4 Two oppositely charged parallel metal plates P and Q are placed in a vacuum. The electric field is uniform in the region between the plates.

A uniform magnetic field also exists in the region between the plates. The direction of the magnetic field is into the page, as illustrated in Fig. 4.1.

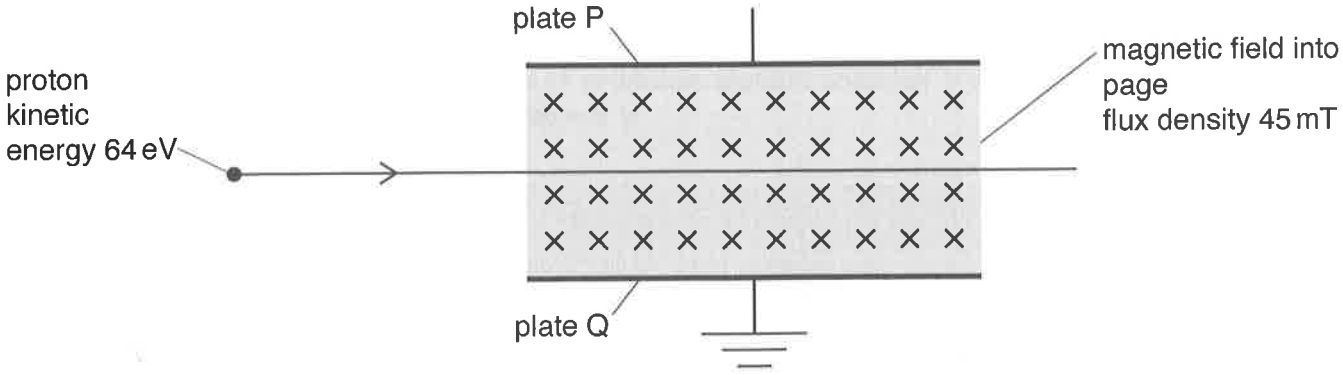

Fig. 4.1

A proton enters the region between the plates at right angles to both the electric field and the magnetic field. The proton travels through the fields without deviating, as shown in Fig. 4.1.

The magnetic flux density is 45 mT. The kinetic energy of the proton is 64 eV.

(a) (i) State and explain the polarity, positive or negative, of plate P.

.....

.....

..... [2]

(ii) Calculate the magnitude E of the electric field strength so that the proton is not deviated as it passes between the plates.

E = ... NC^{-1} [5]

(iii) A second proton travels along the same initial path with a kinetic energy of less than 64 eV.

On Fig. 4.1, sketch the path of this proton between the plates. [1]

(b) Two long, straight wires X and Y are separated by a distance of 0.12 m. The current in wire X is 5.5 A. The current in wire Y is 8.4 A.

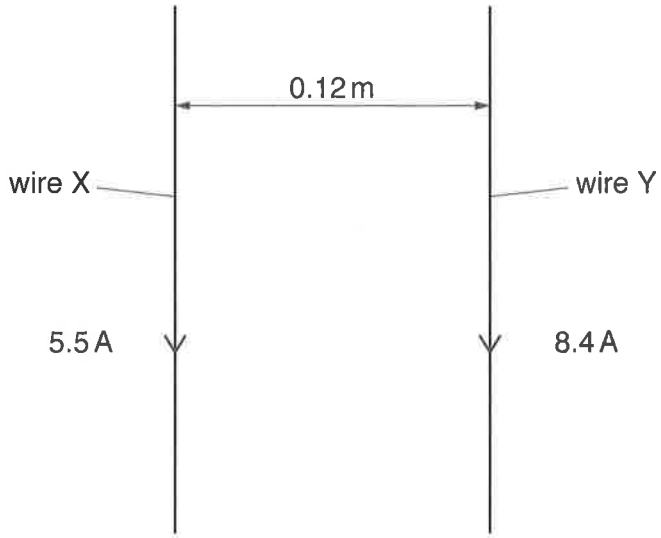

Fig. 4.2

Both currents are in the same direction, as shown in Fig. 4.2.

Calculate the force per unit length on wire X. State the direction of this force.

force per unit length = ... $N\,m^{-1}$

direction .....

[4]

[Total: 12]