cdot \frac{1000}{5 \times 10^{-3}} = 2 \times 10^5$ J

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

$E = \frac{F}{q}$ $F = Eq$

$F = 2 \times 10^5 \times -1.602 \times 10^{-9} = -3.204 \times 10^{-4}$ N

(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.

$F = -3.204 \times 10^{-4}$ V

$B = 2 \times 10^5$

$F = 3 \times 10^6$

$0 =$

$F = -1.602 \times 10^{-19} \times 3 \times 10^6 \times B \frac{V}{d}$

$F = -1.602 \times 10^{-19} \times 3 \times 10^6 \times \frac{1000}{5.00 \times 10^{-3}}$ ✓ from (a)

$= -7.812 \times 10^{-8}$