7 A rigid wire is pivoted at point P so that it is free to move in a vertical plane, as shown in Fig. 7.1. The lower end of the wire dips into mercury, which is contained in a conducting container. The arrangement is connected to a d.c. supply at points P and Q as shown. A uniform magnetic field of flux density 4.0×10^{-2} T acts over the region ABCD and is directed perpendicularly into the page. The length of sides AB and CD are 9.0 cm respectively.

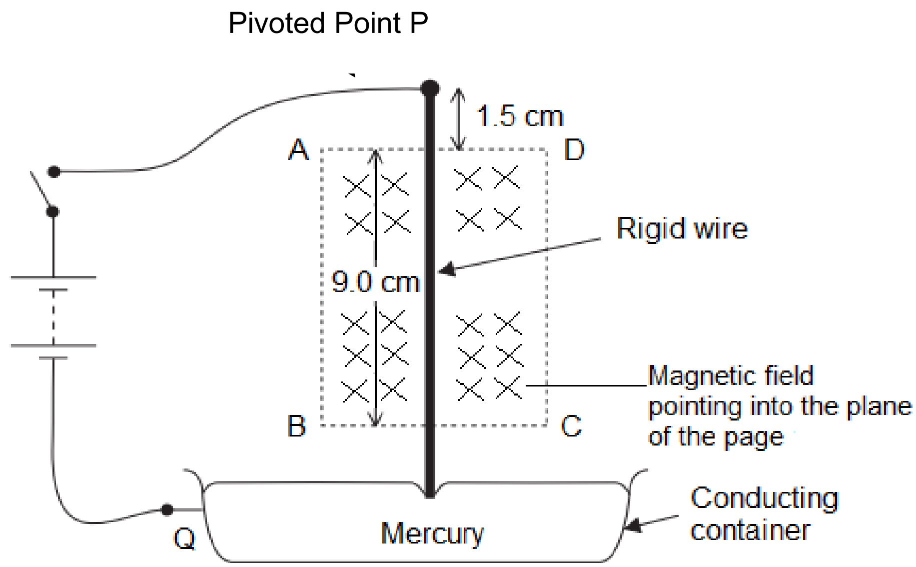

Fig. 7.1

(a) When the switch is closed the wire is seen to continually 'kick' out of the mercury and then return to it. Explain, with reference to the forces that act on the wire, why it moves like this.

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(b) The electromagnetic force on the wire may be assumed to act at the midpoint of the part of the wire which lies in the magnetic field. The initial moment of this force about P, produced when the switch is closed, is 5.0×10^{-4} N m.

Calculate the magnitude of the force.

force = ... N [2]

(c) If the diameter of the rigid wire is doubled and the length is kept constant, explain how the initial acceleration of the rod changes, if any. Assume that the resistance of the rigid wire is much greater than other resistances of the closed circuit.

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[Total: 8]