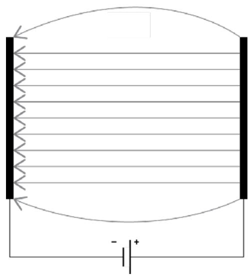
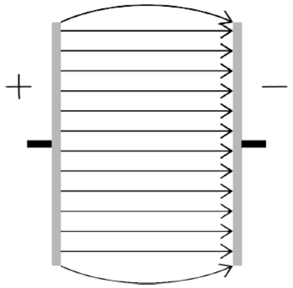
Level 2 Physics: Electricity – Static Electricity - Answers

Question	Evidence	Achievement	Merit	Excellence
2020 (1) (a)	$d = \frac{V}{E} = \frac{1.75\times10^8}{8.57\times10^4} = 2042\text{ m}$	Correct answer.		
(b)	$F = Eq = 8.57\times10^4\times3.7\times10^{-6} = 0.317 = 0.32\text{ N}$ Upwards	Direction or force.	Correct answer and direction.	
(c)	The field between the plates is uniform. This means that it has constant strength and direction. *F* = *Eq*, the charge and the field are constant, so the force is constant.	Uniform field or constantforce.	Constant force and constant/uniform field.	
(d)	Energy gained $= \frac{1}{2}\times9.1\times10^{-31}\times(4.2\times10^5)^2 - \frac{1}{2}\times9.1\times10^{-31}\times(1.2\times10^5)^2$ $= 7.37\times10^{-20} = Eqd = 8.57\times10^4\times1.6\times10^{-19}\times d$ $d = 5.37\times10^{-6}\text{ m}$	Found one E_k. OR Realised ½mv^2 = Eqd Calculates d but writes down the E_k.without the *v* squared.	Finds d by using eitherof the given speed	Correct answer. 5.37×10^{-6} OR 5.37×10^{-6} (missing the squaring on the energies).

2019 (2) (a)	$E=\frac{V}{d}=\frac{550\times10^3}{1.2}=4.6\times10^5\ \text{V m}^{-1}$	Correct answer.		
(b)	$E = ½mv^2 = Eqd$ Double *v* means 4 × the kinetic energy, which means 4 × the stoppingdistance as *E*, *q* and *m* constant.	Distance increases. Includes distance doubles.	4 times the stopping distance.	
(c)		At least one arrow showing correct field direction.	Correct answer.	
(d)	$\frac{1}{2}mv^2=Eqd$ $\Rightarrow\frac{1}{2}\times0.13v^2=4.6\times10^5\times3.5\times10^{-6}\times1.2$ $v=5.45\ \text{m s}^{-1}$	Made one valid step to the solution.	One error.	Correct answer- allowing for incorrect part (a)
2018 (1) (a)	$E=\frac{V}{d}\rightarrow V=Ed=2.50\times10^6\times0.08=200\,000\ \text{V}$	Correct answer.		

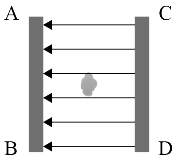
(b)	Electric field shown, including curved arrows: *Field lines must be perpendicular to the plates, parallel to each other and equally spaced.* 	Electric field without curved lines.	Electric field with curved lines. AND Positive plate correctly identified.	
(c)	$E_p = Eqd = 2.5\times10^{6}\times6.52\times10^{-13}\times0.04$ $E_p = E_k = \frac{1}{2}mv^2$ $6.52\times10^{-8} = \frac{1}{2}mv^2 \rightarrow$ $v = \sqrt{\frac{6.52\times10^{-8}}{\frac{1}{2}\times4.5\times10^{-6}}} =$ $v = 0.170 \text{ m s}^{-1}$	Correct substitution but wrong answer. OR $E_p = 6.52 \times 10^{-8}$	Correct answer	

(d)	Increase its charge ($F = Eq$). (ii) Increasing the charge, causes the force acting on the charge to increase from $F = Eq$, links to more acceleration and negligible mass [causing it to accelerate more quickly (assuming the increase in charge adds negligible mass), causing it to have a faster velocity]. Increase E by decreasing the distance between plates. Increase E by increasing voltage across plates. (ii) Increasing the electric field strength by…, causes the charged smoke to experience a greater force from $F = Eq$. Links to greater acceleration and higher top speed for E. Decrease its mass of smoke particle. (ii) Causes a force of the same magnitude to accelerate the particle by a greater proportion from $F = ma$, links to higher velocity for E. Rotate the magnet so it is 90° to the motion of the smoke particles. Magnetic fields need to be 90° to the direction of the motion of a charged particle to have the most force acting. Currently the magnetic force will have little to no effect. Needs to describe direction and link force to acceleration for E.	**Any one change** • increase *V*oltage • increase charge • decrease mass of smoke particle • increase the distance AB, (move candle right) • increase the electric field (E).	Any one change explained incompletely. E.g. increasing the voltage increases the E and the force so it goes faster.	Any change and **linked** explanation. E.g. increasing charge, increases the force, causing it to have a higher acceleration, so a higher v. E.g. Increasing voltage, causes a larger E-field, which from $F = Eq$ causes a larger force, so a higher acceleration, so a higher velocity. E.g. Increasing voltage, E increases, and so E_k increases, and then v increases.

2017 (1) (a)	$E = \frac{V}{d} = \frac{6000}{0.03} = 200\,000\ \text{V m}^{-1}$	SHOW question, evidence must be provided.		
(b)	$q = 3.70 \times 10^{-12} \times -1.60 \times 10^{-19} = -5.92 \times 10^{-7}\ \text{C}$ $F = Eq = 200\,000 \times -5.92 \times 10^{-7}$ *F* = –0.1184 = 0.118 N to the right (B)	Correct charge. OR Correct direction. OR Correct force.	Correct force AND direction.	
(c)	Force is constant, as electric field strength is constant $(E = \frac{V}{d})$. Force acts uniformly across diaphragm as the charge is uniformly distributed; each part of the diaphragm will experience the same force (*F* = *Eq*), so no bending will occur. <u>More detail not expected:</u> The electric field (*E*) between the plates is uniform, as the distance (*d*) between each plate and voltage across the plates is constant $(E = \frac{V}{d})$.	Electric field strength is constant. OR Uniform distribution of charge linked to bending.	Electric field strength is constant. AND EITHER Uniform distribution of charge linked to bending. OR Explanation why the field is constant.	

(d)	$E_p = Eqd = 200\ 000 \times 4.2 \times 10^{-5} \times 0.005$ $E_p = 0.042$ J of potential energy. Assume energy conservation, $E_p = E_k$ $E_k = \frac{1}{2}mv^2 \rightarrow v = \sqrt{\frac{2E}{m}}$ $v = \sqrt{\frac{2 \times 0.042}{5.8 \times 10^{-5}}} = 38.1\ \text{m s}^{-1}$	States Ep=Ek. OR States energy conservation / no losses due to friction.	Assume energy conservation. AND Attempt at finding *v* using $E_k = \frac{1}{2}mv^2$ Or Correct *v* = 38.1	*v* = 38.1 and assumption stated in words.
2016 (2) (a)	$E = \frac{V}{d}$ $= \frac{20000}{0.05}$ $= 400\ 000\ \text{V m}^{-1} = 4 \times 10^5\ \text{V m}^{-1}$ Direction positive (anode) to negative (cathode) plate.	Correct working and correct direction.		
(b)	• The electron loses electrostatic potential energy (EPE) and gains kinetic energy (KE). • The electric field is working on the electron, so it loses EPE and lost EPE changes into KE.	Names one energy.	Names both energies and implies "change".	

(c)	work done = Eqd work done = $4 \times 10^5 \times 1.6 \times 10^{-19} \times 0.05 = 3.2 \times 10^{-15}$ work done = $\frac{1}{2} mv^2$ $3.2 \times 10^{-15} = \frac{1}{2} \times 9.1 \times 10^{-31} \times v^2$ $v = 8.39 \times 10^7$ m s^{-1}	Work done is calculated correctly. OR Showing the understanding that kinetic energy equals work done. OR Incorrect work done and consequently incorrect speed.	Correct answer.	
(d)	• The forces acting on the oil drop are downward weight force and upward electrical force. • These two forces must be balanced, as the oil drop is stationary. • For the electrical force to be upwards, the type of charge on the oil drop must be opposite to the charge on the top plate.	Identifies the two forces. OR Saying that the forces must be balanced. OR Top plate should be positive and the charge on the oil must be negative, or vice versa.	Identifies the forces and that the forces must be balanced, as the charged drop is stationary.	Explain that the electrical force must be upwards to balance the downward weight force, as the oil drop is stationary. AND For the electric force to be upwards, the charge on the oil drop must be negative.
2015(1) (a)	$E = \frac{V}{d} = \frac{6.0}{1.0} = 6.0 \text{ V m}^{-1}$	Correct answer.		
(b)	The force on an electron is $F = Eq$ The charge is constant, so if the electric field strength is constant, then the force will be constant.	Constant force.	Constant force AND reason.	
(c)	$\Delta E = Eqd$ $d = \frac{\Delta E}{Eq} = \frac{9.6 \times 10^{-20}}{6.0 \times (1.6 \times 10^{-19})}$ $d = 0.10 \text{ m}$	Correct equation and re-arrangement.	Correct answer.	

(d)	$F = Eq \qquad E = \dfrac{V}{d}$ $F = \dfrac{Vq}{d}$ If he adds another battery in series, this will double the voltage. If he halves the wire length, this will double the electric field strength. Both together will cause the force to be 4 times larger.	Recognises the voltage will double by adding another battery in series. OR Recognises the electric field strength will double by halving the length of wire.	Recognises the voltage will double by adding another battery in series. AND Recognises the electric field strength will double by halving the length of wire.	Complete answer linking ideas to show that force increases four times.
2015(3) (a)	 Field is uniform. Field is directed right to left.	Correct direction, and uniform spacing.		
(b)	$F = Eq$ $E = \dfrac{F}{q} = \dfrac{5.88 \times 10^{-16}}{2 \times (1.6 \times 10^{-19})}$ $E = 1837.5$ $E = 1800 \text{ N C}^{-1}$	Correct except for charge.	Correct answer.	
(c)	The force is zero. A charged particle experiences a force due to a magnetic field only when it is cutting across the field.	The force is zero.	Correct answer and reason.	

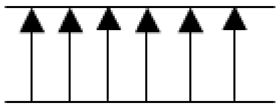
(d)	$\Delta E = Eqd \qquad \Delta E = \frac{1}{2}mv^2$ $\frac{1}{2}mv^2 = Eqd$ $v = \sqrt{\frac{2Eqd}{m}}$ $v = \sqrt{\frac{2 \times 1837.5 \times (2 \times 1.6 \times 10^{-19}) \times 0.0024}{1.7 \times 10^{-7}}}$ $v = 4.07 \times 10^{-6}\ \text{m s}^{-1}$	Attempts to link both equations.	Links equations but mis-calculation.	Correct answer and working.
2014(1) (a)	**Electric** force upwards. Gravitational force downwards.	**Electric** force **upwards**. Gravitational force downwards.		
(b)	$F_{el} = Eq = 610 \times 24 \times 10^{-10}$ $= 1.464 \times 10^{-6}$ N Electric force upwards = mg $m = \frac{1.464 \times 10^{-6}}{9.8} = 1.49 \times 10^{-7}$ kg	Correct answer to electric force. 1.464×10^{-6}	Correct answer for mass. 1.49×10^{-7}	
(c)	The oil drop would accelerate (move) towards the positive plate. The field strength would increase when distance between plates is decreased, so the force on the oil drop would increase.	The oil drop would accelerate (move) towards the positive plate.	The field strength would increase when distance between plates is decreased, so the force on the oil drop would increase.	

(d)	They would both experience the same electric force, since the electric field strength is the same, and both have the same sized charge on them. The electron would experience a greater acceleration, since it is much lighter (has smaller mass) than the proton.	They would both experience the same electric force. OR The electron would experience a greater acceleration.	They would both experience the same electric force, since the electric field strength is the same, and both have the same sized charge on them. OR The electron would experience a greater acceleration, since it is much lighter (has smaller mass) than the proton.	They would both experience the same electric force, since the electric field strength is the same, and both have the same sized charge on them. AND The electron would experience a greater acceleration, since it is much lighter (has smaller mass) than the proton.
2013(1) (a)	$I = \frac{q}{t} = \frac{1\times10^{15}\times1.6\times10^{-19}}{1} = 1.6\times10^{-4}$ A	Correct		
(b)	The electron is moving in the same direction as the magnetic field. So the magnetic force acting on the electron is zero.	One correct statement.	Correct explanation.	
(c)	Kinetic energy gained $\Delta E = \frac{1}{2}mv^2$ $\Delta E = \frac{1}{2}\times9.1\times10^{-31}\times(3.0\times10^7)^2$ $\Delta E = 4.095\times10^{-16}$ $V = \frac{\Delta E}{q} = \frac{4.095\times10^{-16}}{1.6\times10^{-19}}$ $V = 2.6\times10^3$ V	One correct equation and substitution.	Correct working except for one error.	Correct working AND answer.

(d)	$F = Eq$ **and** $E = \frac{V}{d}$ So if the distance between the plates is halved, the electric field strength doubles. This will cause the force on the electron to double. $\Delta E = Eqd$ So if the electric field strength doubles and the distance is halved, the gain in KE is the same.	One correct statement.	Two correct statements.	Correct answer AND explanation.

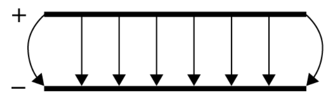
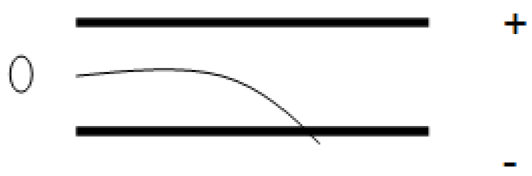
Question	Achievement	Merit	Excellence
2012(3) (a)	The upper plate has to be positive to prevent the negatively charged oil drop from falling down. OR Electric field is directed downwards, so the electrons will be attracted upwards.	The upper plate has to be positive to prevent the negatively charged oil drop from falling down OR electric field is directed downwards, so the electrons will be attracted upwards. AND The force of gravity acts downwards, so the oil drop is held stationary by an equal force acting upwards.	
(b)	The gravity force (weight force) should be equal in size and opposite in direction to the electric force.		
(c)	$F_g = mg = 2.54 \times 10^{-5} \times 9.8 = 2.4892 \times 10^{-4}$ N	$F_{el} = F_g = 2.4892 \times 10^{-4}$ N $E = F / q = 2.4892 \times 10^{-4} / (3.6 \times 10^{-9})$ $= 69\,144$ N C^{-1}	$F_g = mg = 2.54 \times 10^{-5} \times 9.8$ $= 2.4892 \times 10^{-4}$ N $F_{el} = F_g = 2.4892 \times 10^{-4}$ N $E = F / q = 2.4892 \times 10^{-4} / (3.6 \times 10^{-9})$ $= 69\,144$ N C^{-1} $E = V / d \rightarrow V = Ed \rightarrow$ $V = 69144 \times 4.8 \times 10^{-4} = 33.18$ $V = 33$ V
(d)	33	2sf Since the final answer cannot be any more accurate than the least number of sf in the question. OR The least number of sf in the question is 2.	

Question	Evidence	Achievement	Merit	Excellence
2011(1) (a)	The left-hand plate, A. Field lines go from positive to negative. OR Field lines show the direction a positive test charge would move.	[1]ONE part correct.	[1]BOTH parts correct.	
(b)	The field lines are equally spaced.	[1]Correct answer.		
(c)	$E = V/d$ $V = Ed$ $V = 3.33\text{x}10^6 \text{ x}0.12$ $V = 399\ 600 = 4.0 \text{ x}10^5 \text{ V} = 400 \text{ kV}$	[2]Correct working except for ONE error.	[2]Correct answer.	
(d)	$V = \frac{\Delta E}{q}$ $\Delta E = Vq$ $\Delta E = 4\times10^5 \times 1.5\times10^{-10}$ $\Delta E = 6\times10^{-5}$ J $E_K = \frac{1}{2}mv^2 = 6\times10^{-5}$ J $v = \sqrt{\frac{2\times6\times10^{-5}}{2.5\times10^{-2}}} = \sqrt{4.8\times10^{-3}} = 0.069 \text{ m s}^{-1}$	[2]Correct calculation of energy change. OR $F = 4.995 \text{ x}10^{-4}$	[2]Correct working with ONE error. $a = 0.01998$	[2]Correct working and answer.

(e)	When the ball touches the negative plate, it will gain electrons until it has an overall negative charge. It then experiences a force in the opposite direction to the field (OR is attracted to the positive plate OR is repelled from the negative plate). When the ball touches the positive plate, it loses electrons until it has an overall positive charge. It then experiences a force in the same direction as the field (OR is attracted to the negative plate OR is repelled from the positive plate).	[1]ONE correct idea. E.g. moves towards positive plate	[1]TWO correct ideas. Moves towards + and attraction / force / repulsion	[1]Full explanation linking the charging process and the force due to the field. M+ **Electron** movement and repetition
2010(1) (a)		[1]Upward arrow (s).		
(b)	$E = \frac{V}{d}$ $E = \frac{20.0}{3.0 \times 10^{-3}} = 6.667 \times 10^{3}\ \text{V m}^{-1}$ Alternate unit is NC^{-1}	[2]Correct working and answer without the unit.	[2]Correct answer including correct alternate unit $N\ C^{-1}$.	

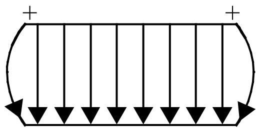
(c)(i) (ii)	At the negative plate, the electron has electric potential energy. As it goes towards the positive plate electric potential energy is changed to kinetic energy. The electron accelerates towards the positive plate.	[1]Idea of EITHER the electron possessing electric potential energy at the negative plate. OR Electron gaining kinetic energy as it approaches the positive plate. OR Electron accelerating towards positive plate.	[1]Potential to kinetic + accelerating down/towards positive plate.	
(d)	$E_p = Eqd$ $E_p = 6.667 \times 10^3 \times 1.6 \times 10^{-19} \times 3.0 \times 10^{-3}$ $E_p = 3.20 \times 10^{-18}$ $3.20 \times 10^{-18} = \frac{1}{2} \times 9.0 \times 10^{-31} \times v^2$ $v = 2.67 \times 10^6 \text{ m s}^{-1}$ As it reaches the positive plate, $E_p = E_k$	[2]Recognition that $E_p = E_k$ OR [2]Finds $F = 1.07 \times 10^{-15}$	[2]Correct except for one error. E.g. finds $a = 1.19 \times 10^{15}$ OR uses $d = 3$	[2]Correct answer for speed of electron.

2009(1) (a)	Arrow towards top of page.	[1]Correct answer.		
(b)	$I = \frac{Q}{t}$ $Q = I \times t = (3.5 \times 10^{-6}) \times 60$ $Q = 2.1 \times 10^{-4}$ C $N = \frac{2.1 \times 10^{-4}}{1.6 \times 10^{-19}} = 1.3 \times 10^{15}$ ions	[2]Correct charge.	[2]Correct answer.	
(c)	The force remains constant because the electric field strength is constant ($F = Eq$).		[1]Correct answer	
(d)	If the voltage increases, the force on the ion increases. Greater force means greater acceleration, which means greater maximum velocity. OR If the voltage increases, the ion gains more kinetic energy, and therefore has a greater velocity.	[1]Greater velocity. Except if based on V=Bvl,	[1]Achievement plus partial explanation.	[1]Correct answer and full and **concise** explanation.
(e)	$F = Eq$ $E = \frac{F}{q} = \frac{3.2 \times 10^{-15}}{1.6 \times 10^{-19}} = 2.0 \times 10^{4}$ N C^{-1}(or V m^{-1})	[2]Correct answer.		

(f)	$KE = \frac{1}{2}mv^2$ $\Delta E = Eqd = 2.0\times10^4 \times 1.6\times10^{-19} \times 0.04$ $\Delta E = 1.28\times10^{-16}$ J $\frac{1}{2}mv^2 = 1.28\times10^{-16}$ $\frac{1}{2}\times 5.31\times10^{-26} \times v^2 = 1.28\times10^{-16}$ $v^2 = \frac{2\times1.28\times10^{-16}}{5.31\times10^{-26}} \Rightarrow v = 69\ 434\ \text{m s}^{-1}$ $v = 6.9\times10^4\ \text{m s}^{-1}$	[2]Correct KE.	[2]Correct working except for one error.	[2]Correct working and answer.
2008(1) (a)		[1]Downward line.	[1]Evenly spaced parallel lines with curved end(s).	
(b)		[1]Curves towards negative plate.		
(c)	The electric force is at right angles to the direction in which the positive particle is moving. This causes the particle to describe a parabolic path.	[1]Force is down. OR [1]Repelled from +. OR [1]Attracted to –.	[1]Achievement plus has link to forward motion **or** constant downwards force and parabolic path	
(d)	Magnetic field **into the page**.	[1]Correct answer.		

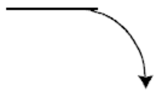
(e)	The electric force depends only on the electric field strength and the size of the charge. Hence is not affected by the velocity of the particle. The magnetic force *F* = *Bqv* increases as the velocity of the particle increases, as the magnetic force is directly proportional to the velocity, provided the magnetic field strength is a constant.	[1]Electric force is not affected by the velocity OR Magnetic force increases as velocity increases.	[1]Electric force is not affected by the velocity, but the magnetic force increases as the velocity increases.	[1]Merit, plus *F* depends only on *E* and q; e.g. $F = E_q$ AND $F = Bqv$ depends on *v*.
(f)	$E = \frac{V}{d} = \frac{220\text{ V}}{0.05\text{ m}} = 4400\text{ V m}^{-1}$ $F = Eq \Rightarrow F = 4400 \times 1.6 \times 10^{-19}$ $F = 7.0 \times 10^{-16}\text{ N}$	[2]**Correct formula** used to find *E*, but did **not** convert cm to m (E= 44) Correct sig figs. Any attempt to find F correct to **2sf**	[2]Correct value for *E* (4400) OR **F using cm** F = 7.0×10^{-18} N	[2]Correct answer. 7.0×10^{-18}
(g)	$I = \frac{q}{t}$ $I = \frac{3.5 \times 10^{15} \times 1.6 \times 10^{-19}}{10}$ $I = 5.6 \times 10^{-5}\text{ A}$	[2]Correct except for charge, e.g. $I = \frac{3.5 \times 10^{15}}{10}$ $= 3.5 \times 10^{14}$	[2]Correct answer. 5.6×10^{-5} A	

2007(1) (a)	Left to right.	[1]Correct answer.		
(b)	Electrical/potential to kinetic.	[1]Correct answer. Electrical to kinetic Potential to kinetic		
(c)	$\Delta E_k = \frac{1}{2}m\Delta v_f^2 - \frac{1}{2}m\Delta v_i^2$ $\Delta E_k = \frac{1}{2}\times 1.67\times10^{-27}\times((8.8\times10^5)^2-(6.2\times10^5)^2)$ $\Delta E_k = 3.25\times10^{-16}$ J $E = \frac{\Delta E_k}{qd} = \frac{3.25\times10^{-16}}{1.6\times10^{-19}\times0.02} = 1.0\times10^5$ V m^{-1} **Or** $v_f^2 = v_1^2 = 2ad$ gives $a = 9.75\times10^{12}$ $F = ma$ and $F = Eq$ give $E = \frac{1.67\times10^{-27}\times9.75\times10^{12}}{1.6\times10^{-19}}$ $= 101\,765 = 100\,000$	[2]Calculates **a** kinetic energy. Attempts to use or states $\Delta E = Eqd$ Finds *a*	[2]Calculates the gain in energy **OR** correctly uses $\Delta E = Eqd$ uses *F* = *ma*	[2]Correct working and answer.
(d)	N C^{-1}	[1]Correct unit.		
(e)	$V = Ed = 100\,000\times0.02 = 2000$ V	[2]Correct answer.		
(f)	Towards the top of the page.	[1]Correct answer. Upward.		

(g)	$F = Bvq$ $F = 3.5 \times 10^{-3} \times 8.8 \times 10^{5} \times 1.6 \times 10^{-19}$ $F = 4.9 \times 10^{-16}$ Unrounded is 4.928×10^{-16}	[2]Correct answer Accept correct substitution into formula.		
	2 sig figs.	[2]Correct sf. For **any** attempt to find ***F***.		
2006(2) (a)	Upper plate is positive.	[1]Top plate positive		
(b)		[1]Correct direction Evenly spaced parallel lines. Curved ends.	[1]Direction and: Evenly spaced parallel lines. Curved ends.	• [1]Direction with evenly spaced parallel lines and Curved ends.
(c)	$E = \frac{V}{d}$ $E = \frac{45}{8.0 \times 10^{-3}}$	[2]$E = \frac{45}{8.0 \times 10^{-3}}$		
(d)	$E = \frac{V\ (\text{V})}{d\ (\text{m})}$ $E = \frac{F\ (\text{N})}{q\ (\text{C})} = \text{N C}^{-1}$ $E = \frac{E_p\ (\text{J})}{q\ (\text{C})\ d\ (\text{m})} = \text{J C}^{-1}\text{m}^{-1}$	[1]One unit correctly derived. • $E = \frac{V\ (\text{V})}{d\ (\text{m})}$ • $E = \text{N C}^{-1}$ • $E = \text{J C}^{-1}\ \text{m}^{-1}$	[1]any 2 correct	

(e)	$F = Eq$ $F = 5625 \times 1.6 \times 10^{-19}$ N $F = 9.0 \times 10^{-16}$ N	[2]9×10^{-16}		
(f)	The electron experiences an electric force and is moving in the same direction as the electric force, hence it is losing electrical potential energy but gaining kinetic energy as it accelerates.	[1]the electron experiences ***work / attraction / repulsion / force / acceleration***. • the electron ***moves*** in the electric field / to the positive plate. • Velocity or Kinetic energy *increases*.	[1]any 2 correct linked ideas	[1]All 3 correct linked ideas.
2005(1) (a)	Right to left (chair to spray gun).	[1]Correct answer.		
(b)	Charge = no. of electrons × charge of each electron = $3.0 \times 10^{6} \times 1.60 \times 10^{-19}$	[2]Correct factors using data are shown (ignore presence or absence of –ve sign on charge).		
(c)	$F = Eq \qquad E = \frac{V}{d}$ $F = \frac{Vq}{d}$ $F = \frac{110 \times 10^3 \times 4.8 \times 10^{-13}}{0.65}$ $F = 8.1 \times 10^{-8}$ N	[2]Evidence of electric field calculation and a substitution $E = \frac{V}{d} = \frac{110 \times 10^3}{0.65}$ (ignore $\times 10^{-3}$)	[2]Equations are combined correctly. Force is calculated using correct E or q $F = Eq$ $F = 1.69 \times 10^5$ $\times -4.8 \times 10^{-13}$ ($q = -1.6 \times 10^{-19}$)	

(d)	The force will increase. If the length of the field decreases, and the voltage remains the same, the field strength will increase. $\left(E = \frac{V}{d} \right)$ A stronger field causes a greater force. ($F = Eq$)	[1]Force increases. Electric Field increases $F = \frac{V}{d}q$ given.	[1]TWO correctly linked ideas Electric field correctly linked to distance Force vs $\frac{1}{d}$ given.	[1]THREE ideas linked correctly. Correct statement linking less distance, more Electric Field and more Force. Force increases as distance decreases if V & q constant.
(e)	$V = \frac{\Delta E_p}{q}$ $\Delta E_p = Eqd$ $\Delta E_p = F.d$ $\Delta E_p = Vq$ $= 110 \times 10^3 \times 4.8 \times 10^{-13}$ $= 5.28 \times 10^{-8}$ J $= 5.3 \times 10^{-8}$ J	[2]Valid equation and a substitution (ignore x 10^3) (force from 1c)	[2]Correct answer.	
(f)	**Rate** of flow of charge / electrons.	[1]Correct answer, or indication of Coulomb per second.		
(g)	$I = \frac{Q}{t}$ $I =$ $\frac{6.5 \times 10^5}{60}$ drops / s $\times 8.0 \times 10^{-13}$ C / drop $= 8.7 \times 10^{-9}$ C/s (A)	2 $\frac{8 \times 10^{-13}}{60}$ 2 $\frac{6.5 \times 10^5 \times 8 \times 10^{13}}{1}$ (Ignore presence or absence of –ve sign on charge).	[2]Correct equation, substitution and answer. (Ignore presence or absence of –ve sign on charge).	

(h)	$F = Bvq$ $= 7.10 \times 10^{-5}\text{T} \times 12.1 \times 4.8 \times 10^{-13}$ $= 4.1 \times 10^{-16}\text{ N}$	[2]Correct formula and substitution (ignore × 10^{-3}, mT) [1] Answer to 2 significant figures.	[2]Correct answer.	
(i)	Clockwise circular path 	[1]Correct direction (downwards).	[1]Correct direction and continuous shape (curved).	

The Mess that is NCEA Assessment Schedules….

Level 2 Physics: **AS 91173** replaced **AS 90257.**

In 90257, from **2004 to 2011**, there was an Evidence column with the correct answer and Achieved, Merit and Excellence columns explaining the required level of performance to get that grade. Each part of the question (row in the Assessment Schedule) contributed a single grade in either Criteria 1 (Explain stuff) or Criteria 2 (Solve stuff). From 2003 to 2008, the NCEA shaded columns that were not relevant to that question (Sorry haven't had time to do 2004 yet).

In 91173, from **2012 onwards**, the answers/required level of performance are now within the Achieved, Merit and Excellence columns. Each part of a question contributes to the overall Grade Score Marking of the question and there are no longer separate criteria. There is no shading anymore. At least their equation editor has stopped displaying random characters over the units.

And **in 2013-2015**, with 91173, we are back to an Evidence column with the correct answer and Achieved, Merit and Excellence columns explaining the required level of performance to get that part. Each part of a question contributes to the overall Grade Score Marking of the question. And now in **2014 - 2017**, we have the Evidence column back……