

Question			Marking details	Marks available				Maths	Prac
				AO1	AO2	AO3	Total		
9	(a)		Without – [fast] random motion <b>or</b> motion with collisions (1) mean velocity zero <b>or</b> no preferred direction (1) With (any 2 of) random motion still present (1) [can be implied] but (slight) acceleration between collisions (1) drift velocity (1)	4			4		
	(b)		Algebra, that is $T = \frac{mv^2}{3k}$ (1) 220 K (1)		2		2	2	
	(c)		<b>Either</b> Equating $qE = ma$ Extra detail in explanation, for example $q = e$ or $m = m_e$ or stating that resultant force = electric force. (1) <b>Or</b> $F = ma$ and $F = qE$ (1) Where $q = e$ or $m = m_e$ (1)		2		2	1	
	(d)		Re-arrangement for $E$ as subject (1) $E = 0.071 \text{ V m}^{-1}$ or $\text{N C}^{-1}$ <b>UNIT</b> (1) Slips in powers of 10: –1		2		2	1	
	(e)		Comparison with $R = \frac{\rho \ell}{A}$ with eq 8 or equivalent substitution (1) $d = \ell$ [or by implication] and convincing algebra / brief explanation (1)		2		2	1	
	(f)		Re-arrangement to make $\tau = \frac{2m_e}{ne^2\rho}$ (1) $\tau = 50 \text{ fs}$ (1)		2		2	2	

	(g)	$\text{time} = \frac{d}{v} \quad (1) \quad [v = c_{\text{rms}}]$ $\rho \propto \frac{1}{\text{time}} \propto v \quad (1)$ $v^2 \propto T \text{ (kinetic theory) } (1)$ $\rho \propto v \propto \sqrt{T} \quad (1)$			4	4	2	
	(h)	positive (1) excess electrons either side / because electrons are attracted (1)		2		2		
		<b>Question 9 total</b>	<b>4</b>	<b>12</b>	<b>4</b>	<b>20</b>	<b>10</b>	<b>0</b>