# Uniform Electric Fields

## Question paper 1

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|---|---|
| **Level** | International A Level |
| **Subject** | Physics |
| **Exam Board** | CIE |
| **Topic** | Electric Fields |
| **Sub Topic** | Uniform Electric Fields |
| **Paper Type** | Theory |
| **Booklet** | Question paper 1 |

**Time Allowed:** **58 minutes**

**Score:** **/48**

**Percentage:** **/100**

| A* | A | B | C | D | E | U |
|---|---|---|---|---|---|---|
| >85% | '77.5% | 70% | 62.5% | 57.5% | 45% | <45% |

**1** **(a)** Explain what is meant by an *electric field*.

.....

.....[1]

**(b)** A uniform electric field is produced between two vertical metal plates AB and CD, as shown in Fig. 7.1.

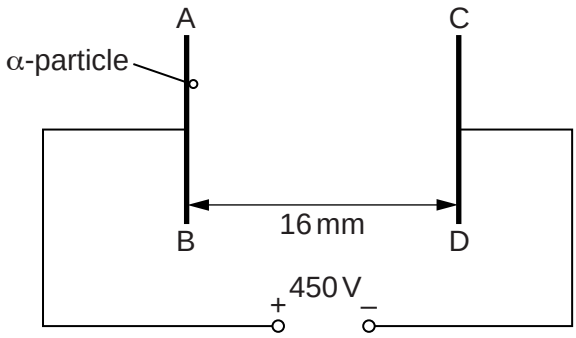


**Fig. 7.1**

The potential difference between the plates is 450 V and the separation of the plates is 16 mm.

An α-particle is accelerated from plate AB to plate CD.

**(i)** On Fig. 7.1, draw lines to represent the electric field between the plates. [2]

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

electric field strength = ..... $V\,m^{-1}$ [2]

**(iii)** Calculate the work done by the electric field on the α-particle as it moves from AB to CD.

work done = ..... J [3]

**(iv)** A β-particle moves from AB to CD. Calculate the ratio

$$\frac{\text{work done by the electric field on the } \alpha\text{-particle}}{\text{work done by the electric field on the } \beta\text{-particle.}}$$

Show your working.

ratio = ..... [1]

**2** **(a)** Define *electric field strength*.

.....

.....[1]

**(b)** A sphere S has radius $1.2 \times 10^{-6}$ m and density 930 kg m$^{-3}$.

Show that the weight of S is $6.6 \times 10^{-14}$ N.

[2]

**(c)** Two horizontal metal plates are 14 mm apart in a vacuum. A potential difference (p.d.) of 1.9 kV is applied across the plates, as shown in Fig. 3.1.

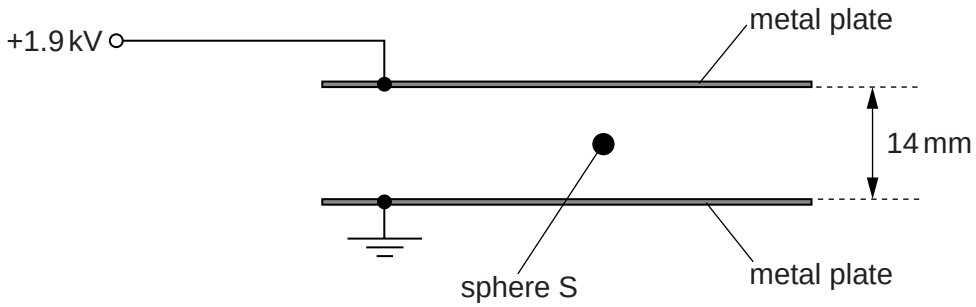


**Fig. 3.1**

A uniform electric field is produced between the plates.
The sphere S in **(b)** is charged and is held stationary between the plates by the electric field.

**(i)** Calculate the electric field strength between the plates.

electric field strength = .....V m$^{-1}$ [2]

**(ii)** Calculate the magnitude of the charge on S.

charge = ..... C [2]

**(iii)** The magnitude of the p.d. applied to the plates is increased.
Explain why S accelerates towards the top plate.

.....

.....[2]

**3** **(a)** An electric field is set up between two parallel metal plates in a vacuum. The deflection of $\alpha$-particles as they pass between the plates is shown in Fig. 7.1.

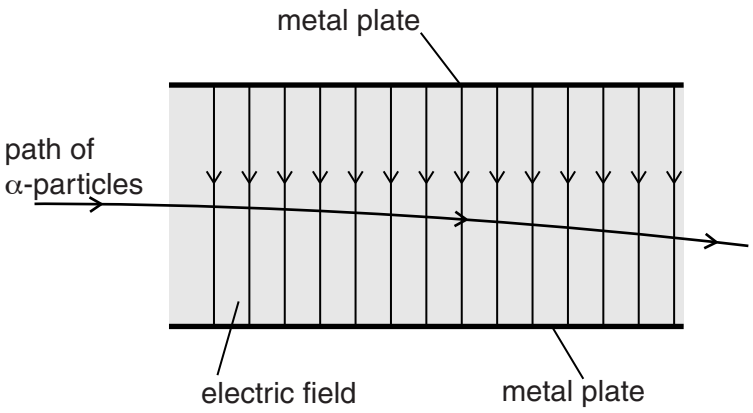


**Fig. 7.1**

The electric field strength between the plates is reduced. The $\alpha$-particles are replaced by $\beta$-particles. The deflection of $\beta$-particles is shown in Fig. 7.2.

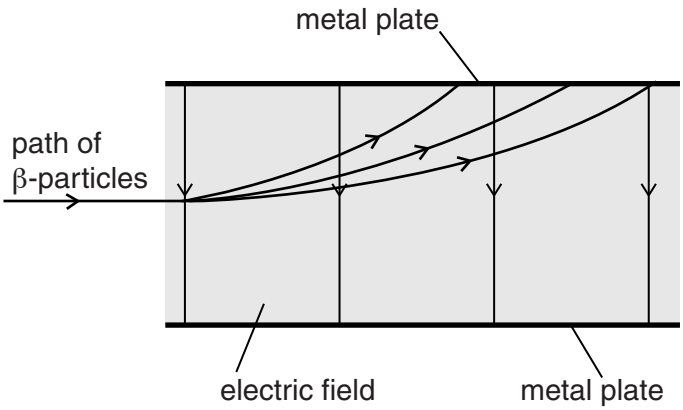


**Fig. 7.2**

**(i)** State one similarity of the electric fields shown in Fig. 7.1 and Fig. 7.2.

.....

..... [1]

**(ii)** The electric field strength in Fig. 7.2 is less than that in Fig. 7.1. State two methods of reducing this electric field strength.

1. .....

2. .....

[2]

**(iii)** By reference to the properties of $\alpha$-particles and $\beta$-particles, suggest three reasons for the differences in the deflections shown in Fig. 7.1 and Fig. 7.2.

1. .....

.....

2. .....

.....

3. .....

.....

[3]

**(b)** A source of $\alpha$-particles is uranium-238. The nuclear reaction for the emission of $\alpha$-particles is represented by

$$^{238}_{92}\text{U} \rightarrow {}^{W}_{X}\text{Q} + {}^{Y}_{Z}\alpha.$$

State the values of *W*.....

*X* .....

*Y* .....

*Z* .....

[2]

**(c)** A source of $\beta$-particles is phosphorus-32. The nuclear reaction for the emission of $\beta$-particles is represented by

$$^{32}_{15}\text{P} \rightarrow {}^{A}_{B}\text{R} + {}^{C}_{D}\beta.$$

State the values of *A* .....

*B* .....

*C* .....

*D* .....

[1]

**4** **(a)** Two horizontal metal plates are connected to a power supply, as shown in Fig. 7.1.

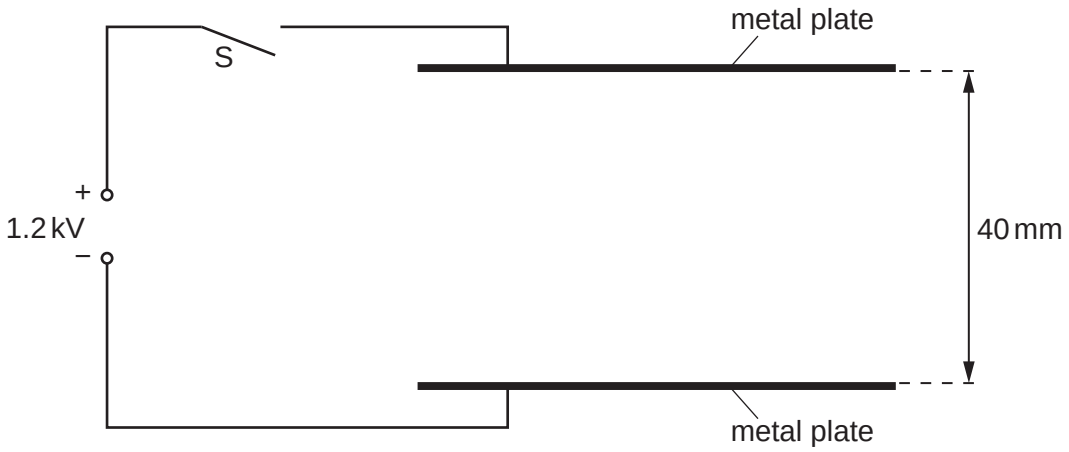


**Fig. 7.1**

The separation of the plates is 40 mm.

The switch S is then closed so that a potential difference of 1.2 kV is applied across the plates.

**(i)** On Fig. 7.1, draw six field lines to represent the electric field between the metal plates. [2]

**(ii)** Calculate the electric field strength $E$ between the plates.

$E$ = ..... V m$^{-1}$ [2]

**(b)** The switch S is opened and the plates lose their charge. Two very small metal spheres A and B joined by an insulating rod are placed between the metal plates as shown in Fig. 7.2.

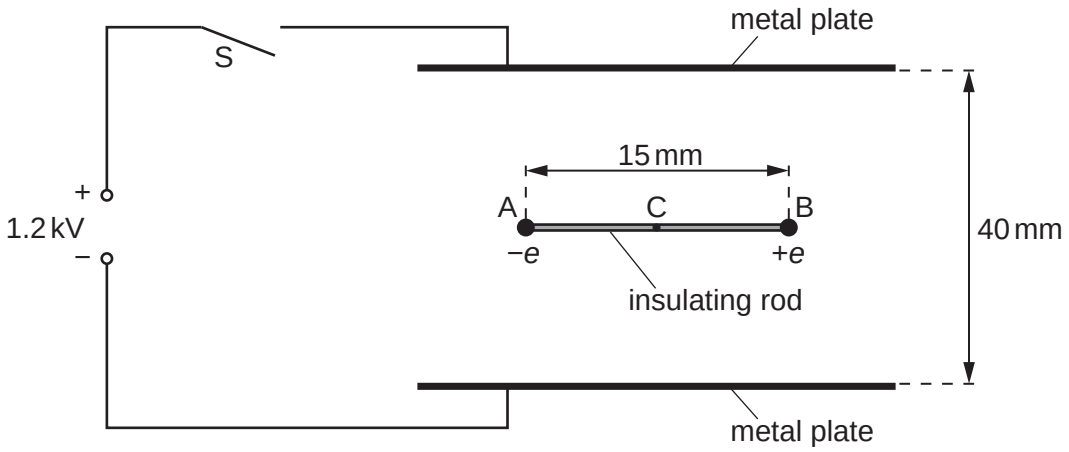


**Fig. 7.2**

Sphere A has charge $-e$ and sphere B has charge $+e$, where $e$ is the charge of a proton. The length AB is 15 mm. The rod is supported at its centre C so that the rod is horizontal and in equilibrium.

The switch S is then closed so that the potential difference of 1.2 kV is applied across the plates.

**(i)** There is a force acting on A due to the electric field between the plates.
Show that this force is $4.8 \times 10^{-15}$ N.

[2]

**(ii)** The insulating rod joining A and B is fixed in the position shown in Fig. 7.2.
Calculate the torque of the couple acting on the rod.

torque = ..... unit ..... [3]

**(iii)** The insulating rod is now released so that it is free to rotate about C.
State and explain the position of the rod when it comes to rest.

.....

.....

.....

..... [2]

**5** **(a)** Define *electric field strength*.

.....

.....[1]

**(b)** A uniform electric field is produced by applying a potential difference of 1200V across two parallel metal plates in a vacuum, as shown in Fig. 4.1.

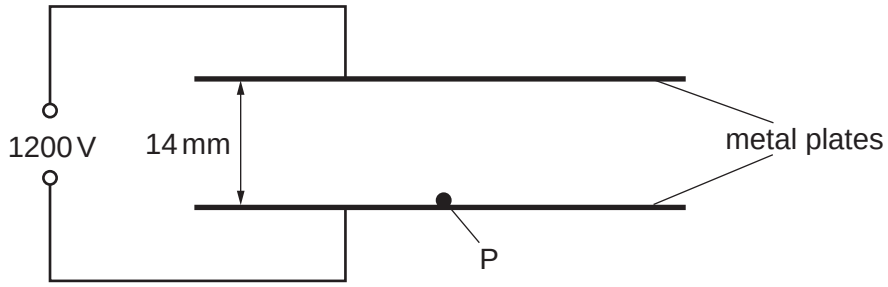


**Fig. 4.1**

The separation of the plates is 14 mm. A particle P with charge $3.2 \times 10^{-19}$ C and mass $6.6 \times 10^{-27}$ kg starts from rest at the lower plate and is moved vertically to the top plate by the electric field.

Calculate

**(i)** the electric field strength between the plates,

electric field strength = ..... $V\,m^{-1}$ [2]

**(ii)** the work done on P by the electric field,

work done = ..... J [2]

**(iii)** the gain in gravitational potential energy of P,

gain in potential energy = ..... J [2]

**(iv)** the gain in kinetic energy of P,

gain in kinetic energy = ..... J [1]

**(v)** the speed of P when it reaches the top plate.

speed = ..... $m\,s^{-1}$ [2]