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.

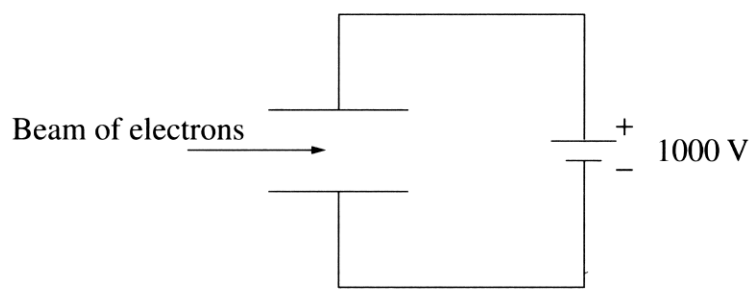
(a) Calculate the magnitude of the electric field strength between the plates. **1**

$E = \frac{V}{d} = \frac{1000}{5.00 \times 10^{-3}}$ ∴ $E = 2 \times 10^5$ N C^{-1}

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

$F = qE$
$= 1.6 \times 10^{-14} \times 2 \times 10^5$ → $F = 3.2 \times 10^{-14}$ 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.

$qF_E = F_B$
$qE = qvB$
$E = \frac{V}{d}$
$= \frac{1000}{3 \times 10^6}$
$= 3.3 \times 10^{-4}$

→ So ∴ $B = \frac{E}{v}$
$B = \frac{3.3 \times 10^{-4}}{3 \times 10^6}$
$B = 1.11 \times 10^{-10}$ T

And the direction of the magnetic field is into the page.