6 In a metallic conductor, conduction electrons do not travel in a straight line through the conductor.

Fig. 6.1 shows some of the conduction electrons in a copper wire. The arrows represent the velocities of these electrons.

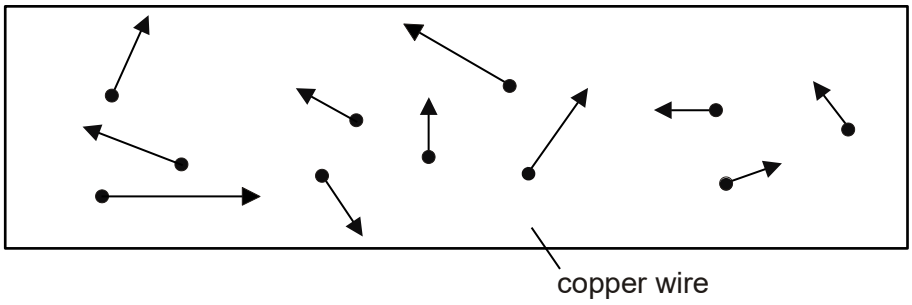

Fig. 6.1

(a) Explain, by reference to the motion of the electrons, why there is no current in the wire.

……

…….. [2]

(b) An electric field is established inside the copper wire directed as shown in Fig. 6.2.

The dots represent electrons. The velocities of the electrons are not shown.

The average velocity that an electron travels along the conductor is called the drift velocity.

Draw on Fig. 6.2 an arrow to indicate the direction of the drift velocity of the electrons.

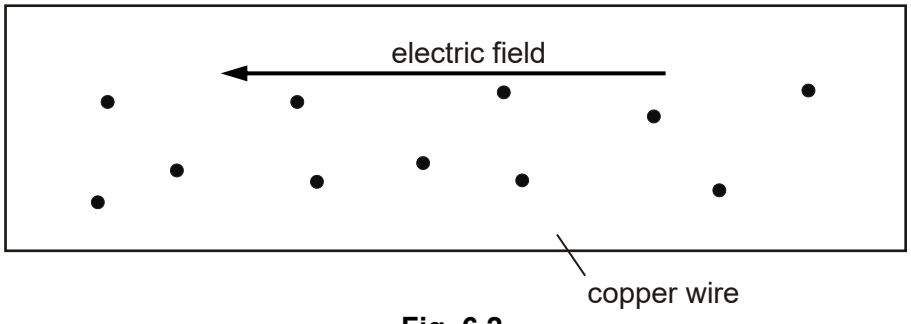

Fig. 6.2

[1]

(c) In the circuit in Fig. 6.3, the length of the copper wire joining the negative terminal of the battery to the lamp is 0.50 m and has a radius of 0.40 mm. There are 8.5×10^{28} mobile electrons per cubic metre in copper.

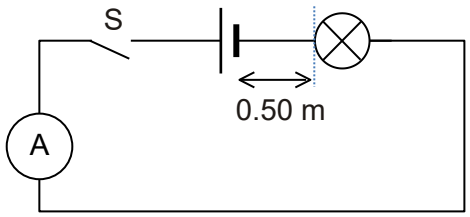

Fig. 6.3

(i) When the switch S is closed, the ammeter reads 2.0 A. Calculate the average time it would take for an electron to move from the negative terminal of the battery to the lamp.

average time = …….. s [2]

(ii) The lamp lights up in a much shorter time than that calculated in **(c)(i)**. Explain this observation.

……

……

…….[1]

(iii) The circuit is now connected with two copper wires of different thickness as shown in Fig. 6.4.

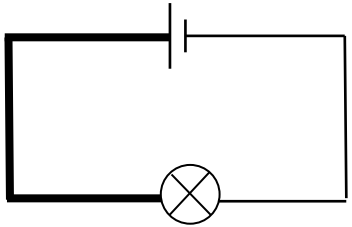

Fig 6.4

State and explain whether the drift velocity of electrons in the thicker wire is smaller than, equal to, or larger than that in the thinner wire.

……

……

……

…… [2]

[Total: 8 marks]