Mark Scheme

Q1.

Question Number	Answer	Mark
	D	1

Q2.

Question Number	Answer	Mark
	D	1

Q3.

Question Number	Answer	Mark
	C	1

Q4.

Question Number	Acceptable answers	Additional guidance	Mark
	• Equipotential lines would be further apart (1)		(1)

Q5.

Question Number	Answer	Mark
	A	1

Q6.

Question Number	Acceptable answers	Additional guidance	Mark
	• A region where a charged particle experiences a force/acceleration **(1)**		**(1)**

Q7.

Question Number	Answer	Mark
	D	**1**

Q8.

Question Number	Answer	Mark
	C	**1**

Q9.

Question Number	Acceptable answers	Additional guidance	Mark
	The only correct answer is B A *is not correct because this is a uniform field so F constant* C *is not correct because this is a uniform field so F constant* D *is not correct because this is a uniform field so F constant*	*F*	**1**

Q10.

Question Number	Acceptable answers	Additional guidance	Mark
	• Charged particle/hair attracts/repels (1) **Or** charged/hair experiences a force		(1)

Q11.

Question Number	Acceptable Answers	Additional guidance	Mark
	• tangent at correct point (1) • triangle with base at least 0.4 m (1) • 5.3×10^6 (Vm^{-1}) (range 4.9×10^6 to 6.1×10^6) (1) • So would ionise as value greater than 3×10^6 (1) Alternative: • Correct value of V at 30 cm (1) • Use of $E = k\frac{Q}{r^2}$ and $V = k\frac{Q}{r}$ (1) • 5.3×10^6 (Vm^{-1}) (1) • So would ionise as value greater than 3×10^6 (1)	Example of calculation: Gradient = 3200000 / 0.6 $E = 5.3 \times 10^6$ V m^{-1} MP4 to be consistent with calculated value $V = 1.6 \times 10^6$ V m^{-1}	4

Q12.

Question Number	Acceptable answers	Additional guidance	Mark
	• Equates $F=Bev$ and $F=eE$ **(1)** • Substitutes $E = V/d$ **(1)** **Or** $F = eV/d$ seen • Replaces v with I/neA **(1)** • Substitute $A = d \times t$ and leads to given equation **(1)** Alternative: • Equates $F = BIl$ and $F = QE$ with Q identified as total charge **(1)** • Substitutes $E = V/d$ **Or** $F = QV/d$ seen • Substitutes $Q = neAl$ and cancels l • Substitute $A = d \times t$ and leads to given equation	Example of derivation: $Bev = eE$ $Bev = eV/d$ $\frac{BI}{neA} = \frac{V_H}{d}$ $V_H = \frac{BI}{net}$ Alternative: $BIl = QE$ Total charge $Q = neAl$ $BIl = neAlE$ $BI = neAV_H / d$ $V_H = BI / net$	**(4)**

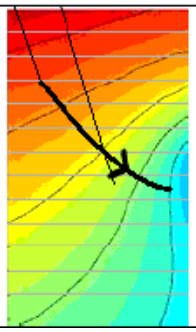
Q13.

Question number	Acceptable answers	Additional guidance	Mark
(b)	• Equate the electric force and the gravitational force **(1)** • Use of E=V/d to obtain $q = mgd/V$ **(1)**	$qE = mg$ $q(V/d) = mg$ $q = mgd/V$	**2**
(c)	An explanation that makes reference to: • Electrostatic/upward force (on drop) would be greater than the weight/downward force **(1)** • So drop would <u>accelerate</u> upwards **(1)**	Indication of which force is greater, unbalanced is insufficient.	**2**

Q14.

Question Number	Answer	Mark
(b)	**Diagram mark for parallel plate**: a minimum of 3 parallel equispaced lines touching plates (ignore edge effect) (1) **Diagram mark for point charge**: minimum of 4 equispaced radial lines touching charged point (1) Direction of fields correct for both diagrams consistent with charges labelled (1) Parallel plate - field strength same at all points (1) Point charge - field strength decreases with (increasing)distance from point (1) **Or** obeys inverse square law	5

Q15.

Question Number	Acceptable answers	Additional guidance	Mark
(i)	• States a value of ΔV (1) • Uses $\Delta V/\Delta d$ with a difference in distance (1) • $E = 560$ V m^{-1} (1) allow range 500-560 V m^{-1}	Example of calculation: $E = \frac{(80-75)V}{0.009m} = 556$ V m^{-1} (Alt: 5.6 V cm^{-1})	(3)
(ii)	• Line perpendicular to a least 2 equipotential lines (1) • Arrow pointing towards flower (1)		(2)
(iii)	• States $V \times r$ = constant (1) • One corresponding pair of values of V and r (1) • At least two pairs of values used to show that the product is not constant therefore not radial (1) (MP3 dependent on MP2)	Example of calculation: Using $V = 95$ and $r =$ 2.0 – 2.2: Vr=190 – 209 $V = 90$ and $r = 2.1 - 2.5$: $Vr = 189 - 225$ $V = 85$ and $r = 2.5 - 2.8$: $Vr = 212 - 238$ $V = 80$ and $r = 3.5 - 3.8$: $Vr = 280 - 304$ $V = 75$ and $r =$ 4.3 – 4.7: $Vr = 323 - 353$ $V = 70$ and $r = 5.8 - 6.2$: $Vr = 406 - 434$ Using $r = 3$ and $V = 82-83$: $Vr = 246-249$ $r = 4$ and $V = 77-78$: $Vr = 308-312$ $r = 5$ and $V = 72-73$: $Vr = 360-365$	(3)

Q16.

Question Number	Answer		Mark
(a)	Arrow(s) downwards	**(1)**	**1**
(b)	Use of $E = V/d$ Use of $F = EQ$ $F = 5.1 \times 10^{-16}$ N Example of calculation $F = (160\ \text{V} \times 1.6 \times 10^{-19}\ \text{C}) / 5.0 \times 10^{-2}\ \text{m}$ $F = 5.12 \times 10^{-16}$ N	**(1)** **(1)** **(1)**	**3**
(c)	Between the plates there is an acceleration/force which is vertical/upwards Constant horizontal velocity Outside the plates no (electric) field /force acts **Or** Outside the plates speed so large that gravitational effect negligible	**(1)** **(1)** **(1)**	**3**
(d)(i)	Release of (surface) electrons due to heating	**(1)**	**1**
(d)(ii)	Use of $E_k = \frac{1}{2}mv^2$ Use of $V = W/Q$ p.d. = 410 V Example of calculation $E_k = 9.11 \times 10^{-31}\ \text{kg} \times (1.2 \times 10^{7}\ \text{m s}^{-1})^2/2$ $E_k = 6.56 \times 10^{-17}$ J p.d. $= (6.56 \times 10^{-17}\ \text{J})/(1.6 \times 10^{-19}\ \text{C})$ p.d. = 410V	**(1)** **(1)** **(1)**	**3**
	Total for question		**11**

Q17.

Question Number	Answer		Mark
(a)	At least three vertical lines spread over symmetrically over more than half of the plate length and touching both plates. (ignore edge ones that might curve) All equispaced and parallel [don't allow gaping to avoid oil drop] Arrow pointing downwards	**(1)** **(1)** **(1)**	**3**
(b)	Negative / - / -ve (negative and/or positive does not get the mark)	**(1)**	**1**
(c)	Upward force labelled: Electric (force) **Or** Electrostatic (force) **Or** force due to electric field **Or** electromagnetic (force) [do not accept repulsive/attractive force. If EQ used, the symbols must be defined] Downward force labelled: mg, weight, W, gravitational force (for both marks the lines must touch the drop and be pointing away from it. Ignore upthrust if drawn but one mark lost for each extra force added)	**(1)** **(1)**	**2**
(d)(i)	E = 5100 V/ 2 cm Conversion of cm to m Use of $QE = mg$ (1.18×10^{-13} kg) $Q = 4.6 \times 10^{-19}$ C (E = 255 000 (V m^{-1}) scores MP1 & 2. unit conversion missed → $Q = 4.62 \times 10^{-17}$ C scores MP1 & 3 if V is halved → $Q = 9.23 \times 10^{-19}$ C scores MP1 ,2 & 3) <u>Example of calculation</u> $E = V/d$ $F = EQ = mg$ $Q = mg / E = mgd/V$ Q = (1.20×10^{-14} kg × 9.81m s^{-2}× 0.02 m) / (5100 V) Q = 4.62×10^{-19} C	**(1)** **(1)** **(1)** **(1)**	**4**
(d)(ii)	Answer to (d)(i) divided by e 3 electrons **Or** sensible integer number less than 500 (answers with very large numbers of electrons can get MP1 only) <u>Example of calculation</u> Number of electrons = 4.62×10^{-19} C / 1.6×10^{-19} C Number = 2.9 i.e. 3 electrons.	**(1)** **(1)**	**2**
	Total for question		**12**

Q18.

Question Number	Answer	Additional guidance	Mark
(a)(i)	thermionic emission		**(1)**

Question Number	Acceptable Answer	Additional guidance	Mark
(a)(ii)	• equate $\frac{1}{2}mv^2$ and VQ (1) • $v = 2.3 \times 10^7$ m s^{-1} (1)	Example of calculation: $E = 1500\text{ V} \times 1.6 \times 10^{-19}\text{ C} = 2.4 \times 10^{-16}\text{ J}$ $v = \sqrt{\frac{2 \times 2.4 \times 10^{-16}\text{ J}}{9.11 \times 10^{-31}\text{ kg}}} = 2.3 \times 10^7$ m s^{-1}	**(2)**

Question Number	Acceptable Answer	Additional guidance	Mark
(b)(i)	• use of $F = EQ$ and $E = \frac{V}{d}$ (1) OR see $F = \frac{VQ}{d}$ • equate $F = ma$ and $F = EQ$ (1)		**(2)**

Question Number	Acceptable Answer	Additional guidance	Mark
(b)(ii)	• use of speed = distance/time (1) • $t = 8.7 \times 10^{-10}$ (s) (1) • use of a = $\frac{VQ}{dm}$ (1) • use of $s = ut + \frac{1}{2}at^2$ (1) with $u = 0$ and vertical acceleration to find s • $s = 3.3 \times 10^{-4}$ m (1)	Example of calculation: $t = \frac{0.02\text{ m}}{2.3 \times 10^7\text{ m s}^{-1}} = 8.7 \times 10^{-10}$ s $s = \frac{1}{2} \times \left(\frac{50\text{ V} \times 1.6 \times 10^{-19}\text{ C}}{0.01\text{ m} \times 9.11 \times 10^{-31}\text{ kg}} \right) \times (8.7 \times 10^{-10}\text{ s})^2$ $s = 3.3 \times 10^{-4}$ m	**(6)**

Question Number	Acceptable Answer	Additional guidance	Mark
(c)	• use of $V = V_0/\sqrt{2}$ (1) • vertical line (1) • positive and negative deflection shown (1) • maximum deflection 75 V (1)	Example of calculation: $V_0 = 53\text{ V} \times \sqrt{2} = 75\text{ V}$	**(4)**