

- 12 In 1931, Sloan and Lawrence built a linear accelerator (linac) with several drift tubes. They used the linac to accelerate mercury ions up to energies of 1.26 MeV. The behaviour of the particles was non-relativistic.

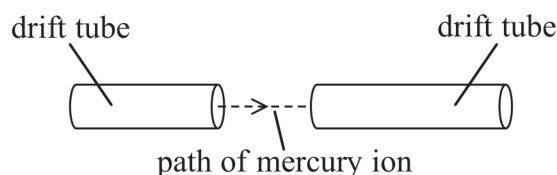
- (a) The kinetic energy of a non-relativistic particle of mass m with momentum p is given by

$$E_k = \frac{p^2}{2m}$$

Derive this formula.

(2)

- (b) A mercury ion with kinetic energy $6.42 \times 10^{-15} \text{ J}$ leaves a drift tube, as shown.



Calculate the momentum of the mercury ion when it reaches the next drift tube.

mass of mercury ion = $3.32 \times 10^{-25} \text{ kg}$

charge of mercury ion = $1.60 \times 10^{-19} \text{ C}$

electric field strength between drift tubes = $7.64 \times 10^6 \text{ V m}^{-1}$

distance between drift tubes = $5.50 \times 10^{-3} \text{ m}$

(4)

Momentum =

(Total for Question 12 = 6 marks)