Questions

Q1.

Electric field strength can have the unit of

- ☒ **A** V m
- ☒ **B** V C^{-1}
- ☒ **C** N m^{-1}
- ☒ **D** N C^{-1}

(Total for question = 1 mark)

Q2.

Which of the following is a property of a uniform electric field?

- ☒ **A** A field that doesn't change over time.
- ☒ **B** A field that acts equally in all directions.
- ☒ **C** A field that only produces a force on moving charged particles.
- ☒ **D** A field that has the same strength at all points.

(Total for question = 1 mark)

Q3.

A potential difference of 50 V is applied between two identical parallel aluminium plates. The plates are separated by a distance of 10 mm.

Which combination of potential difference and separation would double the electric field strength?

	Separation/mm	Potential difference/ V
☒ A	20	100
☒ B	20	25
☒ C	10	100
☒ D	10	25

(Total for question = 1 mark)

Q4.

Some flowers are negatively charged and surrounded by an electric field. This helps to attract bees.

When the bee is collecting nectar from the plant, the electric field strength decreases.
It is thought that this warns other bees that the nectar supply is low.

State the effect of a decreased electric field strength on the equipotential lines.

(1)

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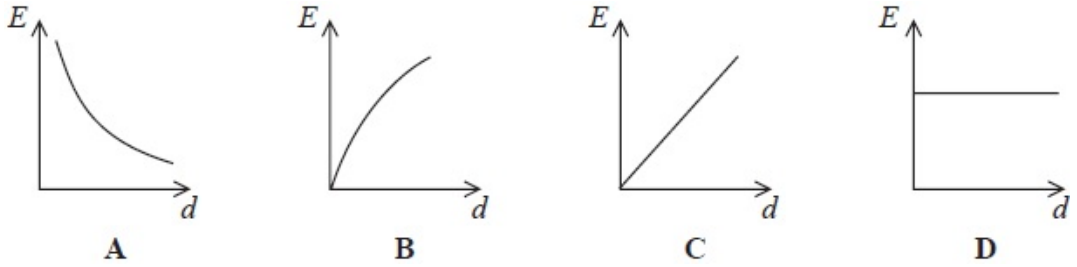
(Total for question = 1 mark)

Q5. Two parallel, conducting plates are connected to a battery. One plate is connected to the positive terminal and the other plate to the negative terminal. The plate separation *d* is gradually increased while the plates stay connected to the battery.

Select the graph that shows how the electric field strength *E* between the plates varies with separation *d*.



☒ **A**

☒ **B**

☒ **C**

☒ **D**

(Total for Question = 1 mark)

Q6.

Some flowers are negatively charged and surrounded by an electric field. This helps to attract bees.

State what is meant by an electric field.

(1)

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(Total for question = 1 mark)

Q7.

What is the acceleration of an electron at a point in an electric field where the electric field strength is 2.0×10^{4} N C^{-1}?

☒ **A** 2.8×10^{-16} m s^{-2}

☒ **B** 3.2×10^{-15} m s^{-2}

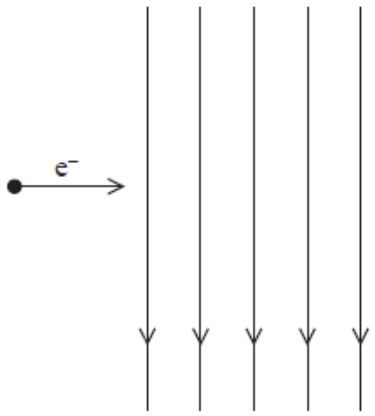
☒ **C** 1.8×10^{11} m s^{-2}

☒ **D** 3.5×10^{15} m s^{-2}

(Total for question = 1 mark)

Q8.

An electron travelling horizontally enters a uniform electric field which acts vertically downwards as shown in the diagram.



Which of the following statements is **incorrect**?

☒ **A** The electron follows a parabolic path.

☒ **B** The electron accelerates while in the field.

☒ **C** The electric force on the electron acts downwards.

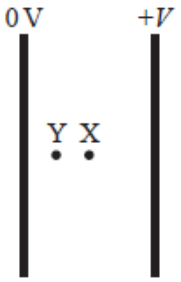
☒ **D** The speed of the electron increases.

(Total for question = 1 mark)

Q9.

Answer the question with a cross in the box you think is correct (☒). If you change your mind about an answer, put a line through the box (☒) and then mark your new answer with a cross (☒).

A potential difference *V* is applied across two parallel plates. An electron midway between the two plates at point X experiences an electric force *F*.



The electron moves to point Y which is halfway between point X and the left-hand plate.

Which of the following is the electric force experienced by the electron at Y?

☒ **A** $2F$

☒ **B** F

☒ **C** $\frac{F}{2}$

☒ **D** $\frac{F}{4}$

(Total for question = 1 mark)

Q10.

Some flowers are negatively charged and surrounded by an electric field. This helps to attract bees.

A bee has short hairs which are thought to carry charge.

State how the bee might use this to detect the electric field of a flower.

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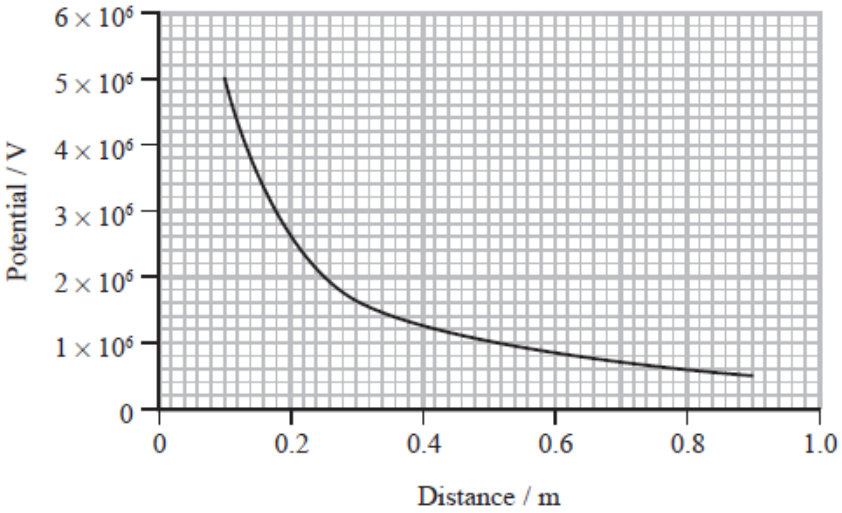
(Total for question = 1 mark)

Q11.

The graph shows how potential varies with distance from the centre of a charged sphere.



Air molecules will be ionised if the electric field strength exceeds 3×10^6 V m^{-1}.

Deduce whether air molecules will be ionised at a distance of 30 cm from the centre of this sphere.

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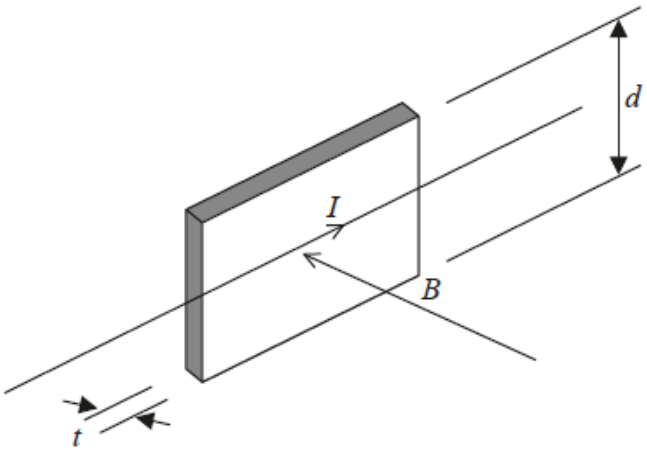
(Total for question = 4 marks)

Q12.

Tiny sensors in smartphones could be used to determine the position of the phone on the Earth's surface by measuring the Earth's magnetic flux density.

A current *I* and a magnetic field of flux density *B* are applied to a slice of semiconductor as shown. The slice has thickness *t* and depth *d*.



Electrons collect at the top edge of the slice and the bottom edge becomes positively charged. As a result a potential difference known as a Hall voltage V_{HALL} develops.

Electrons continue to collect at the top edge of the slice, until the force on a moving electron due to the magnetic field is equal to the force on the electron due to the electric field.

Derive the following equation for V_{HALL}:

$$V_{HALL} = \frac{BI}{nte}$$

where n is the number of charge carriers per unit volume of the semiconductor.

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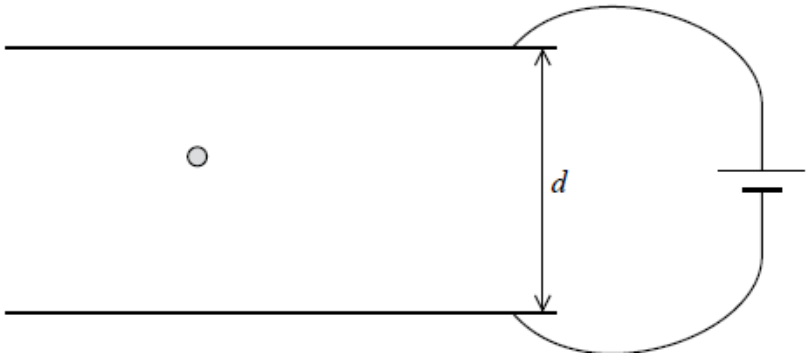
(Total for question = 4 marks)

Q13.

In an experiment to determine the charge on an electron, negatively charged oil drops are

allowed to fall between two parallel metal plates separated by a distance *d*.

A potential difference (p.d.) is applied across the plates. The diagram shows one oil drop between the plates.



When the p.d. is 0 V the oil drop accelerates to terminal velocity. The p.d. is increased. It is observed that at a particular p.d. *V* the oil drop stops falling and remains stationary between the plates.

(a) The oil drop has a mass *m*. Show that the charge *q* on the oil drop is given by

$$q = \frac{mgd}{V}$$

(2)

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(b) Explain what would happen to the oil drop if the p.d. is increased further.

(2)

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(Total for question = 4 marks)

Q14.

Electric fields are caused by both point charges and by parallel plates with a potential difference across them.

Describe the difference between the electric field caused by a point charge and the electric field between parallel plates. Your answer should include a diagram of each type of field and reference to electric field strength.

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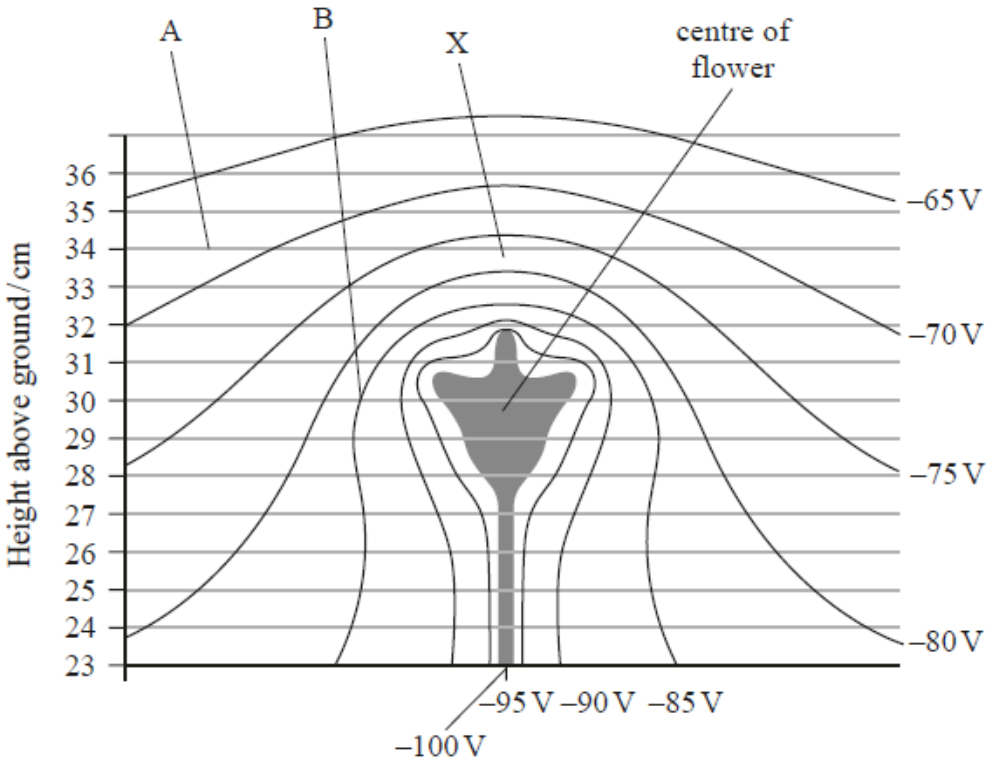
Q15.

Some flowers are negatively charged and surrounded by an electric field. This helps to attract bees.

The diagram shows lines of equipotential surrounding a flower.



(i) Determine the electric field strength at X.

(3)

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Electric field strength at X = ...

(ii) Draw the electric field line between point A and point B on the diagram.

(2)

(iii) An equation for electric potential *V* is

$$V = \frac{Q}{4\pi\varepsilon_0 r}$$

This applies to a radial field.

Deduce whether the electric field in the region directly above the flower is radial.
You should take values from the diagram. A graphical method is not required.

(3)

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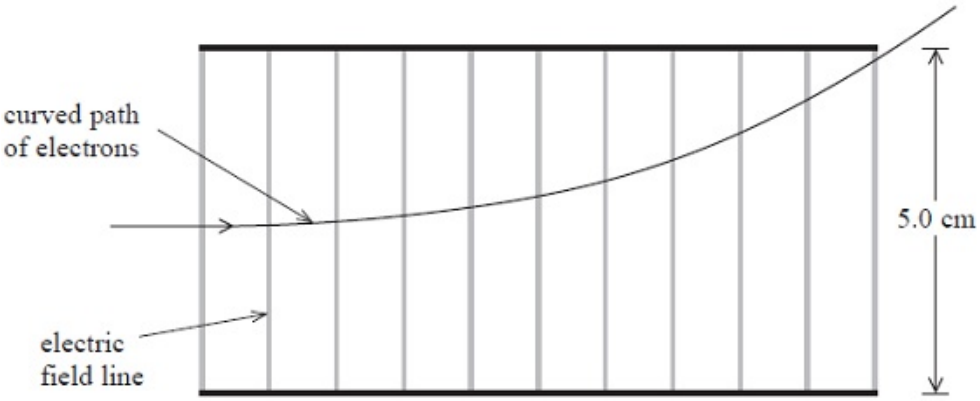
(Total for question = 8 marks)

Q16. A teacher uses an electron beam tube to demonstrate the behaviour of electrons in an electric field. The diagram shows the path of an electron in a uniform electric field between two parallel conducting plates.



(a) Mark on the diagram the direction of the electric field.

(1)

(b) The conducting plates are 5.0 cm apart and have a potential difference of 160 V across them.

Calculate the force on the electron due to the electric field.

(3)

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Force = ...

(c) Explain why the path of the electron is curved between the plates and straight when it has left the plates.

(3)

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(d) The electron was initially released from a metal by thermionic emission and then accelerated through a potential difference before entering the region of the electric field.

(i) State what is meant by thermionic emission.

(1)

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(ii) In order to be able to just leave the plates as shown, the electron must enter the electric field between the plates with a speed of 1.2×10^{7} m s^{-1}.

Calculate the potential difference required to accelerate an electron from rest to this speed.

(3)

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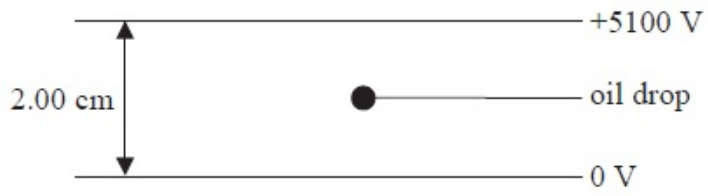
Potential difference = ...

(Total for Question = 11 marks)

Q17. The charge on an electron was originally measured in an experiment called the Millikan Oil Drop experiment.

In a simplified version of this experiment, an oil drop with a small electric charge is placed between two horizontal, parallel plates with a large potential difference (p.d.) across them. The p.d. is adjusted until the oil drop is stationary.

For a particular experiment, a p.d. of 5100 V was required to hold a drop of mass 1.20×10^{-14} kg stationary.



(a) Add to the diagram to show the electric field lines between the plates.

(3)

(b) State whether the charge on the oil drop is positive or negative.

(1)

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(c) Complete the free-body force diagram to show the forces acting on the oil drop. You should ignore upthrust.

(2)

(d) (i) Calculate the magnitude of the charge on the oil drop.

(4)

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Charge = ...

(ii) Calculate the number of electrons that would have to be removed or added to a neutral oil drop for it to acquire this charge.

(2)

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Number of electrons = ...

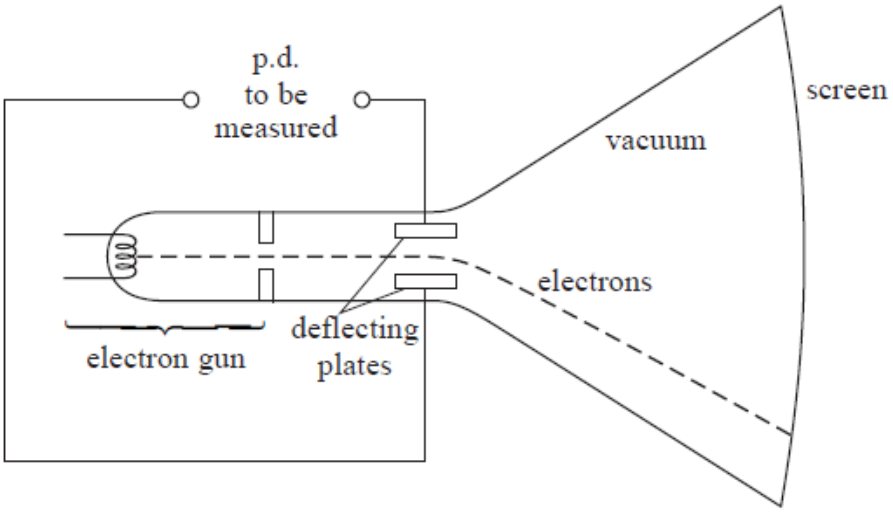
(Total for Question = 12 marks)

Q18.

Cathode ray tubes are used in oscilloscopes.

The diagram shows a simplified cathode ray tube that can be used to determine the magnitude and polarity of a potential difference (p.d.).

The cathode ray tube consists of an electron gun, a pair of deflecting plates and a fluorescent screen.



(a) The electron gun includes a filament. When this filament is heated, electrons are released and are accelerated by a p.d. of 1.5 kV to form an electron beam.

(i) Name the process by which electrons are released from the heated filament.

(1)

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(ii) Show that the maximum velocity of the electrons is about 2×10^7 m s^{-1}.

(2)

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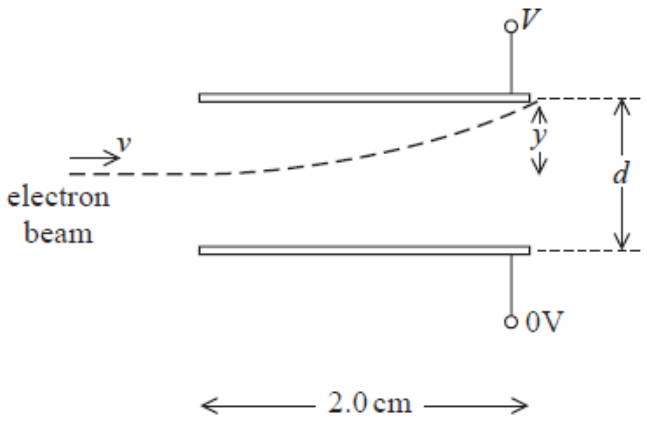
(b) The electron beam then enters a uniform electric field between the two parallel horizontal deflecting plates. The magnitude and direction of the deflection is determined by the p.d. V that is applied across the plates.

The diagram shows one possible path of the electron beam as it passes between the plates.



(i) Show that the acceleration of an electron, of mass m and charge Q, is given by

$$\frac{VQ}{dm}$$

(2)

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(ii) Calculate the magnitude of the vertical deflection y of the beam as it leaves the plates.

V = 50 V
d = 0.01 m

(5)

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y = ...

(c) A laboratory oscilloscope with the time base turned off operates in the same way as this simplified cathode ray tube. A student uses an oscilloscope in this way to monitor an alternating p.d. of 53 V_{rms}

On the grid, draw the trace that would be seen on the screen.

(4)

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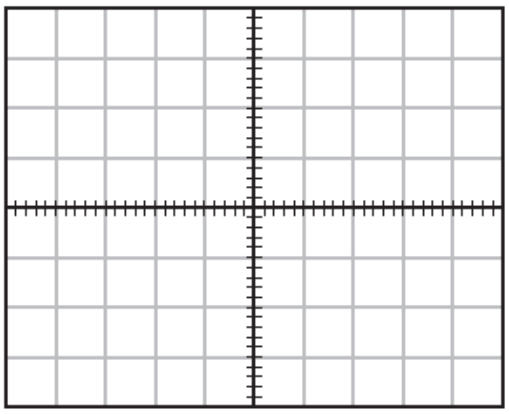

1 square = 25 V

(Total for question = 14 marks)