Uniform Electric Fields

Mark Scheme 2

Level	International A Level
Subject	Physics
Exam Board	CIE
Topic	Electric Fields
Sub Topic	Uniform Electric Fields
Paper Type	Theory
Booklet	Mark Scheme 2

Time Allowed: **56 minutes**

Score: **/46**

Percentage: **/100**

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

1	**(a**	electric field strength = force / positive charge	B1	[1]
	(b) (i)	at least three equally spaced parallel vertical lines	B1	
		direction down	B1	[2
	(ii)	$E = 1500 / 20 \times 10^{-3} = 75000\ \text{V m}^{-1}$	A1	[1
	(iii)	$F = qE$	C1	
		($W = mg$ and) $qE = mg$	C1	
		$q = mg / E = 5 \times 10^{-15} \times 9.81 / 75000$		
		$= 6.5 \times 10^{-19}$ C	A	
		negative charge	A1	[4]
	(iv)	$F > mg$ or F now greater	B1	
		drop will move <u>upwards</u>	B1	[2]

2	**(a (i)**	greater deflection	M0	
		greater electric field / force on α-particle	A1	[1]
	(ii)	greater deflection	M0	
		greater electric field / force on α-particle	A1	[1]
	(b) (*either*	deflections in opposite directions	M1	
		because oppositely charged	A1	
	or	β less deflection	(M1)	
		β has smaller charge	(A1)	[2]
	(ii)	α smaller deflection	M1	
		because larger mass	A1	[2]
	(iii)	β less deflection because higher speed	B1	[1]
	(c) *either*	$F = ma$ and $F = Eq$ *or* $a = Eq / m$	C1	
	ratio = *either*	$\frac{(2 \times 1.6 \times 10^{-19}) \times (9.11 \times 10^{-31})}{(1.6 \times 10^{-19}) \times 4 \times (1.67 \times 10^{-27})}$		
	or	$[2e \times 1 / 2000\ \text{u}] / [e \times 4\text{u}]$	C1	
	ratio =	*or* $2.5 \quad ^{-4}$ *or* $2.7 \quad ^{-4}$	A1	[3]

3	**(a**	**(i)**	path: reasonable curve upwards between plates	B1
			straight and at a tangent to the curve beyond the plates	B1 [2]
		(ii)	**1.** (F =) $E.g$	B1 [1]
			2. (t =) L / v	B1 [1]
	(b)	**(i)**	total momentum of a system remains constant **or** total momentum of a system before a collision equals total momentum after collision	M1
			provided no external force acts on the system	A1 [2]
			(do not accept 'conserved' but otherwise correct statement gets 1/2)	
		(ii)	(Δp =) EqL / v allow ecf from **(a)(ii)**	B1 [1]
		(iii)	*either* charged particle is not an isolated system	M1
			so law does not apply	A1 [2]
			or system is particle and 'plates'	(M1)
			equal and opposite Δp on plates / so law applies	(A1)
4	**(a)**		region/area where a charge experiences a force …….……..	B1 [1]
	(b)	**(i)**	left-hand sphere (+), right-hand sphere (–) ……..…….	B1 [1]
		(ii)	**1** correct region labelled C within 10 mm of central part of plate	
			otherwise within 5 mm of plate ……..……..	B1 [1]
			2 correct region labelled D area of field not included for **(b)(ii)1** …….…….	B1 [1]
	(c)	**(i)**	arrows through P and N in correct directions ……	B1 [1]
		(ii)	torque = force × <u>perpendicular</u> distance (between forces) ……	C1
			= $1.6 \times 10^{-19} \times 5.0 \times 10^{4} \times 2.8 \times 10^{-10} \times \sin 30$	
			= 1.1×10^{-24} N m …….…….……	A1 [2]

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5 **(a)** **(i)** $E = V / d$ C1
$= 350 / (2.5 \times 10^{-2})$
$= 1.4 \times 10^{4}$ N C^{-1} ..... A1 [2]

(ii) force = Eq C1
$= 1.\quad^{4} \times 1\quad^{-19}$ M1
$= 2.24 \times 10^{-15}$ ..... A0 [2]

(b) **(i)** $F = ma$ C1
$a = (2.24 \times 10^{-15}) / (9.1 \times 10^{-31})$
$= 2.4\quad^{15}$ m $^{-2}$ …(*allow* $\times 10^{5}$) ..... A1 [2]

(ii) $s = ½at^2$ C1
$2.5 \times 10^{-2} = ½ \times 2.46 \times 10^{15} \times t^2$
$t = 4.5 \times 10^{-9}$ s ..... A1 [2]

(c) *either* gravitational force is normal to electric force
or electric force horizontal, gravitational force vertical ..... B2 [2]
special case: force/acceleration due to electric field >> force/acceleration due to gravitational field, allow 1 mark

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