9 Worksheet 2

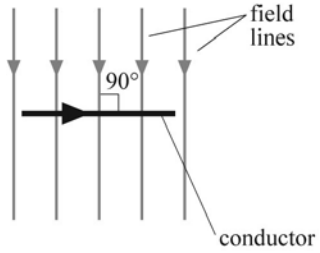
elementary charge $e = 1.6 \times 10^{-19}$ C
mass of electron = 9.1×10^{-31} kg

Intermediate level

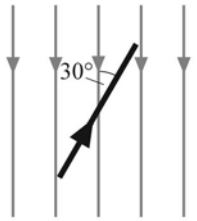
1 A current-carrying wire is placed in a uniform magnetic field.
- **a** When does the wire experience the maximum force due to the magnetic field? [1]
- **b** When does the current-carrying wire experience no force due to the magnetic field? [1]

2 A 4.0 cm long conductor carrying a current of 3.0 A is placed in a uniform magnetic field of flux density 50 mT. In each of **a**, **b** and **c** below, determine the size of the force acting on the conductor. [6]

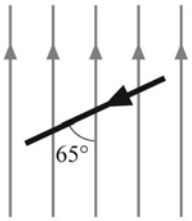
a



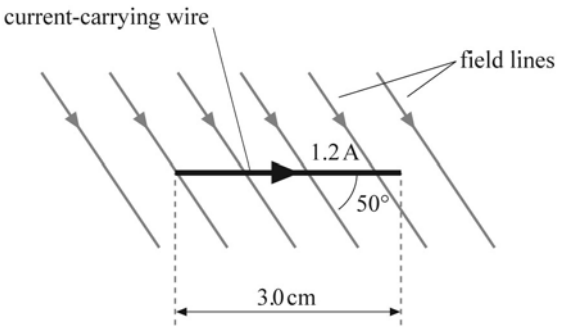
b



c



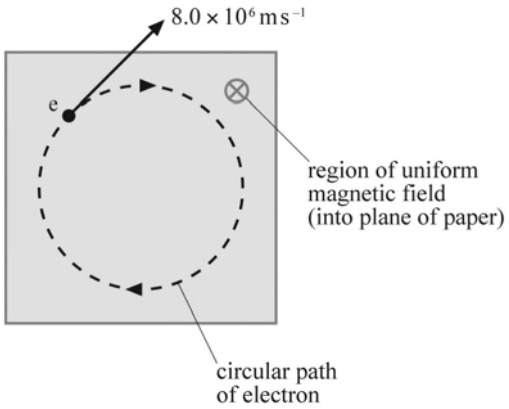
3 A copper wire carrying a current of 1.2 A has 3.0 cm of its length placed in a uniform magnetic field. The force experienced by the wire is 3.8×10^{-3} N when the angle between the wire and the magnetic field is 50°.



- **a** Calculate the magnetic field strength. [3]
- **b** What is the direction of the force experienced by the wire? [1]

4 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]

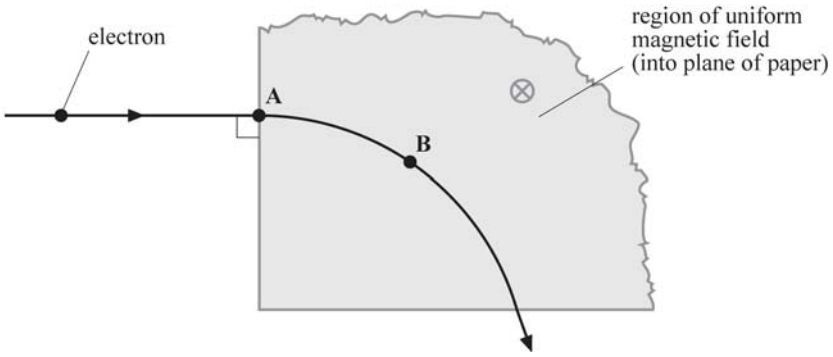
5 The diagram shows an electron moving at a constant speed of 8.0×10^6 m s^{-1} in a plane perpendicular to a uniform magnetic field of magnetic flux density 4.0 mT.



- **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]

Higher level

6 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]

7 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]

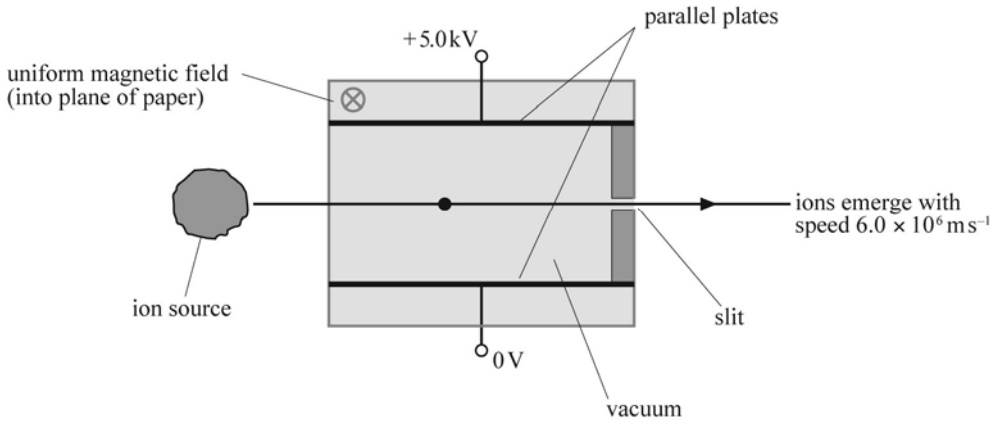
b For this proton, calculate the centripetal force provided by the magnetic field. [3]

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]

Extension

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



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]

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

Total: ——— Score: %
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