Magnetic Fields & Moving Charges

Mark Scheme 2

Level	International A Level
Subject	Physics
Exam Board	CIE
Topic	Magnetic Fields
Sub Topic	Magnetic Fields & Moving Charges
Paper Type	Theory
Booklet	Mark Scheme 2

Time Allowed: **83 minutes**

Score: **/69**

Percentage: **/100**

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

1 **(a** (uniform magnetic) flux normal to long (straight) wire carrying a current of 1 A M1
(creates) force per unit length of 1 N m^{-1} A1 [2]

(b) sketch: concentric circles M1
increasing separation *(must show more than 3 circles)* A1
correct direction (anticlockwise, looking down) B1 [3]

(ii) $B = (4\pi \times 10^{-7} \times 6.3) / (2\pi \times 4.5 \times 10^{-2})$ C
$= 2.8 \times 10^{-5}$ T A1 [2]

(iii) $F = BIL (\sin\theta)$ C1
$= 2.8 \times 10^{-5} \times 9.3 \times 1$
$F/L = 2.6 \times 10^{-4}$ N m^{-1} A1 [2]

(c) force per unit length depends on product $I_X I_Y$ / by Newton's third law / action and reaction are equal and opposite M1
so same for both A1 [2]

2 **(a) (i)** particle must be moving M1
with component of velocity normal to magnetic field A1 [2]

(ii) $F = Bqv \sin \theta$ M1
q, v and θ explained [2]

(b) (i) face BCGF shaded A1 [1]

(ii) between face BCGF and face ADHE A1 [1]

(c) potential difference gives rise to an electric field M1
either $F_E = qE$ (*no need to explain symbols*)
or electric field gives rise to force (on an electron) A1 [2]

3 **(a** force on proton is normal to velocity and field M1
provides centripetal force (for circular motion) A1 [2]

(b) magnetic force = Bqv B1
centripetal force = $mr\omega^2$ *or* mv^2/r B1
$v = r\omega$ B1
$Bqv = Bqr\omega = mr\omega^2$
$\omega = Bq/m$ A1 [4]

4 **(a)** sketch: concentric circles *(minimum of 3 circles)* M1
separation increasing with distance from wire A1
correct direction B1 [3]

(b) (i) arrow direction from wire B towards wire A B1 [1]

(ii) *either* reference to Newton's third law
or force on each wire proportional to product of the two currents M1
so forces are equal A1 [2]

(c) force always towards wire A/always in same direction B1
varies from zero (to a maximum value) (1)
variation is sinusoidal / $\sin^2$ (1)
(at) twice frequency of current (1)
(any two, one each) B2 [3]

5 **(a)** (long) straight conductor carrying current of 1 A — M1
current/wire normal to magnetic field — M1
(for flux density 1 T,) force per unit length is 1 N m^{-1} — A1 [3]

(b) **(i)** (originally) downward force on magnet (due to current) — B1
by Newton's third law (allow "N3") — M1
upward force on wire — A1 [3]

(ii) $F = BIL$
$2.4 \times 10^{-3} \times 9.8 = B \times 5.6 \times 6.4 \times 10^{-2}$ — C1
$B = 0.066$ T *(need 2 SF)* — A1 [2]
(*g missing scores 0/2, but g = 10 leading to 0.067T scores 1/2*)

(c) new reading is $2.4\sqrt{2}$ g — C1
either changes between +3.4 g and –3.4 g
or total change is 6.8 g — A1 [2]

6 **(a** **(i)** $Bqv(\sin\theta)$ or $Bqv(\cos\theta)$ — B1 [1]

(ii) qE — B1 [

(b) F_B must be opposite in direction to F_E — B1
so magnetic field into plane of paper — B1 [2]

7 (a) unit of magnetic flux density — B1
field nonnal to (straight) conductor carrying current of 1 A — M1
force per unit length is 1 Nm^{-1} — A1 [3]

(b) (i) force on particle always normal to direction of motion (and speed of particle is constant) — M1
magnetic force provides the centripetal force — A1 [2]

(ii) $mv^2/r = Bqv$ — M1
$r = mv/Bq$ — AO [1]

(c) (i) the momentum/speed is becoming less — M1
so the radius is becoming smaller — A1 [2]

(ii) 1. spirals are in opposite directions — M1
so oppositely charged — A1 [2]

2. equal initial radii — M1
so equal (initial) speeds — A1 [2]

8 (a) region (of space) where there is a force — M1
either on / produced by magnetic pole
or on / produced by current carrying conductor / moving charge — A1 [2]

(b) (i) force on particle is (always) normal to velocity / direction of travel — B1
speed of particle is constant — B1 [2]

(ii) magnetic force provides the centripetal force — B1
$mv^2 / r = Bqv$ — M1
$r = mv / Bq$ — A0 [2]

(c) (i) direction from 'bottom to top' of diagram — B1 [1]

(ii) radius proportional to momentum — C1
ratio = 5.7 / 7.4
= 0.77 — A1 [2]
*(answer must be consistent with direction given in **(c)(i)**)*