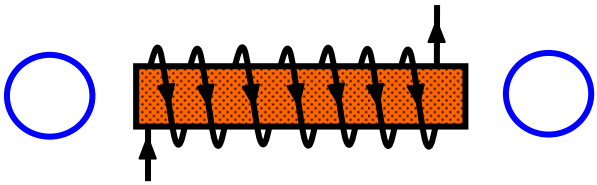
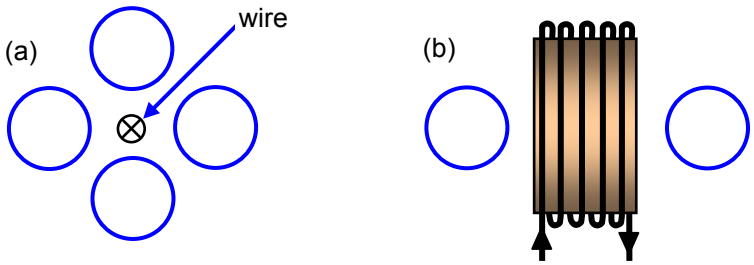
TAP 411- 5: Flux and flux density

1 Draw the magnetic field produced by a straight wire carrying a current.

2 Copy the following diagram and mark in the polarities of the two ends of the coil.



3. Copy the following diagram and mark in the compass directions.



Question 4 take $\mu_o = 4\pi \times 10^{-7}$ N A^{-2}

4. Calculate the magnetic flux density at the following places:

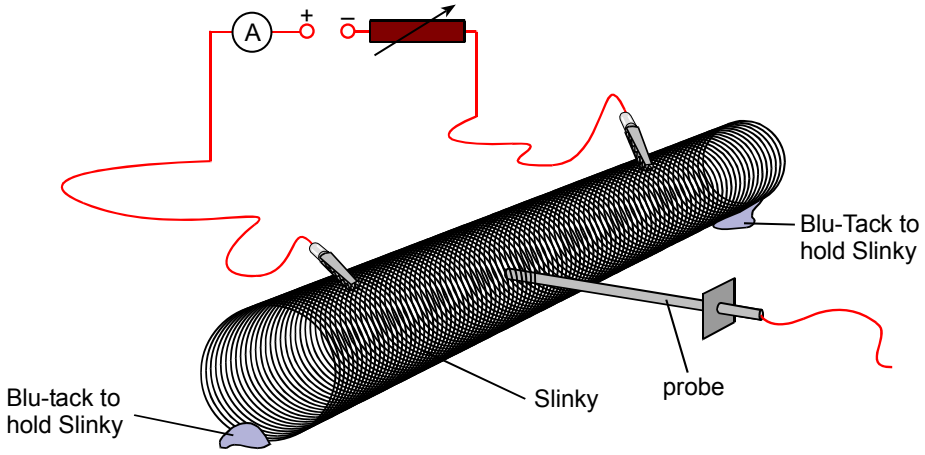
(a) 2 m from a long straight wire carrying a current of 3 A

(b) at the centre of a solenoid of 2000 turns 75 cm long when a current of 1.5 A flows

5 A solenoid of length 25 cm is made using 100 turns of wire wrapped round an iron core. If the magnetic flux density produced when a current of 2 A is passed through the coil is

2.5 T calculate the permeability (μ) of the core.

6 A Hall probe measures a steady magnetic field directly by detecting the effect of the field on a slice of semiconductor material. A student sets up the circuit below to investigate, using a Hall probe, the factors which determine the magnetic flux density within a long solenoid.



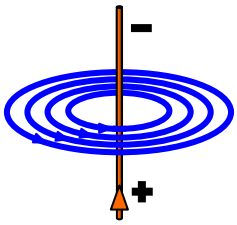
6 Suggest and explain two ways of varying the magnitude of the flux density in the solenoid.

7. A solenoid similar to that shown in the diagram has 100 turns connected in a circuit over a length of 0.50 m. $\mu_o = 4\pi \times 10^{-7}$ N A^{-2}

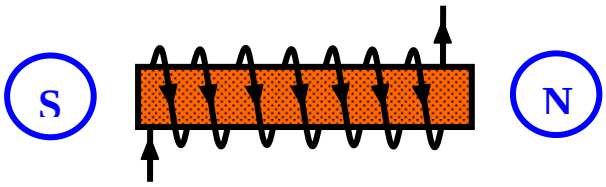
Calculate the flux density at the centre of the solenoid when a current of 10 A flows.

Answers and worked solutions

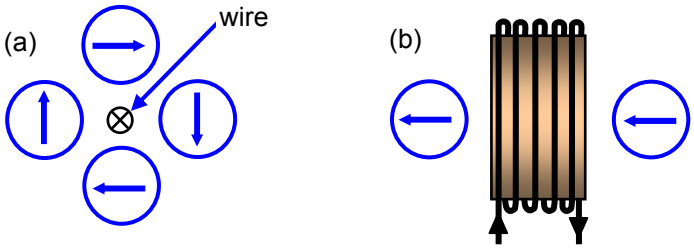
1



2



3



4

(a) At distance r from a long straight wire: Magnetic flux density (B) = $\mu_o I / 2\pi r = 3 \times 10^{-7}$ T

(b) At the centre of a solenoid: Magnetic flux density (B) = $\mu_o NI / L = 5.03 \times 10^{-3}$ T

5 Magnetic flux density (B) = $\mu NI / L = 2.5 = \mu \times 100 \times 2 / 0.25$ T

Permeability of the core (μ) = $2.5 \times 0.25 / 100 \times 2 = 0.0031$ N A^{-2}

6 Factors affecting field strength are current I and spacing of coils, N coils in length L:

$$B \propto I, \quad B \propto \frac{N}{L}$$

7. Calculation using I = 30 A, N = 100, L = 0.50 m:

$$B = \frac{\mu_o NI}{L} = \frac{4\pi \times 10^{-7}\ \text{N A}^{-2} \times 100 \times 10\ \text{A}}{0.50\ \text{m}} = 2.5\ \text{mT}$$

External references

Questions 1-5 of this activity are taken from Resourceful Physics

Questions 6 and 7 of this activity are taken from Advancing Physics chapter 15, 70S