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.

$P = IV$

$V = \frac{P}{I}$

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

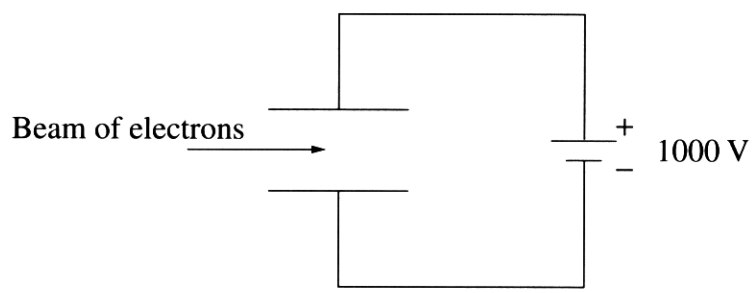
$E = \frac{V}{d} = \frac{1000}{5 \times 10^{-3}} = 200\,000\ V m^{-1}$

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

$E = \frac{F}{q} = 2 \times 10^5$

$F = -1.602 \times 10^{-19} \times 2 \times 10^5 = 3.204 \times 10^{-14}$

(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.

$F = qvB\sin\theta$

$= 1.602 \times 10^{-19} \times 3 \times 10^6 \times B \quad (\sin 90° = 1,\ \theta = 90°)$

$F = qE$

$F = qVB\sin\theta$

$E = VB\sin\theta \quad (\sin\theta = 1,$ perpendicular$)$

$E = VB$

$2 \times 10^5 = 3 \times 10^6 \times B$

$B = \frac{2 \times 10^5}{3 \times 10^6}$

$= \frac{1}{15}$

$\doteq 0.067\,T$