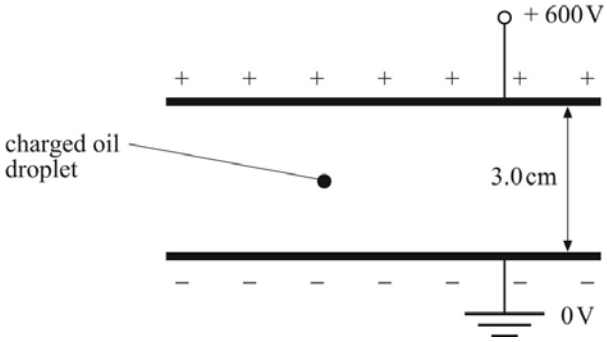
26 Worksheet (A2)

Data needed to answer questions can be found in the Data, formulae and relationships sheet.

1 Calculate the force experienced by an oil droplet with a charge of 3.2×10^{-19} C due to a uniform electric field of strength 5.0×10^{5} V m^{-1}. [2]

2 The diagram shows two parallel, horizontal plates separated by a vertical distance of 3.0 cm. The potential difference between the plates is 600 V.



a Calculate the magnitude and direction of the electric field between the plates. [3]

b Describe the electric field between the plates. [2]

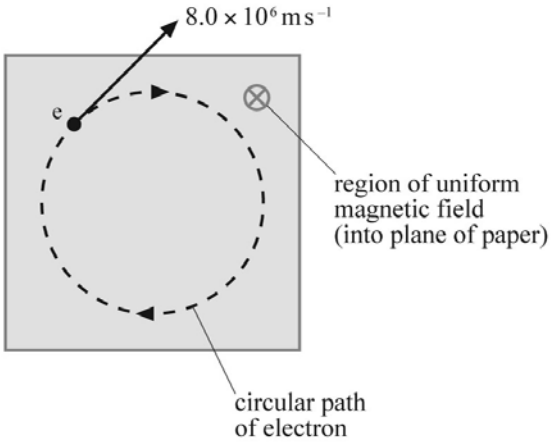
c A charged oil droplet of weight 6.4×10^{-15} N is held stationary between the two plates.

i State whether the charge on the droplet is positive or negative.
Explain your answer. [2]

ii Determine the charge on the oil droplet. [2]

3 Calculate the force experienced by an electron travelling at a velocity of 4.0×10^{6} m s^{-1} at right angles to a magnetic field of magnetic flux density 0.18 T. [3]

4 The diagram shows an electron moving at a constant speed of 8.0×10^{6} m s^{-1} in a plane perpendicular to a uniform magnetic field of magnetic flux density 4.0 mT.

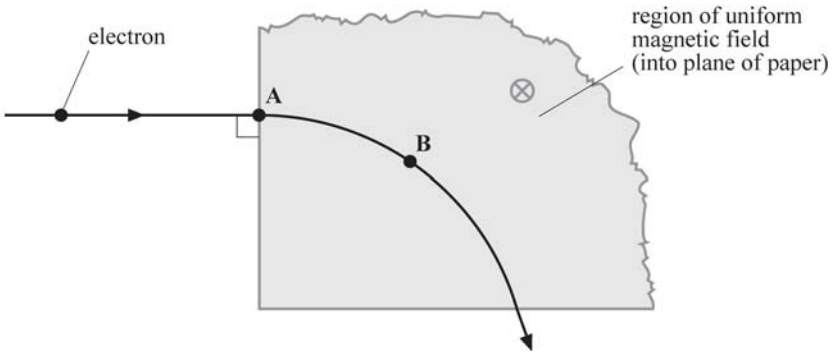


a Calculate the force acting on the electron due to the magnetic field. [3]

b What is the centripetal acceleration of the electron? [2]

c Use your answer to **b** to determine the radius of the circular path described by the electron. [2]

5 The diagram shows the trajectory of an electron travelling into a region of uniform magnetic field of flux density 2.0 mT. The electron enters the region of magnetic field at 90°.



a Draw the direction of the force experienced by the electron at points **A** and **B**. [1]

b Explain why the electron describes part of a circular path while in the region of the magnetic field. [1]

c The radius of curvature of the path of the electron in the magnetic field is 5.0 cm. Calculate the speed v of the electron. [5]

d Explain how your answer to **c** would change if the electron described a circular path of radius 2.5 cm. [2]

6 A proton of kinetic energy 15 keV travelling at right angles to a magnetic field describes a circle of radius of 5.0 cm. The mass of a proton is 1.7×10^{-27} kg.

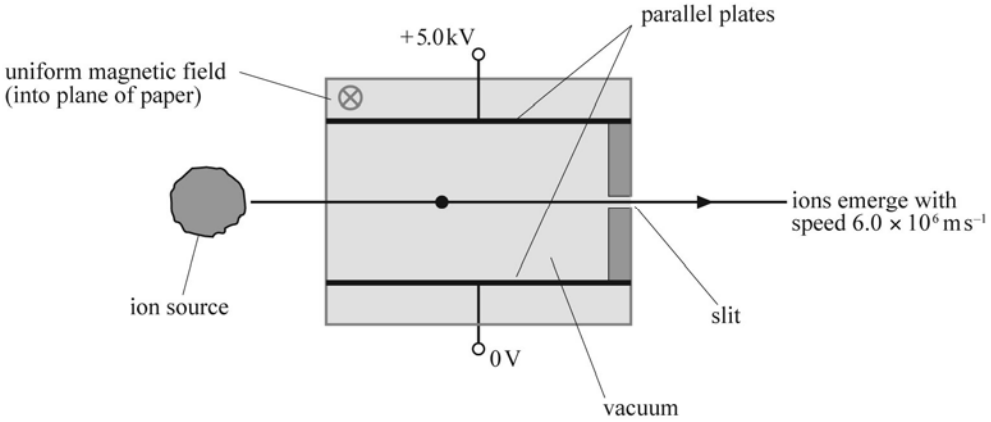
a Show that the speed of the proton is 1.7×10^{6} m s^{-1}. [3]

b For this proton, calculate the centripetal force provided by the magnetic field. [3]

c Determine the magnetic flux density of the magnetic field that keeps the proton moving in its circular orbit. [3]

d How long does it take for the proton to complete one orbit? [2]

7 The diagram shows a velocity-selector for charged ions. Ions of speed v emerge from the slit.



a The parallel plates have a separation of 2.4 cm and are connected to a 5.0 kV supply. A magnetic field is applied at right angles to the electric field between the plates such that the positively charged ions emerge from the slit of the velocity-selector at a speed of 6.0×10^{6} m s^{-1}. Calculate the magnetic flux density of the magnetic field. [6]

b Ions from the velocity-selector pass into a mass spectrometer which contains another magnetic field, of flux density B. The ions all have charge Q but either have mass m_1 or mass m_2. Show that the difference in the radius of the two isotopes in the magnetic field is given by:

$$\Delta r = \frac{(m_1 - m_2)v}{BQ}$$ [2]

8 An electron describes a circular orbit in a plane perpendicular to a uniform magnetic field.

a Show that the time T taken by an electron to complete one orbit in the magnetic field is independent of its speed and its radius, and is given by:

$$T = \frac{2\pi m}{Be}$$

where B is the magnetic flux density of the magnetic field, e is the charge on an electron and m is the mass of an electron. [5]

b Explain in words how a faster electron takes the same time to complete one orbit as a slower electron. [1]

Total: ———— Score: %
55