Question Number	Answer	Mark
1(a)	Use of $E = V/d$ **(1)** Answer = 1.5×10^{5} V m^{-1} or N C^{-1} **(1)** Eg $E = 1.5 / 10 \times 10^{-6}$	**2**
1(b)	Opposite forces (act on either end of molecule) **(1)** Molecule rotates / aligns with field **(1)** - at top / + at bottom **(1)**	**3**
	Total for question	**5**

Question Number	Answer	Mark
2(a)	Straight lines (at least 4) touching proton **(1)** Equi spread (by eye) **(1)** Arrow on at least one pointing away from proton **(1)**	**3**
2(b)	Use of $F = k\,QQ/r^2$ [requires 2 subs to qualify as use] **(1)** Know $Q_p = 1.6 \times 10^{-19}$ (C) eg $QQ=(1.6 \times 10^{-19})^2$ **(1)** Answer = 7.9×10^{-8} N **(1)** Eg $F = 8.99 \times 10^{9} (1.6 \times 10^{-19})^2 / (5.4 \times 10^{-11})^2$	**3**
	Total for question	**6**

Question Number	Answer		Mark
3a	Space/area/region where a force acts on a charged particle	**(1)**	
	The force is the same at all points **Or** Field strength is constant **Or** Field lines equispaced (accept diagram with a minimum of three equispaced parallel lines, with arrows for 2nd mark)	**(1)**	**2**
3b	Two <u>parallel</u> plates (accept wires for plates)	**(1)**	
	Connected to a potential difference **Or** potential difference is applied	**(1)**	
	Practical method to show force Eg seeds in tray of glycerol, Charged foil on end of rule, Charged pith ball on thread, Beam of electrons (in teltron tube) Charged oil drops (do not credit charged object) (All 3 marks can be scored from a diagram. To score the third mark the set-up must be labelled.)	**(1)**	**3**
	Total for question		**5**

Question Number	Answer		Mark
4(a)	Weight/W/mg vertically down Tension/T parallel to thread and pointing away Electrical (force) horizontal to left Accept electrostatic (force), repulsive (force), coulomb (force) repelling (force). Do **not** accept just F or drag All three correct 2 marks Any two correct 1 mark The lines must start on the ball and have arrow heads to indicate direction. Minus 1 mark for each extra force line. (Candidates who draw forces on M correctly but also include forces on N score 1)		**2**
4(b)(i)	Use of $T \cos 35° = mg$ **Or** $T \sin 55° = mg$ g to kg and × 9.81 Tension = 3.2×10^{-2} (N) Example of calculation $T \cos 35° = mg$ $T = (2.7 \times 10^{-3}\ \text{kg} \times 9.81\ \text{N kg}^{-1}) / \cos 35°$ $T = 0.0323$ N	**(1)** **(1)** **(1)**	**3**
4(b)(ii)	Equates electric force to $T \sin 35°$ **Or** $T \cos 55°$ **Or** $W \tan 35°$ **Or** use of pythagoras $F_E = 0.018$ **Or** 0.019 (N) ($F_E = 0.017$ N if show that value used. ecf *T* from (i) Example of calculation $F_E = 0.032 \times \sin 35°$ $F_E = 0.018$ N	**(1)** **(1)**	**2**
4(b)(iii)	Use of $F = Q^2/4\pi\varepsilon_o r^2$ **Or** $F = kQ^2/r^2$ (ecf value of *F* from (ii) conversion cm to m $Q = (2.9 - 3.1) \times 10^{-7}$ C (candidates who half the value of *r* can score the first 2 marks) Example of calculation $Q^2 = Fr^2/k$ $Q^2 = (0.020\ \text{N}) \times (20.6 \times 10^{-2}\ \text{m})^2/(8.99 \times 10^9\ \text{N m}^2\ \text{C}^{-2})$ $Q = 3.07 \times 10^{-7}$ C	**(1)** **(1)** **(1)**	**3**
4(c)	Both balls would move through the same angle/distance **Or** the balls are suspended at equal angles (to the vertical) (Because) the force on both balls is the same	**(1)** **(1)**	**2**
	Total for question		**12**

Question Number	Answer		Mark
5(a)	Thermionic emission	**(1)**	**1**
5(b)	Substitution of 1.6×10^{-19} C and 4800 V in $W = QV$ Use of $E_k = ½mv^2$ $v = 4.1 \times 10^7$ (m s^{-1}) Example of calculation $v^2 = 2\ E_k/m = 2eV/m$ $v^2 = 2 \times 1.6 \times 10^{-19}$ C $\times$ 4800 V/9.11×10^{-31} kg = 1.69×10^{15} m^2 s^{-2} $v = 4.1 \times 10^7$ m s^{-1}	**(1)** **(1)** **(1)**	**3**
5(c)(i)	Use of $E = V/d$ Use of $E = F/Q$ $F = 2.6 \times 10^{-15}$ N Example of calculation $F = VQ/d$ F = (800 V $\times$ 1.6×10^{-19} C) / 0.05 m $F = 2.6 \times 10^{-15}$ N	**(1)** **(1)** **(1)**	**3**
5(c)(ii)	See a = their $F/9.11 \times 10^{-31}$ kg See t = 0.15 (m) /4.1×10^7 (m s^{-1}) (or show that value or candidate's value) Substitution of calculated values of a and t into formula given $h = 1.9 \times 10^{-2}$ m (ecf from (b) & (c)(i)) (Only award MP3 if methods for MP1 & 2 are correct) Example of calculation $a = 2.6 \times 10^{-15}$ N / 9.11×10^{-31} kg = 2.85×10^{15} m s^{-2} t = 0.15 m / 4.1×10^7 m s^{-1} = 3.66×10^{-9} s $h = at^2/2$ $h = 2.85 \times 10^{15}$ m s^{-2} $\times$ $(3.66 \times 10^{-9}$ s$)^2/2$ $h = 1.88 \times 10^{-2}$ m	**(1)** **(1)** **(1)** **(1)**	**4**
5(d)	(i)Path A: less curved than original (accept labelling (d)(i)) (ii) Path B: more curved than original (accept labelling (d)(ii)) For both lines the curvature must change by the gap between 15 and cm on the label below diagram. Curvature must be consistently less or more whilst between the plates. Minimum of one line to be labelled. If neither line is labelled then 0 marks for both parts.	**(1)** **(1)**	**2**
	Total for Question		**13**