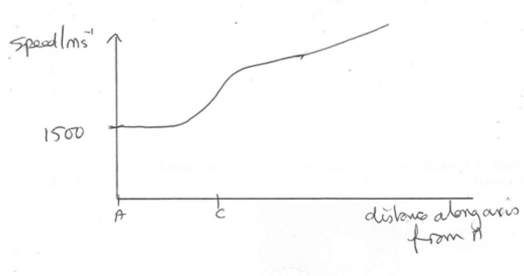
Electric Fields MS2

Question Number	Answer		Mark
1	Use of $W = mg$	**(1)**	
	Use of $F = \frac{kQ_1Q_2}{r^2}$ **Or** Use of $F = \frac{Q_1Q_2}{4\pi\varepsilon_0 r^2}$	**(1)**	
	F = 8990 N and W = 9810 N **Or** r = 957 m for Q = 1 C and m = 1 tonne **Or** Q = 1.05 C for r = 1 km and m = 1 tonne **Or** m = 916 kg for Q = 1 C and r = 1 km	**(1)**	
	Correct comparison and conclusion using their calculated values E.g. The statement isn't true because the force is less than the weight at that distance.	**(1)**	**4**
	<u>Example of calculation</u> W = 1000 kg × 9.81 N kg^{-1} 9810 N = 8.99 × 10^{9} N m^{2} C^{-2} × 1 C × 1 C ÷ r^2 r = 957 m		
	Total for question 1		**4**

Question Number	Answer		Mark
2(a)	Electrons emitted from hot metal (surface) **Or** states thermionic emission Idea that electrons accelerated by electric field produced by charge on the anode (e.g. Electrons accelerated by anode; electrons attracted to positive charge; electrons attracted to anode)	**(1)** **(1)**	**2**
2(b)	Use of $W = QV$ Use of $E_k = ½ mv^2$ $v = 2.72 \times 10^7$ m s^{-1} <u>Example of calculation</u> $W = 1.6 \times 10^{-19}$ C × 2100 V = 3.36×10^{-16} J 3.36×10^{-16} J = ½ × 9.11×10^{-31} kg × v^2 $v = 2.72 \times 10^7$ m s^{-1}	**(1)** **(1)** **(1)**	**3**
2 (c)	Straight vertical lines, at least 3, equally spaced, touching both plates Downward direction	**(1)** **(1)**	**2**
2(d)(i)	Use of $E = V/d$ Use of $F = EQ$ $F = 1.8 \times 10^{-15}$ (N) <u>Example of calculation</u> E = 550 V / 0.05 m = 11 000 V m^{-1} F = 11 000 V m^{-1} × 1.6×10^{-19} C $F = 1.76 \times 10^{-15}$ N	**(1)** **(1)** **(1)**	**3**
2(d)(ii)	Use of $F = ma$ (ecf from (d)(i)) Use of $v = s/t$ Use of $s = ut + ½ at^2$ with $u = 0$ s = 0.020 m <u>Example of calculation</u> $a = F/m = 1.76 \times 10^{-15}$ N / 9.11×10^{-31} kg = 1.93×10^{15} m s^{-2} t = 0.1 m / 2.2×10^7 m s^{-1} = 4.55×10^{-9} s $s = ½ \times 1.93 \times 10^{15}$ m s^{-2} × $(4.55 \times 10^{-9}$ s$)^2$ s = 0.020 m	**(1)** **(1)** **(1)** **(1)**	**4**
	Total for question 2		**14**

Question Number	Answer		Mark
*3	(QWC- Work must be clear and organised in a logical manner using technical wording where appropriate **Max 4** <u>Uniform</u> electric field (between plates) **(1)** Force due to E **or** idea of attraction/repulsion **(1)** (Ball has an) <u>acceleration</u> (**not** an increasing velocity) **(1)** Which is constant/uniform (can be with reference to increasing velocity) **(1)** Vertical line/ + and – values shows change in direction **(1)** Inelastic collision/less energy after impact **(1)**		4
	Total for question 3		**4**

Question Number	Answer		Mark
4(a)	Use of $E = kQ/r^2$ with $Q = 4.0 \times 10^{-13}$ (C) Their E value × cos 49 2 components added $E = 0.043$ N C^{-1} (Candidates who calculate Force can score MP2 and MP3 only) <u>Example of calculation</u> Resultant field = 2 × (kQ/r^2) cos 49 $E = (2 \times 8.99 \times 10^9 \text{ N m}^2 \text{ C}^{-2} \times 4.0 \times 10^{-13} \text{ C} \times 0.656)/0.33^2$ $E = 0.043$ N C^{-1}	**(1)** **(1)** **(1)** **(1)**	**4**
4(b)	At A fields are equal and opposite (in direction) Explains decrease in terms of E α 1/r^2.	**(1)** **(1)**	**2**
4(c)(i)	Use of $F = EQ$ with $Q = 3.2 \times 10^{-19}$ (C) Use of $F = ma$ $a = 2.1 \times 10^6$ m s^{-2} <u>Example of calculation</u> $EQ = ma$ $a = EQ/m$ $a = (0.0\ 44 \text{ N C}^{-1} \times 3.2 \times 10^{-19} \text{ C}) / 6.6 \times 10^{-27}$ kg $a = 2.1 \times 10^6$ m s^{-2}	**(1)** **(1)** **(1)**	**3**
4(c)(ii)	Graph with initial velocity marked as 1500 (m s^{-1}) Continuously increasing speed Maximum positive gradient at C and graph extends beyond C <u>Example of graph</u>  	**(1)** **(1)** **(1)**	**3**
	Total for question 4		**12**

Question Number	Answer	Mark
5(a)	**Using Equation** F − kg m s^{-2} **(1)** Q − A s **(1)** ε_0 − A^2 kg^{-1} m^{-3} s^4 **(1)** **Or using the unit of F m^{-1}** C − A s J – kg m^2 s^{-2} **(1)** ε_0 − A^2 kg^{-1} m^{-3} s **(1)** **(1**	**3**
5(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)** **(1)** Parallel plate **-** field strength same at all points Point charge **-** field strength decreases with (increasing)distance from point **Or** obeys inverse square law **(1)**	**5**

5(c)	Use of $F_E = kQ_1Q_2/r^2$ **(1)** Use of $W = mg$ **(1)** Resolve vertically $T\cos\theta = mg$ **and** Resolve horizontally $T\sin\theta = F_E$ **(1)** Attempt to combine components to give tan θ ($\tan\theta = F_E/mg$) **(1)** θ = 41° to 42° **(1)** T = 0.035 N **(1)** **Or** Use of $F_E = kQ_1Q_2/r^2$ **(1)** Use of $W = mg$ **(1)** Use of Pythagoras to find tension force **(1)** Tan $\theta = F_E/mg$ **Or** $\cos\theta = mg/T$ **Or** $\sin\theta = F_E/T$ **(1)** θ = 41° to 42° **(1)** T = 0.035 N **(1)** (if they halve the separation or halve the electric force they can still get MP1 and so could score MP1,2, 3 & 4) <u>Example of calculation</u> Weight of sphere = 0.0027 kg × 9.81 N kg^{-1} = 0.026 N Electric force $F_E = kQ_1Q_2/r^2$ = 8.99 × 10^9 N m^2 C^{-2} × (4.0 × 10^{-7} C)^2 / 0.25^2 m^2 = 0.023 N Vertically $T\cos\theta = mg$ Horizontally $T\sin\theta = F_E$ Tan $\theta = F_E$/mg = 0.023 N/ 0.026 N θ = 41° sub into vertical equation $T = mg/\cos\theta$ = 0.026 N /cos 41 T = 0.034 N	**6**
	Total for question 5	**14**