Ink droplets, each of mass 1.60×10^{-10} kg, are ejected horizontally with a speed of 20.0 m s^{-1}. When passing through the charging chamber, they are charged to a suitable value according to the input signal which determines the type and size of the output characters.

Then the ink droplets are deflected by a pair of deflection plates to a suitable position on a paper. The magnitude of the electric field between the plates is 4.00×10^6 N C^{-1}. When there is no input signal, ink droplets are uncharged and travel along a straight line to the gutter.

(a) Neglecting the air resistance and the gravitational force from the Earth, find the charge carried by an ink droplet if the droplet can reach a point 2.0 mm above the gutter. (6 marks)

(b) Suggest two methods that can enlarge the output characters. (2 marks)

17. A positive point charge of +1 μC is fixed at the centre *M* of the gap between two oppositely charged parallel plates as shown. It is known that the electric field strength at *M* due to the plates alone is 2.25×10^7 N C^{-1}.

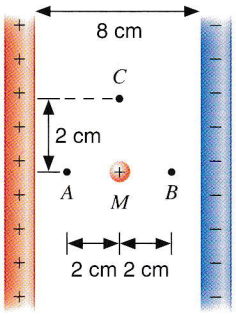

Fig. Q17

(a) Calculate the resultant electric field strengths at *A*, *B* and *C* respectively. (7 marks)

(b) Sketch the electric field lines for the above charge distribution. (3 marks)

18. Two vertical metal plates are connected to a high voltage power supply, as shown in Figure Q18a. An electric field exists in the space between the plates.

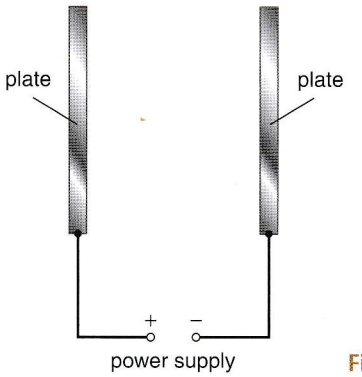

Fig. Q18a

(a) (i) State the definition of electric field.

(ii) On Figure Q18a, sketch the field lines between the two plates. (3 marks)

(b) An uncharged metal ball is hung by an insulating thread between the two plates, as shown in Figure Q18b.

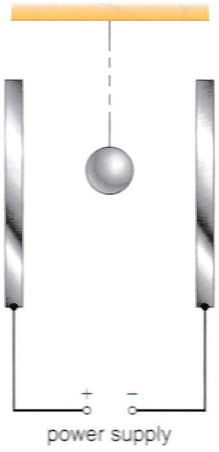

Fig. Q18b

Sketch the distribution of charge that will be found on the metal ball and the field lines to show the new electric field between the plates. (4 marks)

19. (a) Define electric field strength at a point. (1 mark)

(b) A proton, which has a charge of $+1.60 \times 10^{-19}$ C, moves in an evacuated region with a uniform electric field of 3.00×10^5 N C^{-1}. Calculate the magnitude of the force exerted on the proton. (2 marks)

(c) A proton is moved in a vacuum by a uniform electric field of 3.00×10^5 N C^{-1} from *A* to *B*, a distance of 0.008 m (Fig. Q19).

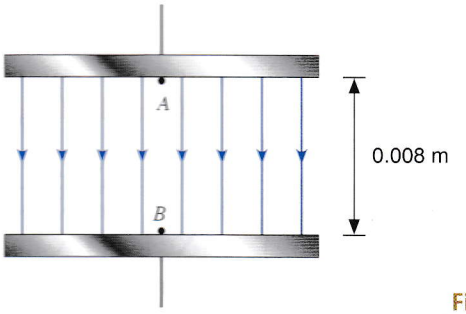

Fig. Q19

(i) Find the work done by the field on the proton. (2 marks)

(ii) What is the gain in the kinetic energy of the proton? (1 mark)