4 **(a)** Two charged particles X and Y travelling in the same direction, each with velocity v, enter a uniform magnetic field of flux density B in a vacuum. Particles X and Y have the same mass m but different charges q_X and q_Y respectively.

The paths of particles X and Y in the magnetic field are shown in Fig. 4.1. The radius of the semi-circular path of particle Y is double that of particle X.

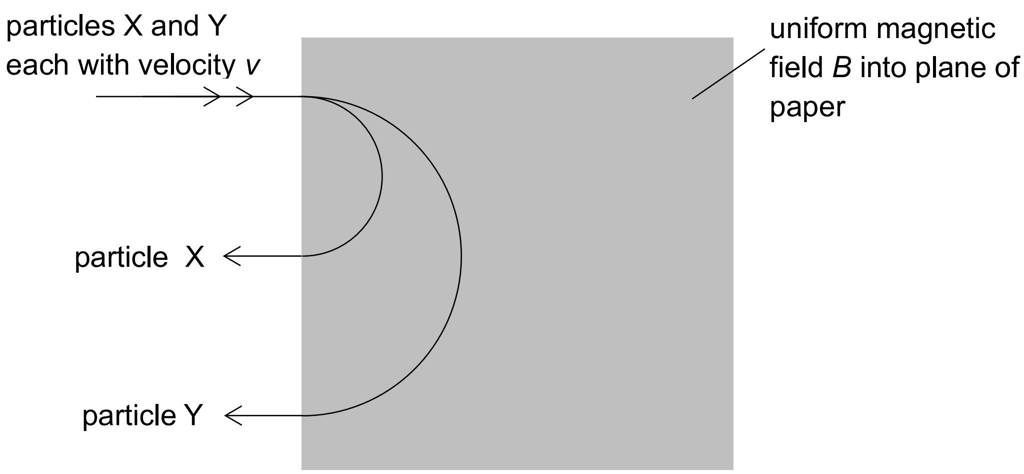

Fig. 4.1

(i) Explain why the paths of the charged particles are circular in the magnetic field.

....

....

....

.... [2]

(ii) State if the charge of the particles is positive or negative.

.... [1]

(iii) Determine the ratio $\frac{q_x}{q_y}$.

$\frac{q_x}{q_y}$ = ………………………….. [2]

(b) Particle X with velocity *v* now enters another uniform magnetic field region having the same flux density *B* as before but with uncharged gas particles throughout. It moves in a path in the magnetic field as shown in Fig. 4.2.

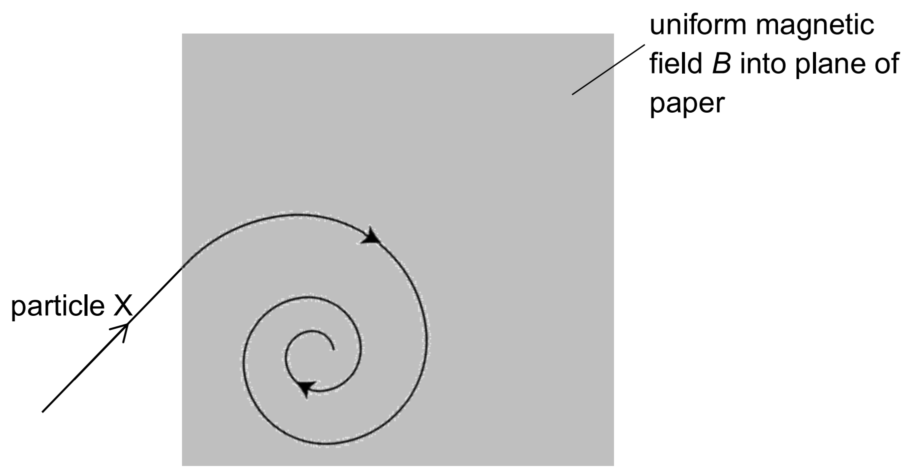

Fig. 4.2

(i) Explain, using any relevant equations, the path of particle X shown in Fig. 4.2.

……

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……………………………………………………………………………………………………… [2]

(ii) **1.** Deduce an expression for the time T taken for one revolution of the path in terms of m, q_X and B.

T = …………………………. [2]

2. The tau particle is an elementary particle that has the same charge as an electron but has a mass that is 3000 times that of an electron. It has a mean lifetime of 2.9×10^{-13} s.

State with a reason if particle X could be a tau particle if B = 1.0 T.

……………………………………………………………………………………….

……………………………………………………………………………………... [1]