Magnetic Fields & Moving Charges

Mark Scheme 4

Level	International A Level
Subject	Physics
Exam Board	CIE
Topic	Magnetic Fields
Sub Topic	Magnetic Fields & Moving Charges
Paper Type	Theory
Booklet	Mark Scheme 4

Time Allowed: **80 minutes**

Score: **/66**

Percentage: **/100**

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

1	**(a**	**(i)**	$BI \sin\theta$	B1	[1]
		(ii)	(downwards) into (the plane of) the paper	B1	[1]
	(b)	**(i)**	magnetic field (due to current) in one loop OR each loop acts as a coil	B1	
			cuts/is normal to current in second loop OR produces magnetic field	B1	
			causing force on second loop OR fields in same direction	M1	
			either Newton's 3rd discussed		
			or vice versa clear gives rise to attraction OR so attracts	A1	[4]
		(ii)	$B = 2 \times 10^{-7}\ I/0.75 \times 10^{-2}$ (= $2.67 \times 10^{-5}\ I$)	C1	
			force = $0.26 \times 10^{-3} \times 9.81$ (= 2.55×10^{-3} N)	C1	
			$F = BIL$		
			$2.55 \times 10^{-3} = 2.67 \times 10^{-5} \times I^2 \times 2\pi \times 4.7 \times 10^{-2}$	C1	
			I = 18 A	A1	[4]

2	**(a**	**(i)**	arrow B in correct direction (down the page)	B1	
		(ii)	arrow F in correct direction (towards Y)	B1	**[2]**
	(b)	**(i)**	When two bodies interact, force on one body is equal but opposite in direction to force on the other body.	B1	**[1]**
		(ii)	direction opposite to that in **(a)(ii)**	B1	**[1]**
	(c)		suggested reasonable values of I and d	B1	
			mention of expression $F = BIL$	B1	
			force between wires is small	M1	
			compared to weight of wire	A1	**[4]**

3	(a	arrow labelled E pointing down the page	B1	[1]
	(b) (i)	$Bqv = qE$	M1	
		forces are independent of mass and charge 'cancels'	M1	
		so no deviation	A1	[3]
	(ii)	magnetic force > electric force	M1	
		so deflects	M1	
		'downwards'	A1	[3]

4	(a)	$\frac{1}{2}mv^2 = qV$ ……(or some verbal explanation) ……	B1	
		$\frac{1}{2} \times 9.11 \times 10^{-31} \times v^2 = 1.6 \times 10^{-19} \times 1.2 \times 10^4$ ……	B1	
		$v = 6.49 \times 10^7$ m s^{-1} ……	A0	[2]
	(b)(i)	*within field:* circular arc ……	B1	
		in 'downward' direction ……	B1	
		beyond field: straight, with no 'kink' on leaving field ……	B1	[3]
	(ii) 1.	v is smaller ……	M1	
		deflection is larger ……	A1	[2]
	2.	(magnetic) force is larger ……	M1	
		deflection is larger ……	A1	[2]

5	(a)		into (plane of) paper/downwards	1	[1]
	(b)	(i)	the centripetal force = mv^2/r	1	
			$mv^2/r = Bqv$ hence $q/m = v/rB$ *(some algebra essential)*	1	[2]
		(ii)	$q/m = (8.2 \times 10^6)/(23 \times 10^{-2} \times 0.74)$	1	
			$= 4.82 \times 10^7$ C kg^{-1}	1	[2]
	(c)	(i)	mass = $(1.6 \times 10^{-19})/(4.82 \times 10^7 \times 1.66 \times 10^{-27})$	1	
			= 2u	1	[2]
		(ii)	proton + neutron	1	[1]

6 **(a)** centripetal force = mv^2/r B1
magnetic force $F = Bqv$ B1
(hence) $mv^2/r = Bqv$ B1
$r = mv/Bq$ ..... A0 [3]

(b) $r_\alpha/r_\beta = (m_\alpha/m_\beta) \times (q_\beta/q_\alpha)$ C1
$= (4 \times 1.66 \times 10^{-27})/(9.11 \times 10^{-31} \times 2)$
$= 3.64 \times 10^3$ ..... A2 [3]

(c) **(i)** $r_\alpha = (4 \times 1.66 \times 10^{-27} \times 1.5 \times 10^6)/(1.2 \times 10^{-3} \times 2 \times 1.6 \times 10^{-19})$
$= 25.9$ m A2

(ii) $r_\beta = 25.9 \times 3.64 \times 10^3 = 7.13 \times 10^{-3}$ m ..... A1 [3]

(d) **(i)** deflected upwards B1
but close to original direction B1

(ii) opposite direction to α-particle and 'through side' ..... B1 [3]

7 **(a)** e.g. E-field, force independent of speed, B-field, force ∝ peed ... B2
E-field, force along field direction, B-field, force normal etc ... B2 [4]

(b) **(i)** out of plane of paper {not 'upwards') B1
(ii) $mv^2 / r = Bqv$ C1
$r = (1.67 \times 10^{-27} \times 4.5 \times 106:)/(0.12 \times 1.6 \times 10^{-19})$ C1
$r = 0.39$ m ..... A1 [4]

(c) **(i)** arrow pointing uppage B1
(ii) $Bqv = Eq$ CI
$E = 0.12 \times 4.5 \times 10^6$
$= 5.4 \times 10^5$ $\mathrm{Vm^{-1}}$ ..... A1 [3]

(d) gravitational force << Fs or FE ..... BI [1]