$E = F/q$

$F = Eq$

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.

d

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

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

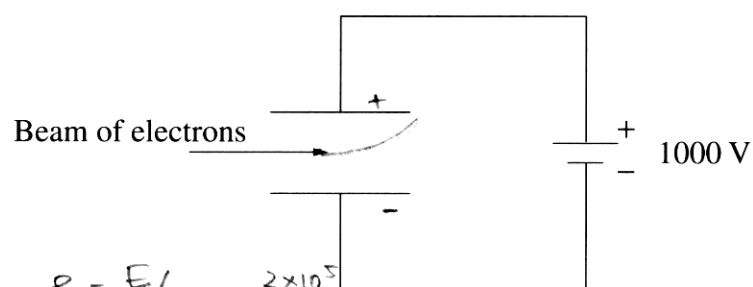
∴ Electric field strength is 2×10^5 V m^{-1}

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

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

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

(c) A beam of electrons is fired with a velocity of 3.00×10^6 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**



$F_B = F_E$

$qvB = qE$

$v = E/B$ $\quad B = E/v = \frac{2 \times 10^5}{3 \times 10^6}$

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

For undeflected beam: $F_B = F_E$ ie $qvB = qE$

∴ $B = E/v$ from (a) $E = 2 \times 10^5$ and $v = 3 \times 10^6$

∴ $B = \frac{2 \times 10^5}{3 \times 10^6} \doteq 0.06\dot{6}$

∴ The magnetic field magnitude is 0.07 T (to 2dp)

The electric field alone forces the electrons up so the magnetic field must force them down. Hence the bottom plate must be a North pole