Magnetic Fields & Moving Charges

Mark Scheme 3

Level	International A Level
Subject	Physics
Exam Board	CIE
Topic	Magnetic Fields
Sub Topic	Magnetic Fields & Moving Charges
Paper Type	Theory
Booklet	Mark Scheme 3

Time Allowed: **75 minutes**

Score: **/62**

Percentage: **/100**

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

1 **(a** field into (the plane of) the paper — B1 [1]

(b) force due to magnetic field <u>provides</u> the centripetal force — B1
$mv^2 / r = Bqv$ — C1
$B = (20 \times 1.66 \times 10^{-27} \times 1.40 \times 10^{5}) / (1.6 \times 10^{-19} \times 6.4 \times 10^{-2})$ — B1
$= 0.454\text{T}$ — A0 [3]

(c) **(i)** semicircle with diameter greater than 12.8 cm — B1 [1]

(ii) new flux density $= \frac{22}{20} \times 0.454$ — C1
$B = 0.499\,\text{T}$ — A1 [2]

2 **(a** force due to *E*-field is equal and opposite to force due to *B*-field
$Eq = Bqv$ — B1
$v = E/B$ — B1 [3]

(b) *either* charge and mass are not involved in the equation in **(a)**
or F_E and F_B are both doubled
or *E, B* and *v* do not change — M1
so no deviation — A1 [2]

3 **(a)** arrow pointing up the page — B1 [1]

(b) $Eq = Bqv$ — C1
$v = (12 \times 10^3) / (930 \times 10^{-6})$ — C
$= 1.3 \times 10^7 \text{ m s}^{-1}$ — A1 [3]

(ii) $Bqv = mv^2 / r$ — C1
$q/m = (1.3 \times 10^7) / (7.9 \times 10^{-2} \times 930 \times 10^{-6})$ — C
$= 1.8 \times 10^{11} \text{ C kg}^{-1}$ — A1 [3]

4 **(a (i)** straight line with positive gradient M1
through origin A1 [2]

(ii) maximum force shown at $\theta = 90°$ M1
zero force shown at $\theta = 0°$ M1
reasonable curve with *F* about ½ max at 30° A1 [3]

(b) (i) force on electron due to magnetic field B1
force on electron normal to magnetic field and direction of electron B1 [2]

(ii) quote / mention of (Fleming's) left hand rule M1
electron moves towards QR A1 [2]

5 **(a)** concentric circles …(*at least three lines*) M1
with increasing separation A1
correct direction clear .... B1 [3]

(b) (i) correct position to left of wire .... B1 [1]

(ii) $B = (4\pi \times 10^{-7} \times 1.7) / (2\pi \times 1.9 \times 10^{-2})$ C1
$= 1.8 \times 10^{-5}$ T .... A1 [2]

(c) distance $\propto$ current C1
current $= (2.8 / 1.9) \times 1.7$
$= 2.5$ A .... A1 [2]

[Total: 8]

6 **(a)** **(i)** concentric circles, anticlockwise ……(*minimum 3 circles*) M1
separation of lines increases with distance from wire .... A1 [2]

(ii) direction from Y towards X .... A1 [1]

(b) **(i)** flux density at wire Y = $(4\pi \times 10^{-7} \times 5.0) / (2\pi \times 2.5 \times 10^{-2})$ C1
= 4.0×10^{-5} T C1
force per unit length = BI
= $4.0 \times 10^{-5} \times 7.0$ C1
= 2.8×10^{-4} N .... A1 [4]

(ii) *either* force depends on product of the currents in the two wires M1
so equal A1
or (isolated system so) Newton's 3rd law applies .... (M1)
so equal ....(A1) [2]

[Total: 9]

7 **(a)** unit of magnetic flux density / magnetic field strength B1
(uniform) field normal to wire carrying current of 1 A M
giving force (per unit length) of 1 N m^{-1} A1 [3]

(b) **(i)** force on magnet / balance is downwards (so by Newton's third law) B1
force on wire is upwards M1
pole P is a north pole A1 [3]

(ii) $F = BIL$ and $F = mg$ (*g missing, then 0/3 in* ***(ii)***) C1
$2.3 \times 10^{-3} \times 9.8 = B \times 2.6 \times 4.4 \times 10^{-2}$ (*g = 10, loses this mark*) C1
$B = 0.20$ T A1 [3]

(c) reading for maximum current = $2.3 \times \sqrt{2}$ C
total variation = $2 \times 2.3 \times \sqrt{2}$
= 6.5 g A1 [2]

8 **(a** region (of space) / area where B1
a force is experienced by M1
current-carrying conductor / moving charge / permanent magnet A1 [3]

(b) **(i)** electric B1 [1]

(ii) gravitational B1 [1]

(iii) magnetic B1 [1]

(iv) magnetic B1 [1]