6 An ion thruster is a device used in spacecraft propulsion in space. It uses an accelerated beam of ions to create thrust for the spacecraft.

Fig. 6.1 shows a common design for an ion thruster. Xenon ions, with a positive charge of +*e*, initially inside a discharge chamber, are accelerated through a uniform electric field within a grid system.

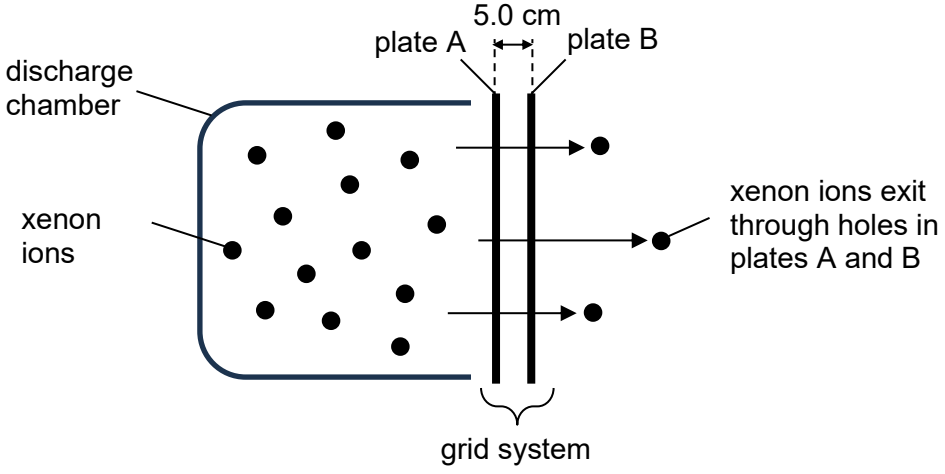

Fig. 6.1

The grid system consists of two parallel plates, A and B, with many tiny holes in them to allow the xenon ions to pass through. They are 5.0 cm apart with a potential difference of 1300 V between them.

(a) Define *electric potential* at a point.

.....

.....

..... [1]

(b) (i) Plate A has a potential of 100 V.

On the axes of Fig. 6.2, sketch the variation with distance *x* from plate A to B of the electric potential *V*. Label the axes with appropriate values.

Fig. 6.2 [2]

(ii) Determine the electric field strength between plates A and B.

electric field strength = ... N C^{-1} [2]

(iii) Hence, or otherwise, assuming a xenon ion of mass 131 *u* was released from rest near plate A, determine the speed of the xenon ion when it exits the grid system. Explain your working clearly.

speed = ... m s^{-1} [3]

(c) As the xenon ions exit the grid system as a beam, a device near the ion thruster injects electrons into the ion beam in order to neutralise the ions.

Suggest why the ion beam needs to be neutralised as it exits the grid system.

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..... [2]

[Total:10]