

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.

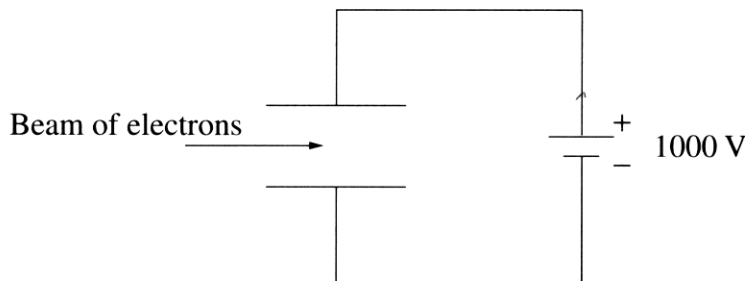
- (a) Calculate the magnitude of the electric field strength between the plates. 1

$$E = \frac{V}{d} = \frac{1000 \text{ V}}{5 \times 10^{-3}} = 200000 \text{ V/m}$$

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

$$F = qE = 1.6 \times 10^{-19} \times 200000 = 3.2 \times 10^{-14} \text{ N}$$

- (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.

$$F = qvB \sin \theta$$

$$F = 1.6 \times 10^{-19} \times 3.00 \times 10^6 \text{ B}$$

$$-1.6 \times 10^{-16} = 1.6 \times 10^{-19} \times 3.0 \times 10^6 \text{ B}$$

$$B = 3.3 \times 10^{-4} \text{ T down the page}$$