

APOLLO

Electric and magnetic fields

HL

Physics

First assessment 2025

23 questions | questions

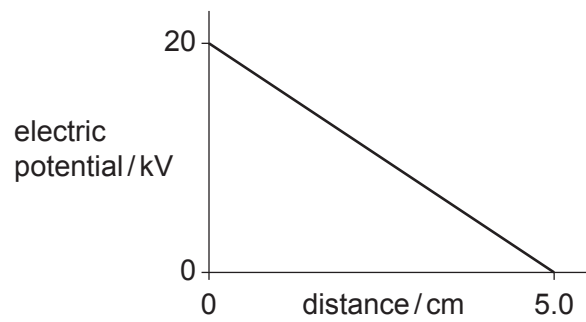
26. The unit of $\mu_0 \times \varepsilon_0$ expressed in fundamental SI units is...

- A. m^{-2}s^2 .
- B. $\text{TCN}^{-1}\text{m}^{-1}\text{s}$.
- C. m^2s^{-2} .
- D. $\text{TC}^2\text{A}^{-1}\text{N}^{-1}\text{m}^{-1}$.

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27. Two parallel conducting plates are separated by 5.0 cm. The variation of electric potential with distance between the plates is shown.



What is the magnitude of the electric field strength between the plates?

- A. 4.0 NC^{-1}
- B. $1.0 \times 10^3 \text{ NC}^{-1}$
- C. $1.0 \times 10^5 \text{ NC}^{-1}$
- D. $4.0 \times 10^5 \text{ NC}^{-1}$

28. Charge is moving in a wire that is at right angles to a uniform magnetic field.

The length of the wire is 0.32 m.

When the current in the wire is increased by 5.0 A, the force acting on the wire increases by 4.0 mN.

What is the strength of the magnetic field?

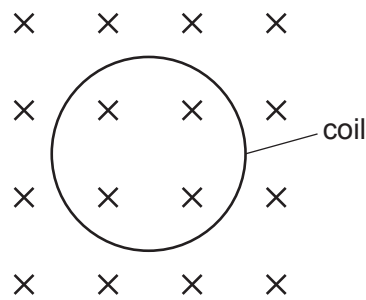
- A. 2.5 mT
- B. 25 mT
- C. 40 T
- D. 40 kT

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- 29.** Negative charge carriers travel counter-clockwise in a circular coil that lies in the plane of the page.

The coil is in a uniform magnetic field directed into the page.



What is the magnetic effect on the coil?

- A. The coil will rotate clockwise in the plane of the paper.
- B. The coil will rotate counter-clockwise in the plane of the paper.
- C. The diameter of the coil will tend to increase.
- D. The diameter of the coil will tend to decrease.

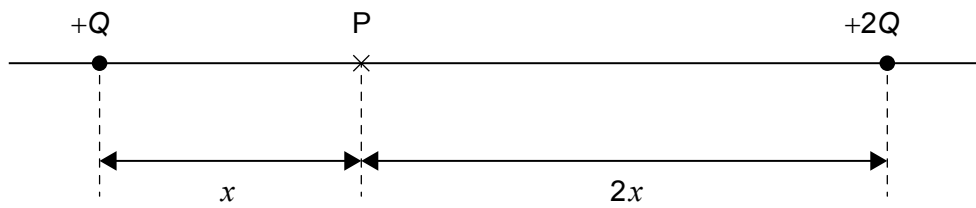
30. Who was the first scientist to show that electric charge is quantized?

- A. Coulomb
- B. Millikan
- C. Planck
- D. Rutherford

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22. A charge $+Q$ and a charge $+2Q$ are a distance $3x$ apart. Point P is on the line joining the charges, at a distance x from one of the charges as shown.



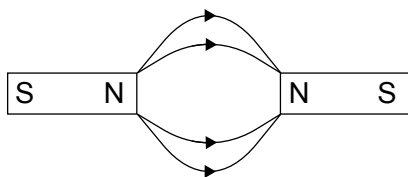
What is the electric field strength E at P?

	Magnitude of E	Direction of E
A.	$\frac{kQ}{2x^2}$	left
B.	$\frac{kQ}{2x^2}$	right
C.	$\frac{kQ}{x^2}$	left
D.	$\frac{kQ}{x^2}$	right

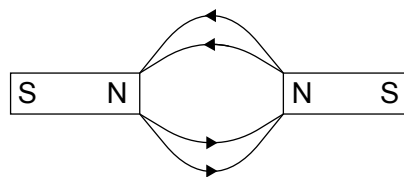
23. Two bar magnets are held in place with the north poles facing each other.

Which diagram shows four correct magnetic field lines?

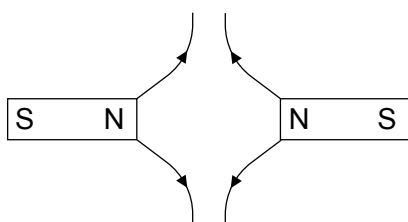
A.



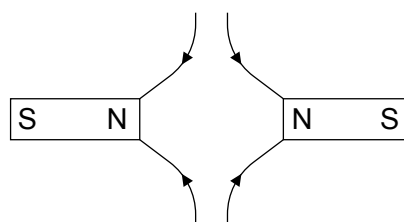
B.



C.



D.



24. A pair of parallel conducting plates are separated by 50 cm. The electric potential of one plate is +200 V and the electric potential of the other plate is +450 V. A proton travels from the +200 V plate to the +450 V plate.

What is the electric field strength between the plates and the change in the kinetic energy of the proton?

	Magnitude / NC^{-1}	Change in kinetic energy
A.	500	positive
B.	500	negative
C.	900	positive
D.	900	negative

27. Two parallel wires X and Y carry the same current. There is a repulsive force per unit length F on each wire. The direction of the current in each wire is reversed. The current in X is doubled and the current in Y stays the same. The separation of X and Y is also doubled.

What is the magnitude and direction of the force per unit length on each wire?

	Magnitude	Direction
A.	F	repulsive
B.	F	attractive
C.	$\frac{F}{2}$	repulsive
D.	$\frac{F}{2}$	attractive

- 29.** In a Millikan's experiment, an oil drop is stationary between two parallel plates. A second oil drop of the same density, between the same plates, has twice the charge and twice the radius of the first oil drop.

The second oil drop will initially

- A. be stationary.
- B. move with constant velocity downwards.
- C. accelerate upwards.
- D. accelerate downwards.

30. Two isolated point charges, X of charge $+Q$ and Y of charge $+2Q$, are separated by a distance $3d$. P is a point d from X and $2d$ from Y respectively.

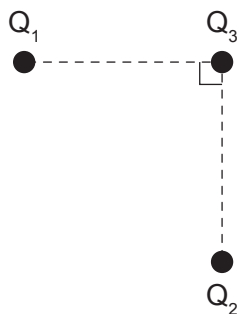


What is the net electric field strength at P?

- A. 0
- B. $\frac{kQ}{2d^2}$
- C. $\frac{3kQ}{4d^2}$
- D. $\frac{3kQ}{2d^2}$

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31. Two isolated positive point charges Q_1 and Q_2 are equidistant from a third charge Q_3 as shown. The force on Q_3 due to Q_1 is F . The force on Q_3 due to Q_2 is $2F$.



What is the resultant force on Q_3 ?

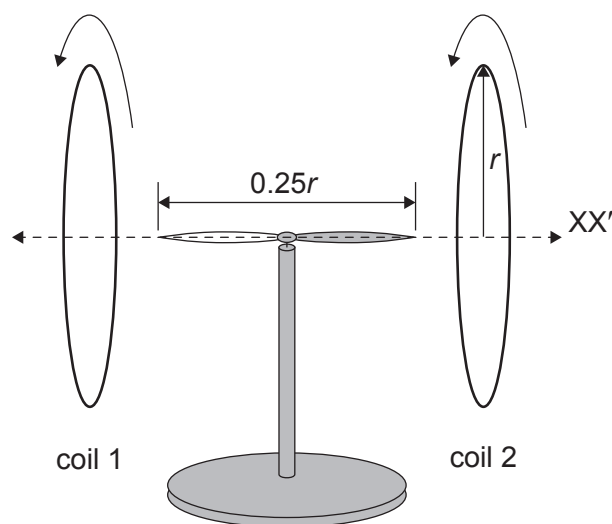
- A. F
- B. $\sqrt{3}F$
- C. $\sqrt{5}F$
- D. $3F$

3. A group of students wants to determine the horizontal component B_H of the Earth's magnetic field.

They place a magnet (in the form of a magnetic needle) midway between two coils.

When there is no current through the coils, the magnet aligns itself in the north-south direction. When there is an identical current established in the coils, the magnetic field produced deflects the magnet.

diagram not to scale



Each coil has a radius r . The length of the magnet is $0.25r$.

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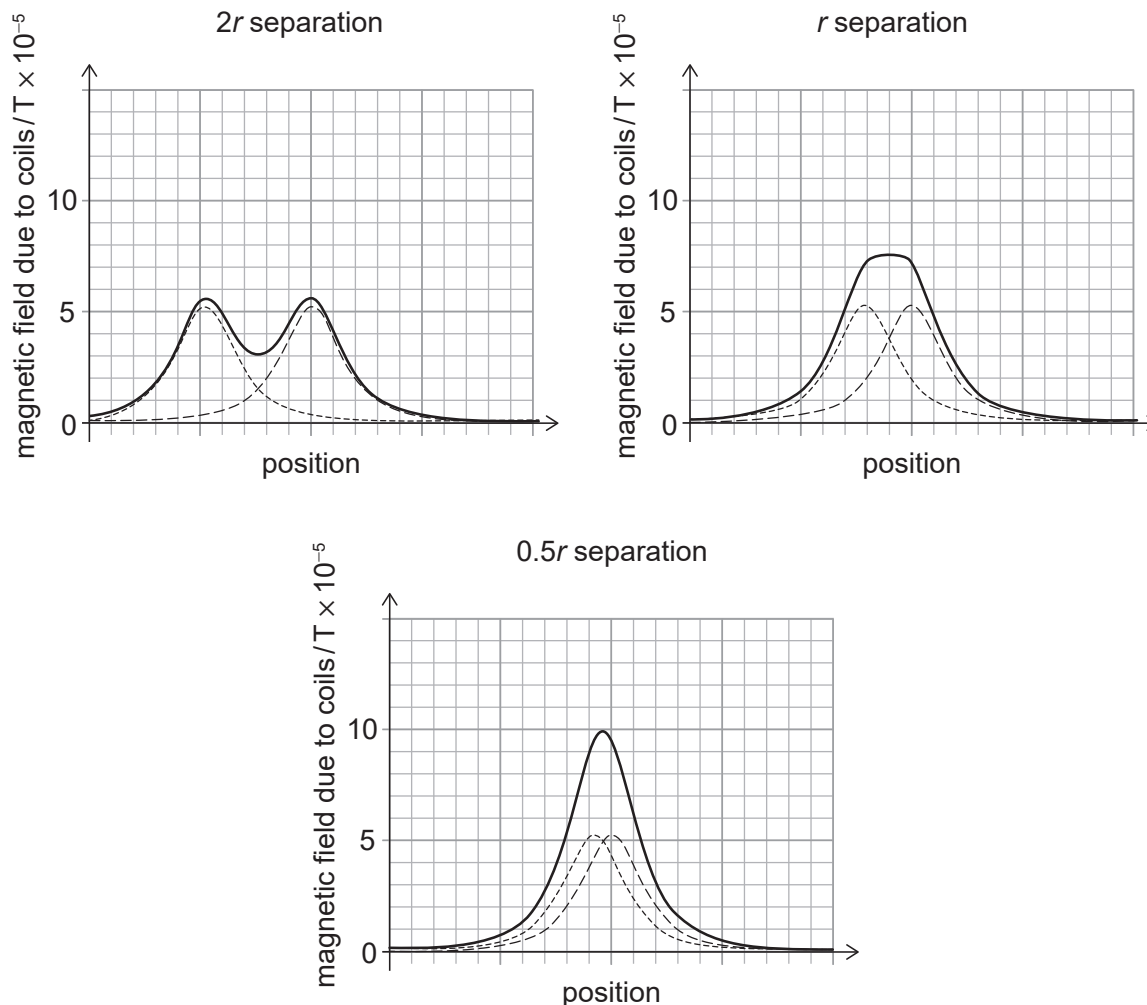


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(Question 3 continued)

The students have to decide on the horizontal separation of the two coils. Their choices are separations of $2r$, r and $0.5r$.

The variation with distance of the magnetic field strength due to each coil and the resultant magnetic field strength for both coils are shown for each of these separations. The dotted line represents the magnetic field from each coil, while the solid line shows the resultant magnetic field.



- (a) State and explain which coil separation the students should choose for this experiment. [2]

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(Question 3 continued)

(b) Explain why the students place axis XX' of the coils in the east-west direction. [2]

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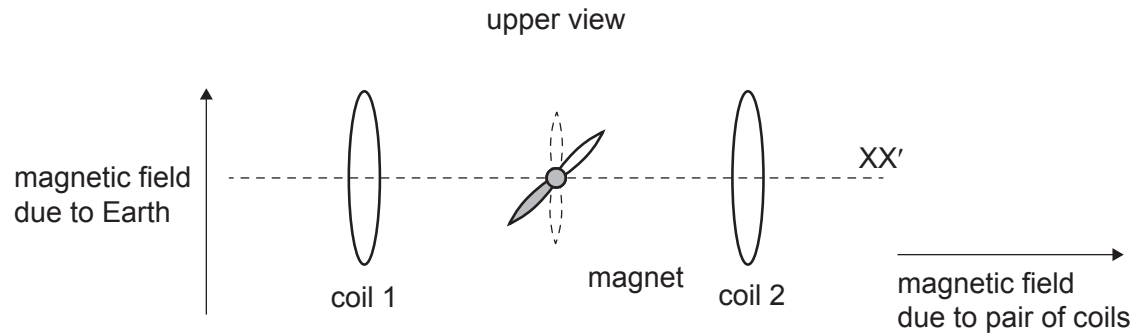
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(c) The deflection of the magnet is shown.

diagram not to scale



The magnet comes to rest when it makes an angle of 24° to XX' .

Determine, using the graphs, B_H . [2]

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will not be marked.



- 26.** Two point charges, $+Q$ and $-Q$, are at a distance d from each other.

What is the magnitude of the electric field strength midway between the charges?

A. Zero

B. $\frac{2kQ}{d^2}$

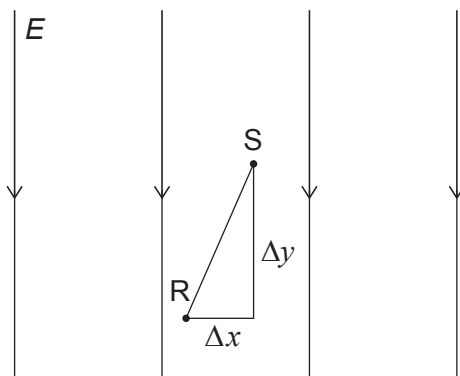
C. $\frac{4kQ}{d^2}$

D. $\frac{8kQ}{d^2}$

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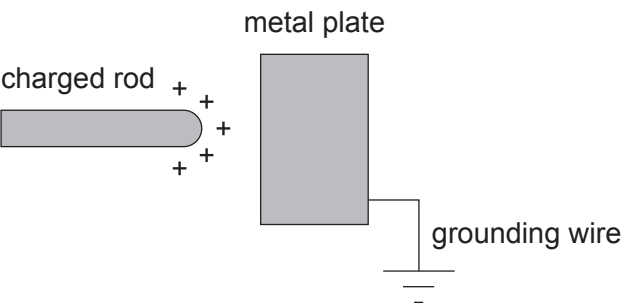
27. Two points R and S are in a uniform electric field of strength E , directed vertically downwards. The horizontal distance from R to S is Δx , and the vertical distance from R to S is Δy .



The electric potential at R is zero. What is the electric potential at S?

- A. $E\sqrt{\Delta x^2 + \Delta y^2}$
- B. $E\Delta y$
- C. $-E\sqrt{\Delta x^2 + \Delta y^2}$
- D. $-E\Delta y$

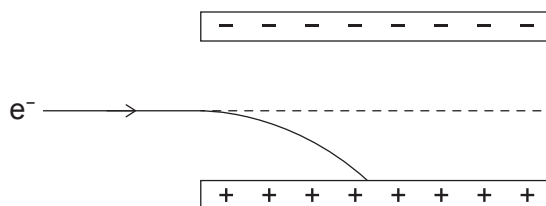
30. A positively charged rod is near a metal plate that is grounded as shown.



The grounding wire and then the rod are removed. What is correct about the overall charge on the plate before and after grounding is removed?

	Charge on plate before grounding is removed	Charge on plate after grounding is removed
A.	neutral	neutral
B.	neutral	negative
C.	negative	neutral
D.	negative	negative

31. An electron with speed v enters the region between two charged parallel plates midway between the plates, as shown. The potential difference between the plates is V .



What is the speed of the electron on impact with the plate?

- A. $\sqrt{v^2 + \frac{eV}{2m_e}}$
- B. $\sqrt{v^2 + \left(\frac{eV}{2m_e}\right)^2}$
- C. $\sqrt{v^2 + \frac{eV}{m_e}}$
- D. $\sqrt{v^2 + \left(\frac{eV}{m_e}\right)^2}$

- 24.** A solid metallic sphere is positively charged and isolated from all other charges.

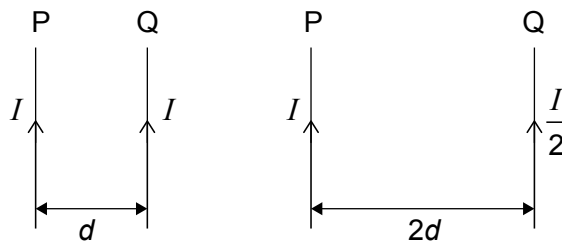
The electric potential due to the sphere

- A. is constant inside the sphere.
- B. is constant outside the sphere.
- C. is smallest at the surface of the sphere.
- D. increases with distance from the sphere.

26. Two long parallel wires P and Q are a distance d apart. They each carry a current.

A magnetic force per unit length F acts on P due to Q.

The distance between the wires is increased to $2d$ and the current in Q is decreased to $\frac{I}{2}$.

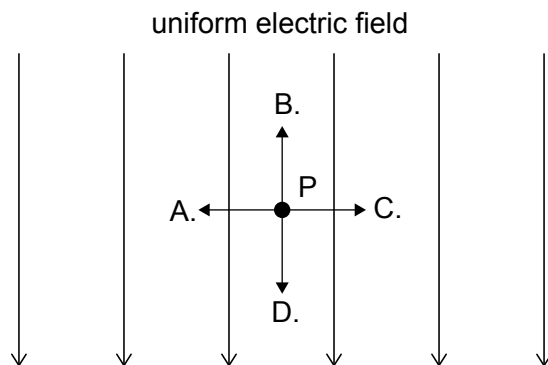


What is the magnetic force per unit length that acts on P due to Q after the changes?

- A. $\frac{F}{8}$
- B. $\frac{F}{4}$
- C. $\frac{F}{2}$
- D. F

27. P is a point in a uniform electric field.

What is the direction in which the electric potential increases at P?



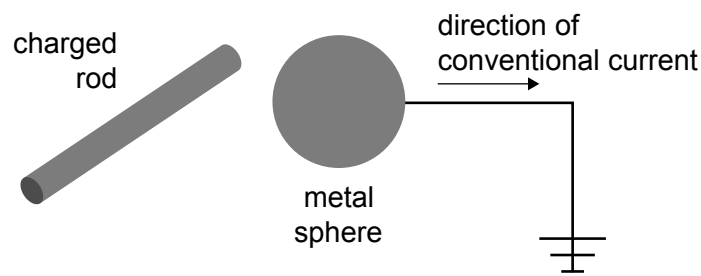
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31. A charged rod is brought near an initially neutral metal sphere without touching it.

When the sphere is grounded (earthed), there is an electric current for a short time from the sphere to the ground.

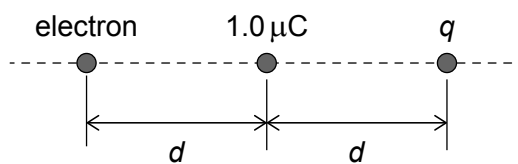


The ground connection is then removed.

What are the charge on the rod and the charge induced on the sphere when the connection is removed?

	Charge on the rod	Charge induced on the sphere
A.	negative	negative
B.	negative	positive
C.	positive	negative
D.	positive	positive

32. A positive point charge of magnitude $1.0\ \mu\text{C}$ and a point charge q are separated by a distance d .

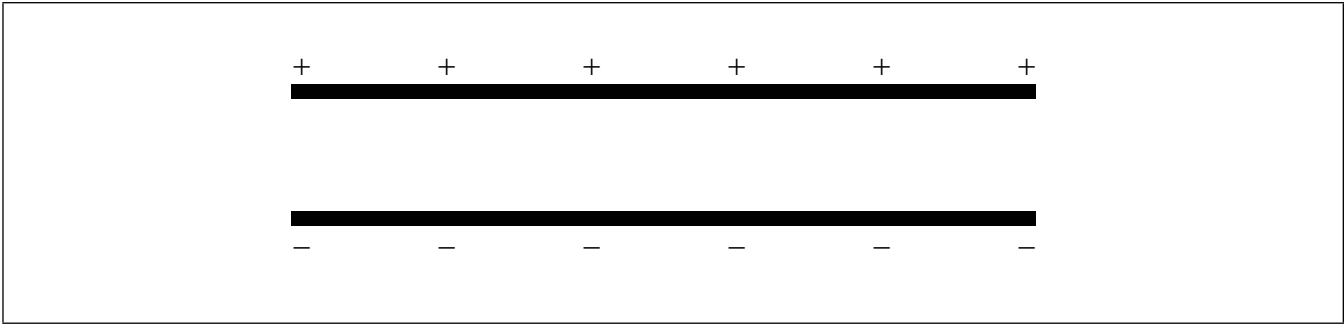


An electron is placed at a distance d from the $+1.0\ \mu\text{C}$ charge. The electric force on the electron is zero.

What is q ?

- A. $-4.0\ \mu\text{C}$
- B. $-2.0\ \mu\text{C}$
- C. $2.0\ \mu\text{C}$
- D. $4.0\ \mu\text{C}$

9. The diagram shows two parallel conducting plates that are oppositely charged.



- (a) (i) Draw the electric field lines due to the charged plates.
 [2]
- (ii) The potential difference between the plates is 960 V and the distance between them is 8.0 mm. Calculate the electric field strength E between the plates.
 [2]

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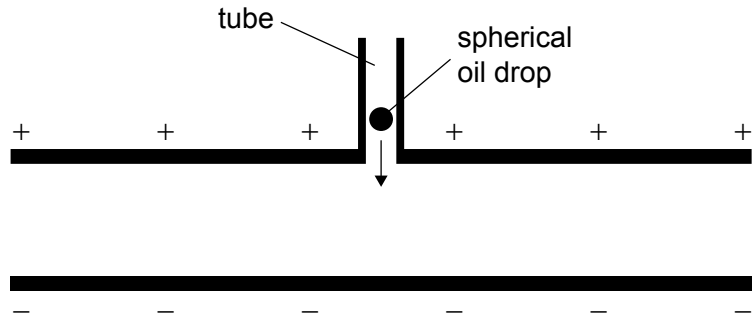
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(Question 9 continued)

In an experiment, an oil drop is introduced into the space between the plates through a small hole in the upper plate. The oil drop moves through air in a tube before falling between the plates.



(b) Explain why the oil drop becomes charged as it falls through the tube. [1]

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(Question 9 continued)

- (c) The oil drop is observed to be stationary in the space between the plates. Buoyancy is one of the forces acting on the drop.

The density of oil is 730 times greater than that of air.

- (i) Show that the buoyancy force is much smaller than the weight. [3]

- (ii) Draw the forces acting on the oil drop, ignoring the buoyancy force. [2]

oil drop

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(Question 9 continued)

(iii) Show that the electric charge on the oil drop is given by

$$q = \frac{\rho_o g V}{E}$$

where ρ_o is the density of oil and V is the volume of the oil drop. [2]

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(iv) State the sign of the charge on the oil drop. [1]

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(Question 9 continued)

- (d) The electric field is turned off. The oil drop falls vertically reaching a constant speed v .
- (i) Outline why, for this drop, $\rho_o g V = 6\pi\eta r v$ where η is the viscosity of air and r is the radius of the oil drop. [2]

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- (ii) Show that the charge on the oil drop is about $4.8 \times 10^{-19} \text{C}$.

The following data for the oil drop are available:

$$\begin{aligned}
 r &= 1.36 \mu\text{m} \\
 \eta &= 1.60 \times 10^{-5} \text{Pa s} \\
 v &= 0.140 \text{mm s}^{-1}
 \end{aligned}$$

[3]

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- (iii) The oil drop splits into two parts of equal mass. Both are charged. Deduce the net charge on each part. [2]

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