Electric Fields - Mark Scheme

Q1.

	Answer	Mark
	C	**1**

Q2.

Question Number	Answer	Mark
	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 **(1)** E.g. The statement isn't true because the force is less than the weight at that distance. <u>Example of calculation</u> $W = 1000 \text{ kg} \times 9.81 \text{ N kg}^{-1}$ $9810 \text{ N} = 8.99 \times 10^9 \text{ N m}^2 \text{ C}^{-2} \times 1 \text{ C} \times 1 \text{ C} \div r^2$ $r = 957$ m	**4**
	Total for question	**4**

Q3.

Question Number	Answer	Mark
	B	**1**

Q4.

Question Number	Answer	Mark
	The only correct answer is C ***A*** *is not correct as this would suggest zero force acting on the sphere with +Q charge but a larger force on the other sphere, therefore not equal and opposite.* ***B*** *is not correct as this suggests a greater force acting on the 10Q sphere, therefore not equal and opposite.* ***D*** *is not correct as this suggests a lesser force acting on the 10Q sphere, therefore not equal and opposite.*	**(1)**

Q5.

Question Number	Answer	Mark
	Use of $E = kQ / r^2$ **(1)** E =25 000 N C^{-1} (accept V m^{-1}) **(1)** (Radially) outward from centre of sphere **(1)** (accept outward, away from sphere, away from centre, do not accept away from charge) <u>Example of calculation</u> $E = 8.99 \times 10^9$ N m^2 $C^{-2} \times 34 \times 10^{-9}$ C $\div$ (0.11 m)^2 = 25 300 N C^{-1}	**3**
	Total for question	**3**

Q6.

Question Number	Answer	Mark
	The only correct answer is **C** A is not the correct answer because it does not account for the increase in distance B is not the correct answer because the distance has not been squared in the new determination D is not the correct answer because the charge has not been squared in the new determination	**1**

Q7.

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

Q8.

Question Number	Answer		Mark
(a)	Use of $F = \frac{kQ_1Q_2}{r^2}$	(1)	
	$F = 3.6 \times 10^{-4}$ N	(1)	2
	Example of calculation $F = 8.99 \times 10^9$ N m^2 C^{-2} $\times 3.1 \times 10^{-9}$ C $\times 2.4 \times 10^{-8}$ C $\div$ (0.043 m)^2 $F = 3.6 \times 10^{-4}$ N		
(b)(i)	Electric field strength is the force per unit (positive) charge	(1)	1
(b)(ii)	At X, a positive charge experiences a force due to A away from A **Or** At X, the electric field due to A is in the direction AX	(1)	
	At X, a positive charge experiences a force due to B towards B **Or** At X, the electric field due to B is in the direction XB	(1)	
	Statement that the components in the direction perpendicular to AB are all balanced by components in the opposite direction	(1)	
	(Resultant) force is in the direction AB **Or** the (resultant) field is in the direction AB	(1)	4
	Total for question		7