Question Number	Answer		Mark
1(a)	Arrow(s) downwards	**(1)**	**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**
1(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**
1(d)(i)	Release of (surface) electrons due to heating	**(1)**	**1**
1(d)(ii)	Use of $E_k = ½mv^2$ Use of $V = W/Q$ p.d. = 410 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. = 41	**(1)** **(1)** **(1)**	**3**
	Total for question		**11**

Question Number	Answer		Mark
2(a)(i)	Use of $v = \frac{2\pi r}{T}$ **Or** $v = rw$ $v = 2.1$ m s^{-1} Example of calculation $v = \frac{2\pi \times 0.4 \text{ m}}{1.2 \text{ s}} = 2.09$ m s^{-1}	**(1)** **(1)**	**2**
2(a)(ii)	Radius/circumference decreased Measured speed greater than actual speed (dependent on first mark)	**(1)** **(1)**	**2**
2(a)(iii)	Use of $F = Bqv$ $F = 5.9 \times 10^{-24}$ N Example of calculation $F = 0.05 \text{ T} \times 1.6 \times 10^{-19}\text{C} \times 7.4 \times 10^{-4} \text{ m s}^{-1} = 5.9 \times 10^{-24}$ N	**(1)** **(1)**	**2**
2(b)	Use of $R\cos\theta = mg$ **and** $R\sin\theta = F$ **Or** $\tan\theta = F/mg$ Use of $F = \frac{mv^2}{r}$ (do not award if mg used as the force) $r = 20$ m ($g = 10$ m s^{-2} leads to $r = 20.04$ m scores MP1 & 2 only) Example of calculation $r = \frac{mv^2}{mg\tan\theta} = \frac{v^2}{g\tan\theta}$ $r = \frac{(9 \text{ m s}^{-1})^2}{9.81 \text{ m s}^{-2} \times \tan 22°} = 20.4$ m	**(1)** **(1)** **(1)**	**3**
	Total for question		**9**

Question Number	Answer		Mark
3(a)	To curve the tracks/paths **Or** to produce a centripetal force/acceleration **Or** to allow particles to spiral **Or** to produce an arc **Or** to produce circular motion	**(1)**	
	So that momentum/energy/charge/ velocity/mass can be investigated	**(1)**	**2**
3(b)	The <u>radius</u> of curve gets less **Or** curvature increases	**(1)**	
	(Because) particle slows down **Or** loses energy **Or** loses momentum	**(1)**	**2**
3(c)	(Magnetic field) out of page	**(1)**	
3(d)(i)	Does not leave a track **Or** there is only one visible track for μ^+	**(1)**	
	Clear demonstration of charge conservation in this situation	**(1)**	**2**
3(d)(ii)	Reference to momentum	**(1)**	
	Reference to change of direction of the visible path	**(1)**	
	(Hence) another particle must have an equal but opposite change of momentum **Or** another particle produced to conserve momentum	**(1)**	**3**
	Total for question		**10**

Question Number	Answer		Mark
4(a)	Use of $\Phi = BA$ Converts cm to m Or mT to T $\Phi = 1.1 \times 10^{-4}$ Wb Example of calculation $\Phi = 6.0 \times 10^{-2}$ m $\times$ 2.4×10^{-2} m $\times$ 74×10^{-3} T $\Phi = 1.07 \times 10^{-4}$ Wb	**(1)** **(1)** **(1)**	**3**
4(b)	Use of $\mathcal{E} = \Delta\Phi/\Delta t$ Use of time = distance/speed $\mathcal{E}$ = 5.3 mV (5.0 mV or 5.5 mV depending on value of Φ used, ecf value of Φ from (a)) **Or** Quotes $\mathcal{E} = Blv$ $l = 6.0 \times 10^{-2}$m used $\mathcal{E}$ = 5.3 mV Example of calculation Time = 0.024 m / 1.2 m s^{-1} t = 0.020 s $\mathcal{E} = 1.1 \times 10^{-4}$ Wb / 0.02 s = 5.5 mV	**(1)** **(1)** **(1)** **(1)** **(1)** **(1)**	**3**
4(c)	Use of $I = V/R$ Use of $F = BIl$ $F = 9.8 \times 10^{-5}$ N (ecf value of $\mathcal{E}$ from (b)) This force is too small to be felt. (this comment must be consistent with their value of force) Example of calculation I = 5.5 mV/ /0.25 Ω = 0.022 A $F = 74 \times 10^{-3}$ T $\times$ 0.022 A $\times$ 0.060 m $F = 9.8 \times 10^{-5}$ N	**(1)** **(1)** **(1)** **(1)**	**4**
	Total for question		**10**