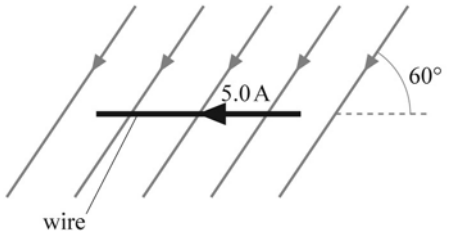
9 End-of-chapter test 2

Answer all questions.

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

1 The diagram shows a copper wire carrying a current of 5.0 A placed at an angle of 60° to a uniform magnetic field.



The force experienced per unit length by the wire is 2.0×10^{-3} N cm^{-1}.

a State the direction of the force experienced by the wire. [1]

b Calculate the magnetic flux density. [3]

2 An α-particle from a radioactive source enters a uniform magnetic field of flux density 50 mT at right-angles. The speed of the α-particle is 4.0×10^6 m s^{-1}.

a Explain why the speed of the α-particle remains constant in the region of the magnetic field. [2]

b The mass of the α-particle is 6.7×10^{-27} kg and it has a charge of 3.2×10^{-19} C. For the α-particle in the magnetic field, calculate:

i the force acting on it due to the magnetic field [3]

ii its centripetal acceleration [2]

iii the radius of its orbit. [2]

3 A proton describes a circular path in a plane perpendicular to a magnetic field.

a Show that the radius r of the circular path of the proton is given by:

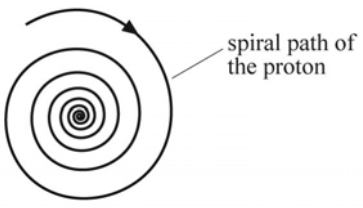
$$r = \frac{mv}{Be}$$

where m is the mass of the proton, v is the speed of the proton, e is the charge on the proton and B is the magnetic flux density. [3]

b Calculate the radius of the path described by a proton travelling at a speed of 4.0×10^5 m s^{-1} in a uniform magnetic field of magnetic flux density 60 mT. [2]
(The mass of a proton = 1.7×10^{-27} kg.)

c Explain how your answer to **b** would change if a proton travelling at twice the speed entered a magnetic field of twice the magnetic flux density. [2]

d The diagram shows the actual trajectory of a proton in a particle detector when it is travelling at right-angles to the magnetic field. Suggest a possible reason why the path is not a circle but a spiral. [1]



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