Question	Answer	Marks
1	D	1
2	B	1
3 a	$F = qVB = 1.6 \times 10^{-19} \times 250 \times 0.018 = 7.2 \times 10^{-19}$ N	1
3 b	$F = \frac{mv^2}{r}$ so $r = \frac{mv^2}{F} = \frac{5.3 \times 10^{-26} \times 250}{7.2 \times 10^{-19}}$ $= 4.6 \times 10^{-3}$ m	1 1
4 a	The equipotential lines are closest together.	1
4 b	Straight line drawn with an arrow(head) pointing directly away from the charge.	1 1
5 a	Number of electrons = $\frac{0.80 \times 10^{-9}}{e}$ $= 5 \times 10^9$	1 1
5 b i	Positive charge due to repulsion of positive droplets (or similar).	1
5 b ii	Three straight lines equally spaced with arrowheads pointing left.	1 1 1
5 c i	$F = EQ$ and $E = \frac{V}{d}$ So $F = \frac{VQ}{d}$ so $V = \frac{Fd}{Q}$	1 1
5 c ii	$V = \frac{Fd}{Q} = \frac{3.6 \times 10^{-6} \times 150 \times 10^{-3}}{0.8 \times 10^{-9}}$ $= 675$ V	1 1
6 a i	Straight, vertical line correctly labelled two thirds of the distance from the cathode to the anode.	1 1
6 a ii	$W = VQ = 600 \times 1.6 \times 10^{-19}$ $= 9.6 \times 10^{-17}$ J $\approx 1 \times 10^{-16}$ J	1 1
6 b i	5 straight, horizontal lines. All equally spaced.	1 1
6 b ii	500 V	1
6 b iii	$E = \frac{V}{d} = \frac{500}{40}$ $= 12\,500$ V m^{-1}	1 2
7 a	$E_k = \frac{1}{2}mv^2 = \frac{1}{2} \times 9.1 \times 10^{-31} \times (1.8 \times 10^7)^2$ $= 1.4 \times 10^{-16}$ J $E = VQ$ so $V = \frac{E}{Q} = \frac{1.4 \times 10^{-16}}{1.6 \times 10^{-19}}$ $= 875$ V ≈ 900 V	1 1 1 1
7 b i	Centripetal force = $\frac{mv^2}{r}$ and magnetic force = QvB (here $Q = e$) So $\frac{mv^2}{r} = QvB$ and $r = \frac{mv}{Be}$	1

7 b ii	$E_k = \frac{1}{2}mv^2$ so $v = \sqrt{\frac{2E_k}{m}}$ $r = \frac{mv}{Be} = \frac{m\sqrt{\frac{2E_k}{m}}}{Be} = \frac{\sqrt{2E_k m}}{Be}$	1 1