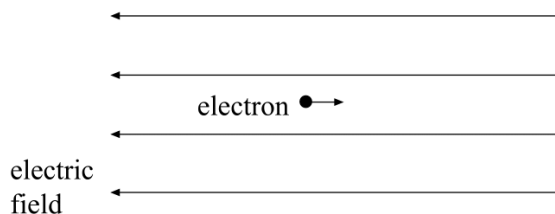


Electric Fields Past Paper Questions Jan 2002—Jan 2010 (old spec)

- 4 (a) An electron moves parallel to, but in the opposite direction to, a uniform electric field, as shown in **Figure 1**.



Q4 Jan 2002

Figure 1

- (i) State the direction of the force that acts on the electron due to the electric field.

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- (ii) What is the effect of this force on the motion of the electron?

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(2 marks)

- (b) An electron, which is travelling in a horizontal path at constant speed, enters a uniform vertical electric field as shown in **Figure 2**.

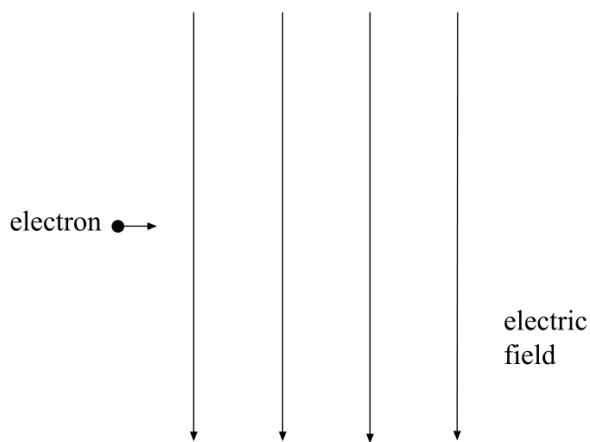


Figure 2

- (i) Sketch on **Figure 2** the path followed by the electron.

- (ii) Explain the motion of the electron whilst in this field.

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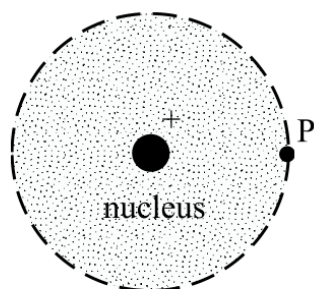
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(3 marks)

- 3 The mass of the nucleus of an isolated copper atom is 63 u and it carries a charge of $+29e$. The diameter of the atom is 2.3×10^{-10} m.

P is a point at the outer edge of the atom.

Q3 Jan 2003



(a) Calculate

- (i) the electric field strength at P due to the nucleus,

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- (ii) the gravitational potential at P due to the nucleus.

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(5 marks)

- (b) Draw an arrow on the above diagram to show the direction of the electric field at the point P.

(1 mark)

- 2 (a) Complete the table of quantities related to fields. In the second column, write an SI unit for each quantity. In the third column indicate whether the quantity is a scalar or a vector.

quantity	SI unit	scalar or vector
gravitational potential		
electric field strength		
magnetic flux density		

Q2 Jan 2004

(3 marks)

- (b) (i) A charged particle is held in equilibrium by the force resulting from a vertical electric field. The mass of the particle is 4.3×10^{-9} kg and it carries a charge of magnitude 3.2×10^{-12} C. Calculate the strength of the electric field.

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- (ii) If the electric field acts upwards, state the sign of the charge carried by the particle.

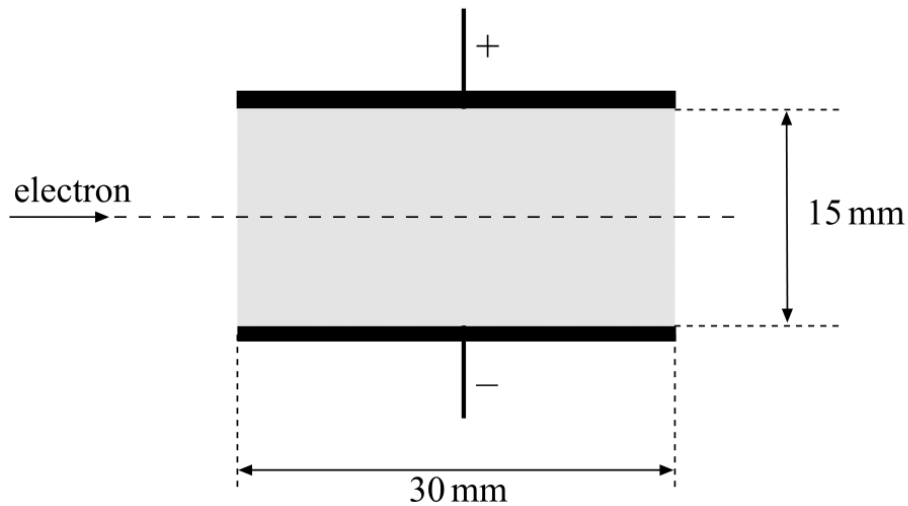
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(3 marks)

- 5 (a) An electron travels at a speed of $3.2 \times 10^7 \text{ m s}^{-1}$ in a horizontal path through a vacuum. The electron enters the uniform electric field between two parallel plates, 30 mm long and 15 mm apart, as shown in **Figure 2**. A potential difference of 1400 V is maintained across the plates, with the top plate having positive polarity. Assume that there is no electric field outside the shaded area.

Q5 Jan 2006

Figure 2



- (i) Show that the electric field strength between the plates is $9.3 \times 10^4 \text{ V m}^{-1}$.

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- (ii) Calculate the time taken by the electron to pass through the electric field.

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- (iii) Show that the acceleration of the electron whilst in the field is $1.6 \times 10^{16} \text{ m s}^{-2}$ and state the direction of this acceleration.

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(5 marks)

- (b) Determine the magnitude and direction of the velocity of the electron at the point where it leaves the field.

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(3 marks)

- 3 (a) (i) Define the *electric field strength*, E , at a point in an electric field.

Q3 Jun 2006

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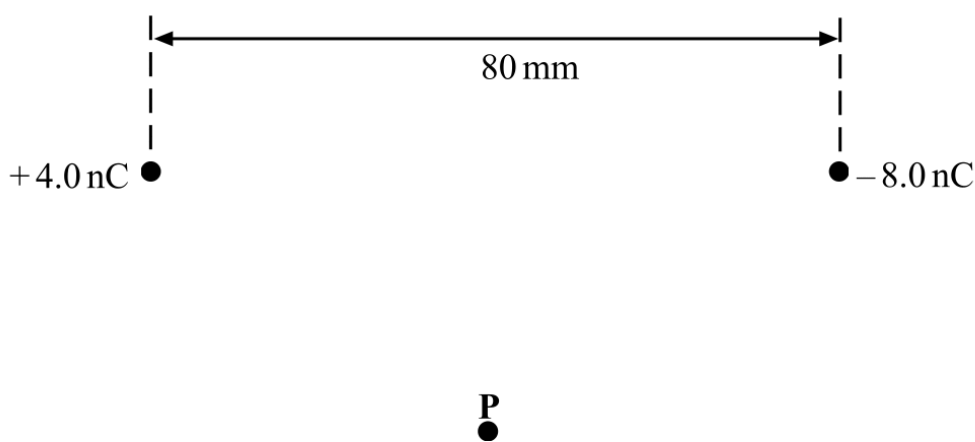
- (ii) State whether E is a scalar or a vector quantity.

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(3 marks)

- (b) Point charges of $+4.0 \text{ nC}$ and -8.0 nC are placed 80 mm apart, as shown in **Figure 2**.

Figure 2



- (i) Calculate the magnitude of the force exerted on the $+4.0 \text{ nC}$ charge by the -8.0 nC charge.

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- (ii) Determine the distance from the +4.0 nC charge to the point, along the straight line between the charges, where the electric potential is zero.

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(4 marks)

- (c) Point **P** in **Figure 2** is equidistant from the two charges.

- (i) Draw two arrows on **Figure 2** at **P** to represent the directions and relative magnitudes of the components of the electric field at **P** due to each of the charges.
- (ii) Hence draw an arrow, labelled **R**, on **Figure 2** at **P** to represent the direction of the resultant electric field at **P**. (3 marks)

4

Figure 4

Q4 Jun 2007



In a Rutherford scattering experiment, an α particle approaches a gold nucleus along the straight line joining their centres and comes momentarily to rest at point **P**, as shown in **Figure 4**.

The α particle then returns along its previous path.

- (a) The distance from the centre of the gold nucleus $^{197}_{79}\text{Au}$, to the point **P** is 3.0×10^{-14} m.

For the point **P**

- (i) show that the strength of the electric field associated with the charge of the nucleus is $1.3 \times 10^{20} \text{ V m}^{-1}$,

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- (ii) calculate the magnitude of the force acting on the α particle,

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- (iii) calculate the electric potential due to the charge of the nucleus.

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(5 marks)

- (b) (i) State the energy changes of the α particle during its interaction with the gold nucleus.

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- (ii) Calculate the initial kinetic energy, in J, of the α particle, explaining your reasoning.

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(4 marks)

- 3 (a) Electrons experience forces in electric fields. In each of the following cases, state the direction of the force that acts on a moving electron, and describe and explain the electron's subsequent motion.

You may be awarded additional marks to those shown in brackets for the quality of written communication in your answer.

Q3 Jan 2008

- (i) An electron enters a uniform electric field that is directed at right angles to the electron's velocity at the point of entry.

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- (ii) An electron enters a uniform electric field whose direction is the same as that of the electron's velocity at the point of entry.

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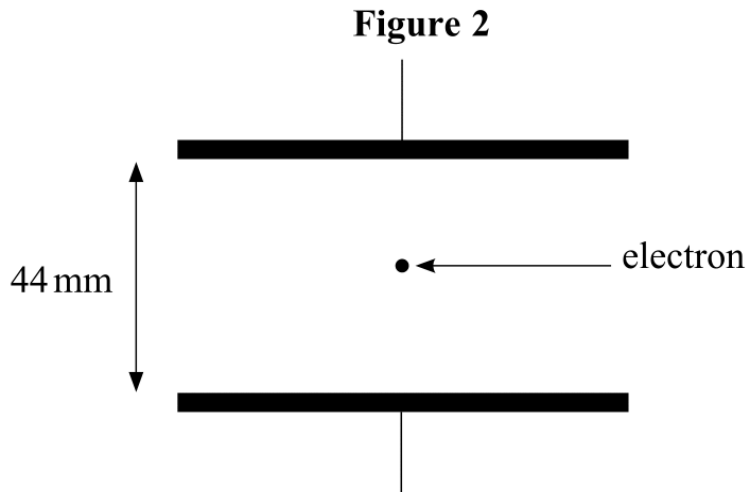
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(5 marks)

- (b) **Figure 2** shows two parallel metal plates, 44 mm apart, which have a pd of 110 V applied across them, with an electron between them.



Calculate

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

- (ii) the magnitude of the force on the electron when it is between the plates,

- (iii) the kinetic energy, in J, that is gained by the electron when it starts from rest at one plate and crosses to the other plate.

(4 marks)

- 4 (a) In order for fusion of two nuclei to take place, they have to be brought together to a separation of about 2 fm.

Q4 Jan 2008

- (i) Show that the electrostatic potential energy of a system consisting of two deuterium (${}^2_1\text{H}$) nuclei at a separation of 2 fm is about 1×10^{-13} J.

Note this question is a little off topic but maybe useful for other modules

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- (ii) Two deuterium nuclei may be brought to this separation by causing them to collide with equal and opposite velocities. Calculate the minimum speed required by **each** nucleus for the system to have the potential energy calculated in part (a)(i).

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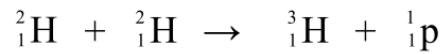
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(5 marks)

(b) One reaction that can occur when deuterium nuclei undergo fusion is



(i) Calculate the energy released, in J, by this reaction.

mass of ${}^2_1\text{H}$ nucleus = 2.01355 u

mass of ${}^3_1\text{H}$ nucleus = 3.01550 u

mass of proton = 1.00728 u

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(ii) How much energy is released, in J, from 1 kg of reactant in the above fusion reaction?

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(4 marks)

(c) State **two** reasons why fusion reactions would be preferable to fission reactions as an energy resource, provided the necessary conditions required for continuous fusion could be maintained.

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(2 marks)

- 4 (a) (i) With the aid of a diagram, describe the electric field around an isolated point negative charge (shown below as $-Q$).

Q4 Jun 2009



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- 4 (a) (ii) Draw a dashed line (- - - - -) on your diagram, along which a small charge could be moved without changing its potential energy. Label this line **L**.

(4 marks)

- 4 (b) (i) Point P is 40 mm from a point charge of -0.80 nC .

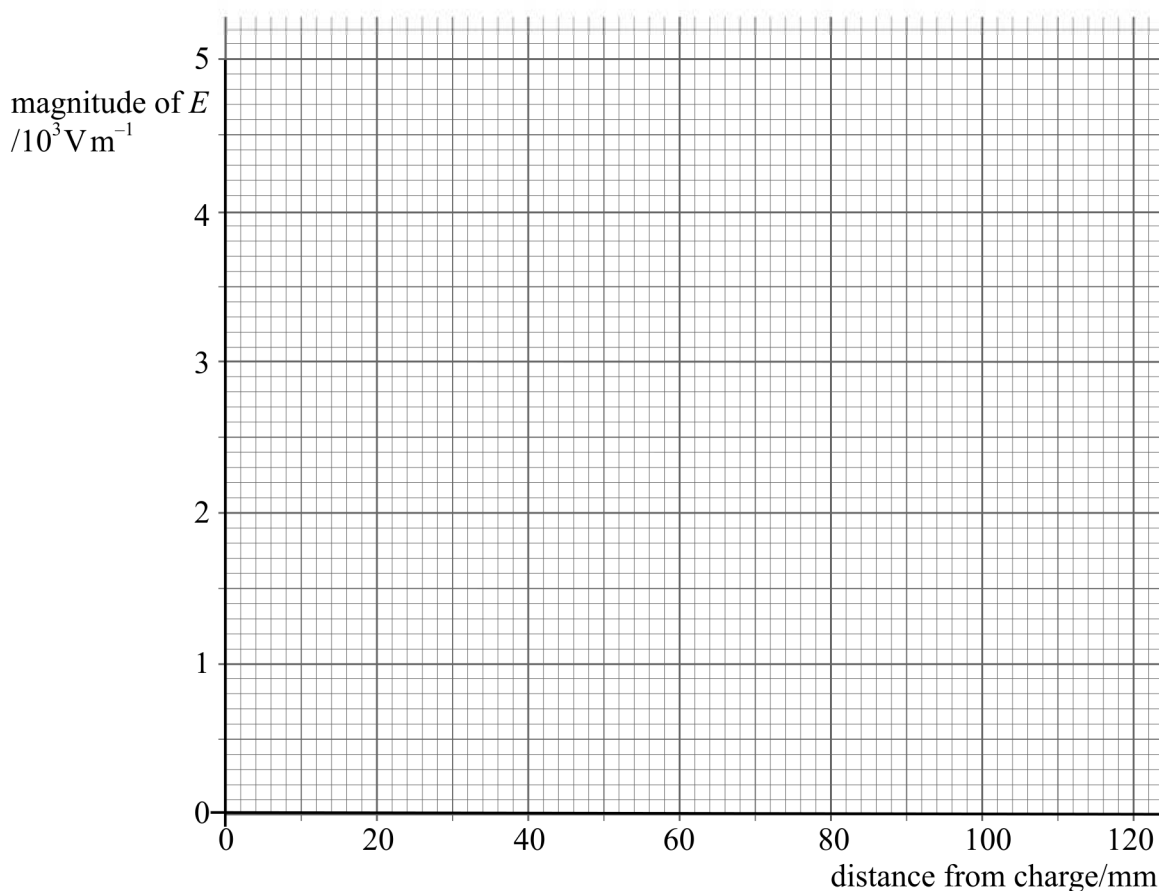
Calculate the magnitude of the electric field strength at P.

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- 4 (b) (ii) Insert your value for the electric field strength at P, from part (b)(i), on **Figure 4**. Then complete, as accurately as you can, a graph on **Figure 4** to show how the magnitude of the electric field strength varies with distance, for points which are at distances greater than 40 mm from the -0.80 nC charge.

Figure 4

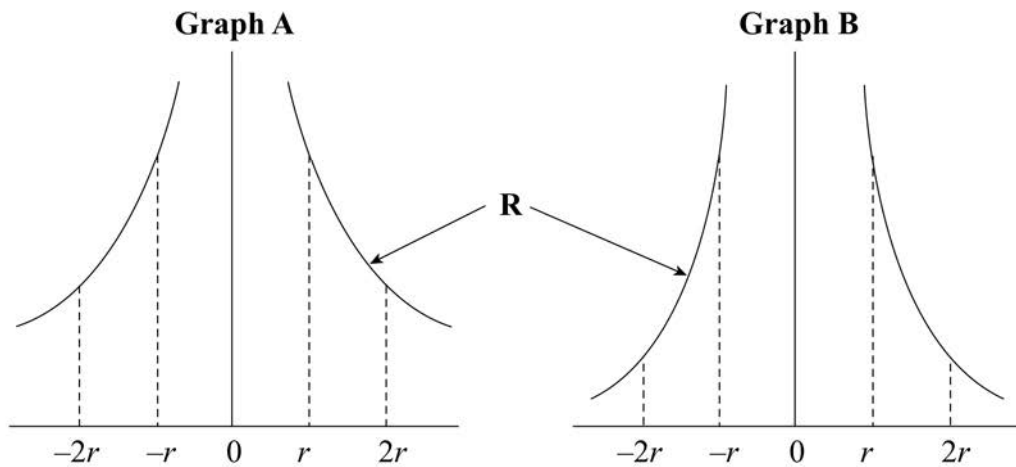


(5 marks)

- 2 **Figure 3** shows graphs of the electric field strength and of the electric potential caused by a point charge. On each graph the vertical axis has a linear scale.

Figure 3

Q2 Jan 2010



- 2 (a) Which of the graphs, **A** or **B**, shows the variation of *electric field strength* against distance?

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 (1 mark)

- 2 (b) State why, in the regions marked **R**, the shapes of the graphs are different from each other.

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 (2 marks)

- 2 (c) At a point where the distance, r , from the point charge is 40 mm, the electric field strength is $3.6 \times 10^4 \text{ Vm}^{-1}$. Calculate the potential at this point.

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 (2 marks)