Electric fields – 2021/20 GCE Physics A Component 02

1. Nov/2021/Paper_H556_02/No.24

(a) **Fig. 24** shows two horizontal metal plates in a vacuum.

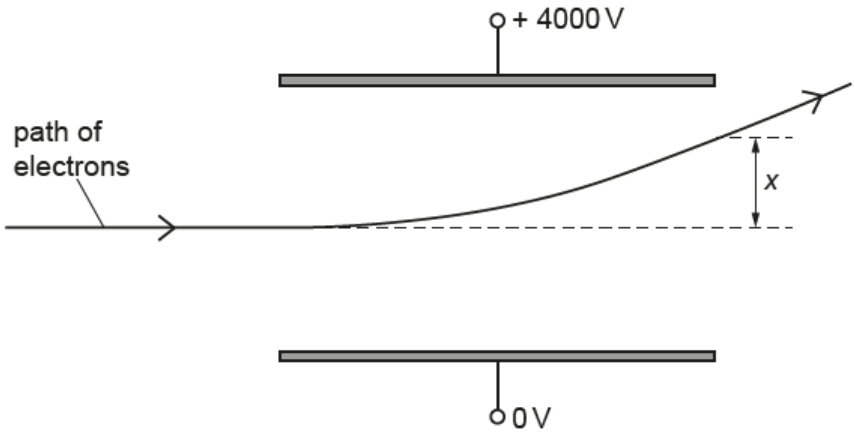

Fig. 24

The diagram is **not** drawn to scale.
Electrons travelling horizontally enter the space between the charged plates and are deflected vertically.

The potential difference between the plates is 4000 V.
The distance between the plates is 0.08 m.
The initial speed of the electrons is $6.0 \times 10^{7}\,\text{m s}^{-1}$.
The vertical deflection of the electrons at the far end of the plates is x.

(i) Show that the vertical acceleration a of an electron between the plates is $8.8 \times 10^{15}\,\text{m s}^{-2}$.

[3]

(ii) The length of each plate is 0.12 m.

Show that the time t taken by the electron to travel this length is 2.0×10^{-9} s.

[1]

(iii) Calculate the vertical deflection x of the electron.

x = ... m **[2]**

(b) The arrangement shown in **Fig. 24** is now used to investigate positrons emitted from a radioactive source.
The speed of the positrons is also $6.0 \times 10^7\,\text{m s}^{-1}$.

The initial path of the positrons is the same as that of the electrons in **Fig. 24**.

On **Fig. 24**, sketch the path of the positrons between the plates. **[2]**

(c) Beta-minus particles (electrons) emitted from a radioactive source have a range of speeds.

Describe and explain how a uniform magnetic field can be applied in the space between the charged plates to select beta-minus particles with a specific speed. No calculations are required.

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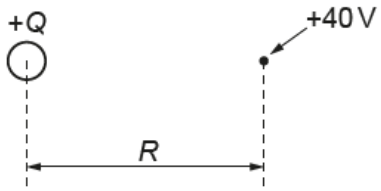
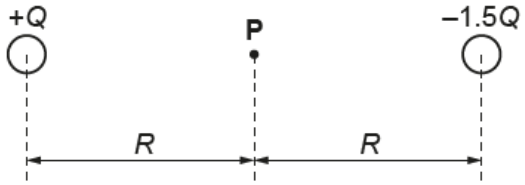
..... **[3]**

2. Nov/2020/Paper_H556_02/No.13

The electric potential at a distance *R* from the centre of a charge +*Q* is + 40 V.



What is the potential at the point **P** for the arrangement of the charges +*Q* and −1.5*Q* as shown below?



A − 20 V

B − 60 V

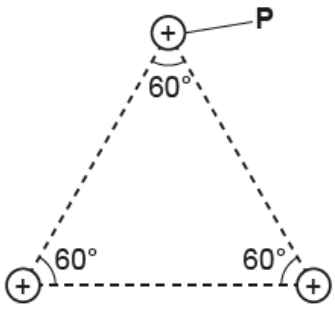
C + 80 V

D + 100 V

Your answer ☐ **[1]**

3. Nov/2020/Paper_H556_02/No.23

(a) The diagram below shows the arrangement of the 3 protons inside the nucleus of lithium-6 ($^{6}_{3}$Li).



The separation between each proton is about 1.0×10^{-15} m.

(i) Calculate the magnitude of the repulsive electric force F experienced by the proton **P**.

F = ... N **[4]**

(ii) On the diagram above, draw an arrow to show the direction of the electric force F experienced by **P**. **[1]**

(iii) Explain how protons stay within the nucleus of lithium-6.

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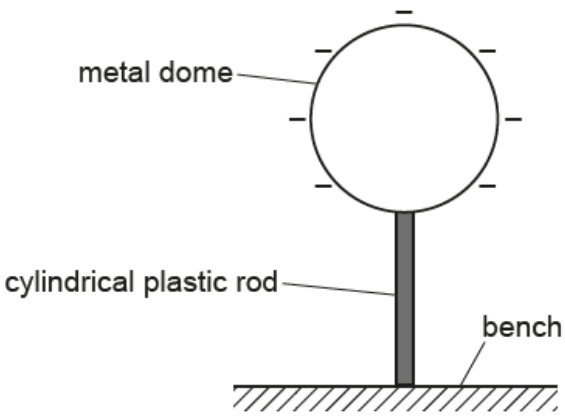
..... **[2]**

(b) A spherical metal dome shown below is charged to a potential of −12 kV.



The dome is supported by a cylindrical plastic rod. The radius of the dome is 0.19 m.

(i) Show that the magnitude of the total charge Q on the dome is 2.5×10^{-7} C.

[2]

(ii) The dome discharges slowly through the plastic rod.
It takes 78 hours for the dome to completely discharge.

1 Show that the mean current I in the plastic rod is about 9×10^{-13} A.

[2]

2 The average potential difference across the plastic rod during discharge is 6000 V.
The rod has cross-sectional area 1.1×10^{-4} m^2 and length 0.38 m.

Calculate the resistivity ρ of the plastic.

ρ = ... Ω m **[3]**