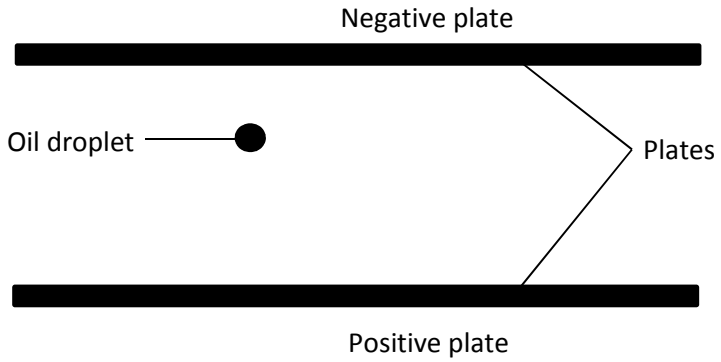
TUTORIAL QUESTIONS_CHARGED PARTICLES

Question 1

An oil droplet between two metal plates across which there is a potential difference,may be observed to be stationary. The arrangement is as shown in figure below.



Show on a similar diagram the forces acting on the oil drop,together with the appropriate charge on the drop and the direction of the electric field. Write down the equation used to determine the charge.

Question 2

An electron is accelerated from rest between a negative cathode and positive anode in a vacuum. The potential difference between the anode and cathode is 2000 V and their separation is 0.074 m. Calculate

a.) the electric field between the electrodes (assume to be uniform)

b.) the kinetic energy of the electron when it reaches the anode.

c.) the speed of the electron when it reaches the anode.

Question 3

In an experiment, an electron travelling with speed 4.3×10^7 ms^{-1} enters a magnetic field of uniform flux density 0.0086 T, in a direction at right angles to the field.

a.) Sketch the path of the electron in the magnetic field and show the direction of the field.

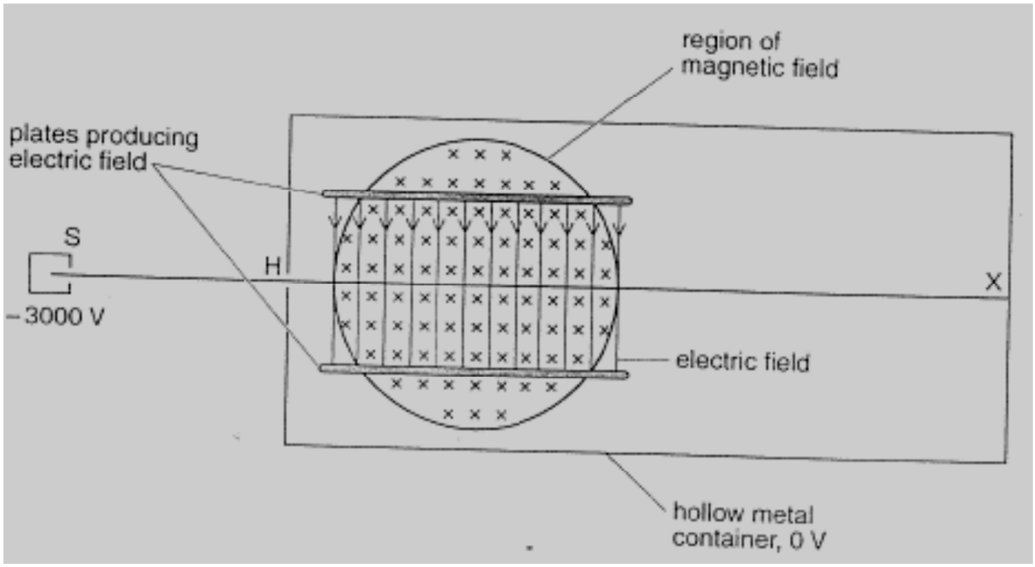
b.) Calculate the radius of the path of the electron in the field.

c.) Calculate the electric field strength required to provide an equal force to that provided by the magnetic field.

d.) Explain how it is possible to select electrons of a particular speed by the use of electric and magnetic fields.

Question 4

A part of a mass spectrometer is illustrated below. The whole arrangement is in a vacuum. Negative ions of mass 2.84 x 10^{-26} kg and charge -1.6 x 10^{-19} C, are generated at S, which is at a potential of -3000 V. The ions are accelerated in a narrow beam towards H, which is a hole in a hollow metal container. The container is kept at zero potential.



Once inside the container the negative ions enter a region in which there is an electric field of field strength E, and a magnetic field of flux density 0.83 T. When in these fields the negative ions continue in a straight line with constant velocity.

a.) Calculate the velocity of the ions when they reach H.

b.) Explain, using a sketch, how it is possible for the ions not to be deflected in the fields.

c.) Calculate the electric field strength E.

d.) The electric field is then switched off. State without calculation, what would happen to the path of the negative ions.

Question 5

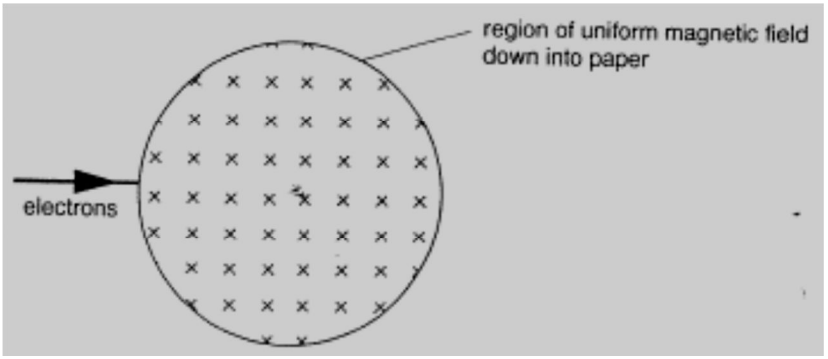
The results of 14 experiments to determine the charge on oil drops were as follows.

negative charge on oil drop/10^{-19}C						
1.605	1.608	3.199	1.598	1.606	1.602	4.806
3.214	4.803	1.610	1.599	3.217	8.001	1.607

a.) Explain how these readings provide experimental evidence for the quantisation of charge.

b.) Use these results to deduce a value for the charge on the electron.

c.) A stream of electrons with a variety of different speeds enters a region of uniform magnetic field.



On the diagram above, draw the path of a few of the electrons when in the field and after they leave the field. Label the path of the slowest and of the fastest electron you have considered.

Question 6

Outline Milikan's experiment and summarise the experimental evidence it provides for the quantisation of charge.