4 A proton moves in a straight line through a vacuum with a constant speed of 3.9×10^6 m s^{-1}. It enters a uniform electric field at point A, as shown in Fig. 4.1.

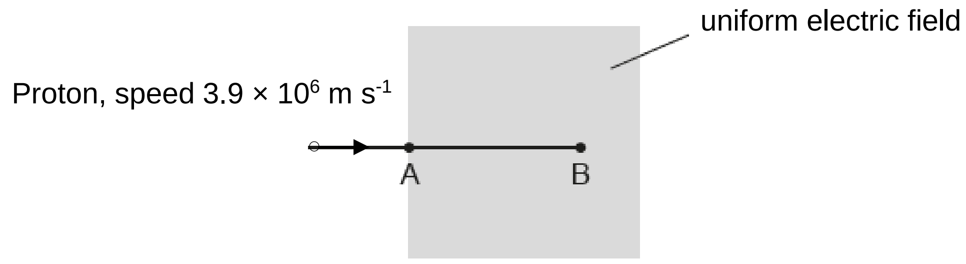


Fig. 4.1

The proton continues to move in a straight line until it is brought to rest at point B in the electric field. The distance AB is 0.032 m.

(a) State the direction of the electric field.

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

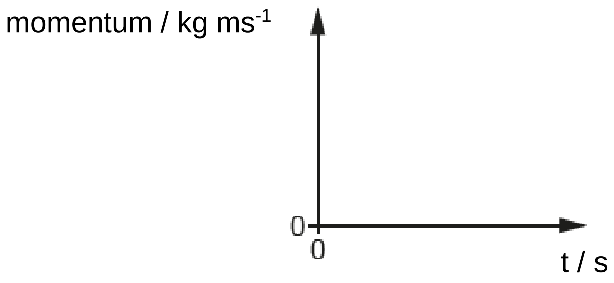
(b) Calculate the deceleration of the proton.

deceleration = ………………… m s^{-2} [2]

(c) Calculate the electric field strength.

field strength = ………………… N C^{-1} [2]

(d) The proton is at point A at time $t = 0$.
On Fig. 4.2, sketch the variation with time t of the momentum of the proton as it travels from point A to point B. Label suitable values on your axis.



[3]

Fig. 4.2

(e) The region of uniform field is replaced by a positive point charge, placed at point B, where its magnitude is 10 times the charge of the proton, as shown in Fig. 4.3.

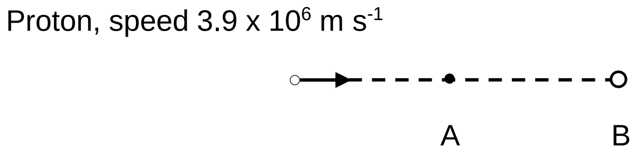


Fig. 4.3

(i) Describe one difference in motion for the proton illustrated in Fig. 4.1 and Fig 4.3. considering it is at point A at time $t = 0$.

……………………………………………………………………………………

…………………………………………………………………………….. [1]

(ii) On Fig. 4.4, sketch the variation with time t of the momentum of the proton as it travels from point A towards point B.
Numerical values are not required.

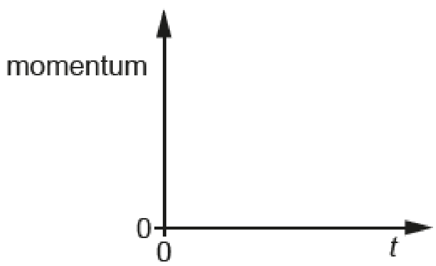


Fig. 4.4 [1]