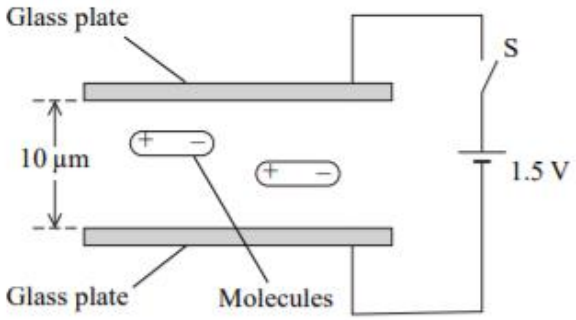
Electric Fields

Have a go at the following exam questions.

Edexcel IAL, Unit 4, Jan 2010

10 Liquid crystal displays (LCDs) are made from two parallel glass plates, 10 μm apart, with liquid crystal molecules between them. The glass is coated with a conducting material.



The molecules are positive at one end and negative at the other. They are normally aligned parallel with the glass plates as shown.

The switch S is closed and 1.5 V is applied across the glass plates.

(a) Calculate the electric field strength between the plates.

(2)

Electric field strength = ...

(b) Explain what happens to the liquid crystal molecules.

(3)

(Total for Question 10 = 5 marks)

3 **(a)** Fig. 3.1 shows two charged horizontal plates.

Fig. 3.1

The potential difference across the plates is 60V. The separation of the plates is 5.0 mm.

(i) On Fig. 3.1 draw the electric field pattern between the plates. **[2]**

(ii) Calculate the electric field strength between the plates.

electric field strength = ... $V m^{-1}$ **[1]**

(b) Positive ions are accelerated from rest in the horizontal direction through a potential difference of 400V. The charged plates in **(a)** are then used to deflect the ions in the vertical direction. Fig. 3.2 shows the path of these ions.

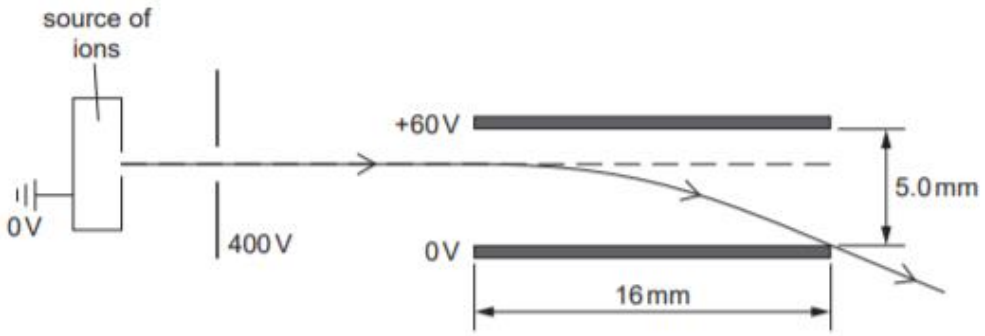


Fig. 3.2

Each ion has a mass of 6.6×10^{-27} kg and a charge of 3.2×10^{-19} C.

(i) Show that the horizontal velocity of an ion after the acceleration by the 400V potential difference is $2.0 \times 10^{5}\,m\,s^{-1}$.

[2]

(ii) The ions enter at right angles to the uniform electric field between the plates. Calculate the vertical acceleration of an ion due to this electric field.

acceleration = ... $m\,s^{-2}$ **[2]**

(iii) The length of each of the charged plates is 16 mm.

1 Show that an ion takes about 8.0×10^{-8} s to travel through the plates.

[1]

2 Calculate the vertical deflection of an ion as it travels through the plates.

deflection = ... m **[2]**

2 This question is about electric fields.

(a) Fig. 2.1 shows the electric field pattern drawn by a student for two oppositely charged plates.

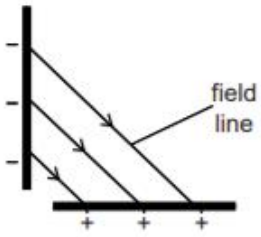


Fig. 2.1

State **two** errors made by the student in this drawing of the field pattern.

.....

.....

..... **[2]**

(b) At a distance r from the centre of a radioactive nucleus the electric field strength is E.

Fig. 2.2 shows the graph of the electric field strength E against $\frac{1}{r^2}$.

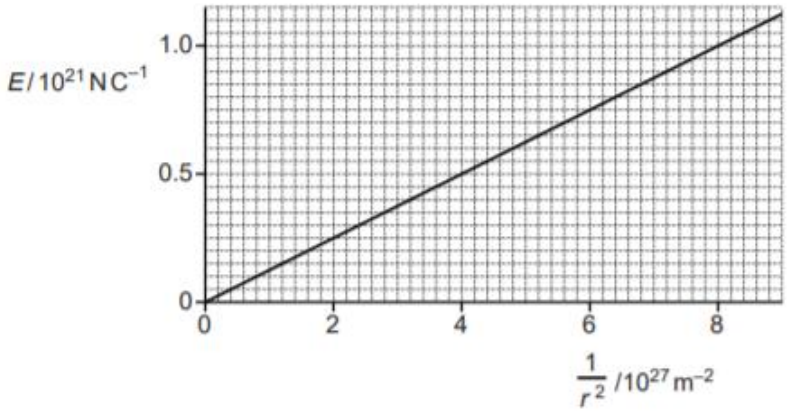


Fig. 2.2

(i) The electric field strength is given by the equation $E = \frac{Q}{4\pi\varepsilon_0 r^2}$.

Determine the gradient of the line and hence calculate the charge on the nucleus.

charge = ... C **[2]**

(ii) The radioactive nucleus emits an alpha particle.
State the change, if any, to the graph shown in Fig. 2.2 for the resultant (daughter) nucleus. Explain your answer.

.....

.....

.....

..... **[2]**

(c) A negatively charged droplet of oil is held **stationary** between two horizontal plates. The potential difference between the plates is 1.50 kV. Fig. 2.3 shows the two forces acting on this charged droplet.

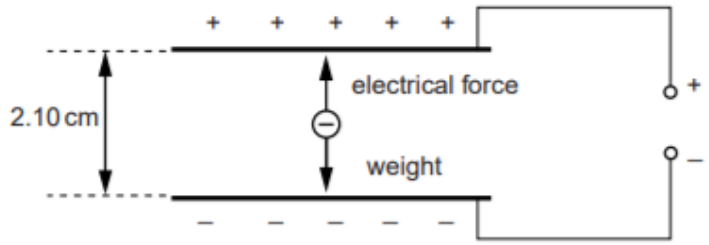


Fig. 2.3

The droplet is spherical and has a radius of 1.27×10^{-6} m. The density of oil is 950 kg m^{-3}. The separation between the plates is 2.10 cm.

(i) Show that the magnitude of the charge on the droplet is about 1.1×10^{-18} C.

[3]

(ii) Calculate the number of electrons causing the charge on the droplet.

number of electrons = ... **[1]**