5 **(a)** Fig. 5.1 shows a proton moving at velocity v in a uniform magnetic field of flux density B.

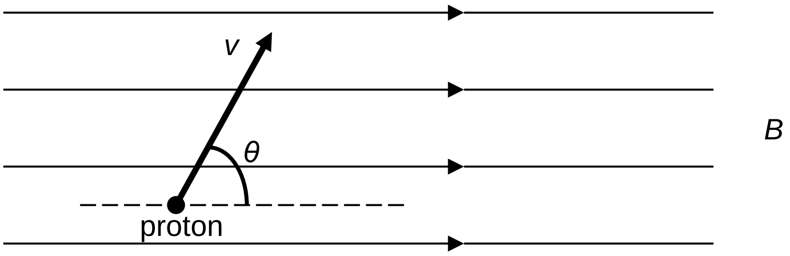

Fig. 5.1

The initial direction of the proton is at an angle θ to the direction of the magnetic field.

By considering the components of the velocity parallel to the magnetic field and at right-angles to the magnetic field, describe and explain qualitatively the motion of the proton in the field.

....

....

....

....

....

....

.... [4]

(b) A *magnetic bottle* may be created in the laboratory using two identical parallel circular coils placed along a central axis passing through the centre of each, as shown in Fig. 5.2.

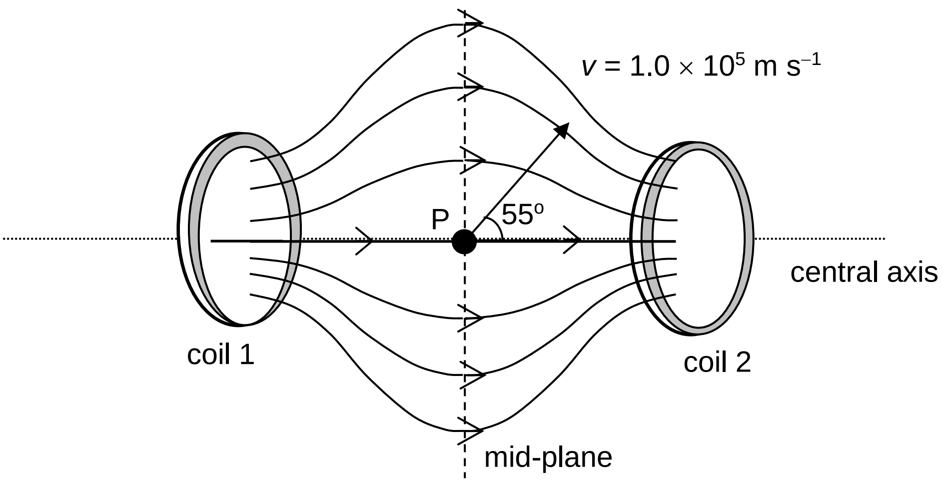

Fig. 5.2 (not to scale)

The magnetic field produced has a minimum value of 3.8×10^{-4} T halfway between the coils (along the mid-plane) and increases symmetrically to a maximum value of 170×10^{-4} T at the locations of the coils.

(i) On Fig. 5.2, draw the direction of the current passing through each coil. [1]

(ii) A proton P was detected moving with a velocity $v = 1.0 \times 10^5$ m s^{-1} at 55° to the horizontal when it was at the mid-plane and along the central axis of these coils as shown in Fig. 5.2. At that point, the magnetic field line is horizontal.

Calculate the magnitude of the magnetic force acting on the proton at that point.

magnetic force = ……………………… N [2]

(iii) On Fig. 5.3, sketch a graph to show the variation with distance of the magnitude of the magnetic flux density along the central axis between the coils.

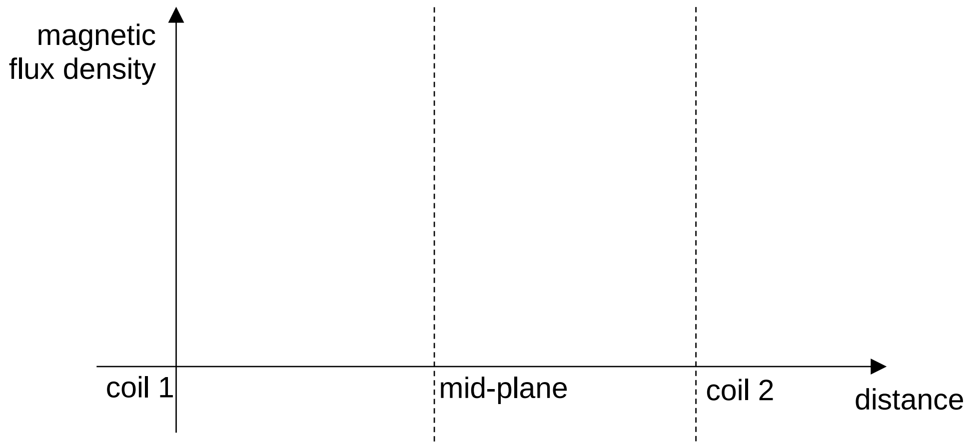

Fig. 5.3

[1]

[Total: 8]