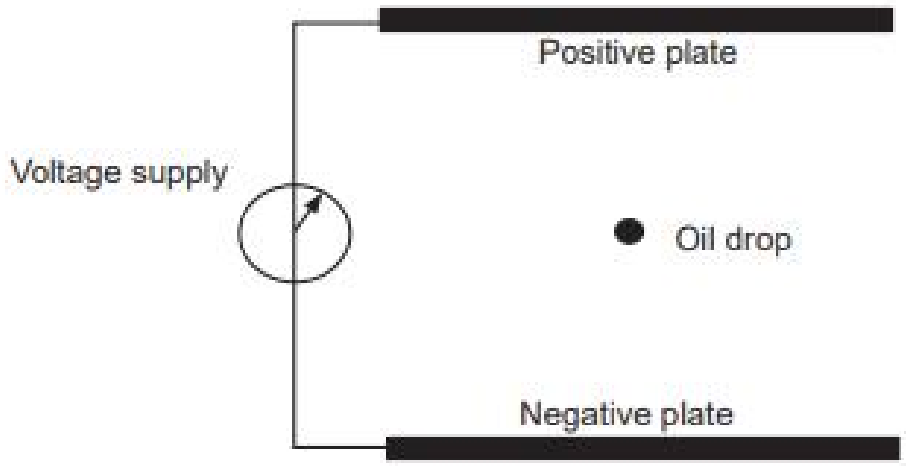
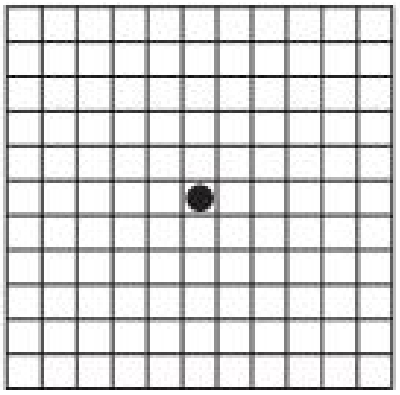
Question 13 **(10 marks)**

In an experiment to measure the charge of an electron, a student creates many tiny oil drops and allows some to enter the space between two horizontal plates that are connected to a variable voltage supply. A diagram of the apparatus is shown below.



Initially there is no potential difference between the plates and the student chooses an oil drop and, using a microscope, watches as it slowly falls, measuring its speed. The student determines that the speed is constant at 0.0313 mm s^{-1}.

(a) On the grid below, draw a free body diagram showing all the forces acting on the oil drop as it falls. (2 marks)



Using the speed of the oil drop and other known quantities the student calculates the mass of the oil drop as 6.88×10^{-16} kg. The oil drop is exposed briefly to radiation and it captures one or more electrons and hence becomes negatively charged.

The student turns on the voltage supply and adjusts the potential difference between the upper and lower plates until the oil drop stops moving. The potential difference at this point is 346 V.

(b) Name the **two** forces now acting on the oil drop. (2 marks)

One: _____

Two: _____

(c) If the plate separation is 7.71 mm, what is the electric field strength experienced by the oil drop? (2 marks)

_____ V m^{-1}

(d) Calculate the electric charge of the oil drop. (3 marks)

_____ C

The student repeats this procedure several times for different oil drops (possibly carrying different numbers of electrons), and calculates the charge for each drop.

Trial number	**Charge** ($\times 10^{-19}$ C)
1	5.99
2	2.99
3	4.49
4	7.53
5	3.01
6	7.50

(e) Solely on the basis of this data, what does the student estimate the electron charge is most likely to be? (1 mark)

Answer: _____ C