5 **(a)** A solenoid of length 0.35 m and 400 turns is placed in a vacuum and a current of 2.3 A is passed through it.

Show that the magnetic flux density inside the coil is 3.3 mT.

[1]

(b) A proton enters the solenoid in **(a)** at a speed of 4200 m s^{-1}, at an angle of 57°, as shown in Fig 5.1. The proton moves in a helical path of constant radius inside the solenoid. It exits the other side of the solenoid.

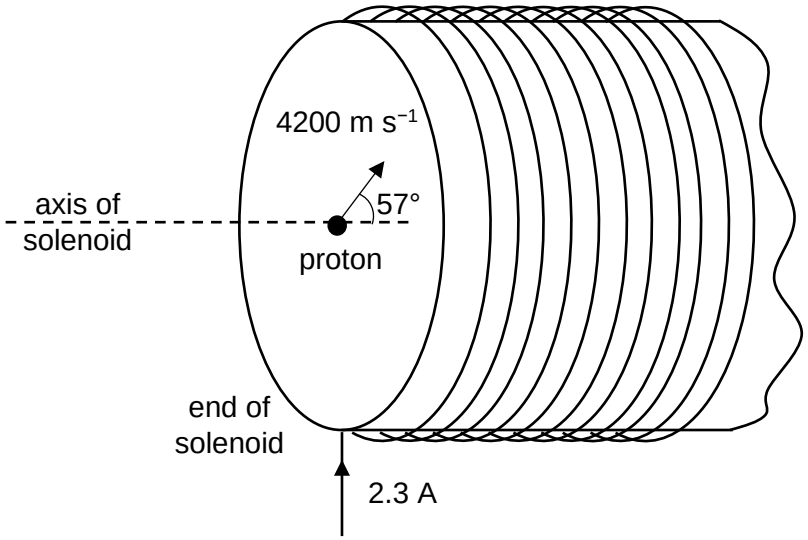

Fig. 5.1

(i) Explain why the proton will move in a helical path inside the solenoid.

……..

……..

……..

…… [2]

(ii) Show that the period of the helix is 20 μs.

[3]

(iii) Calculate the time taken for the proton to exit the solenoid.

time = …… s [1]

(iv) Hence, calculate the number of complete cycles of the helix.

number of complete cycles = …… [1]

(v) When the proton exits the solenoid, it moves in a spiral with increasing radius. Explain why this occurs.

……..……..

……..……..

……..……..

……..…….. [2]