Mark Scheme All Magnetic Field Questions
Jan 2002—Jan 2010 (old spec)

Question 4

Q4 Jan 2005

(a) $\Phi(= BA) = 45 \times 10^{-3} \times \pi \times (70 \times 10^{-3})^2$ ✓
$= 6.9 \times 10^{-4}$ Wb ✓ $(6.93 \times 10^{-4}$ Wb) *(2)*

(b)(i) $N\Delta\Phi$ $(= NBA - 0) = 850 \times 6.93 \times 10^{-4}$ ✓
= 0.59 (Wb turns) ✓ (0.589 (Wb turns))
(if $\Phi = 6.9 \times 10^{-4}$, then 0.587 (Wb turns))
(allow C.E. for value of Φ from (a))

(ii) induced emf $\left(= N\dfrac{\Delta\Phi}{\Delta t}\right) = \dfrac{0.589}{0.12}$ ✓
= 4.9 V ✓ (4.91 V)
(allow C.E. for value of Wb turns from (ii) *(4)*
(6)

3

Q3 Jan 2004

(a) deflects one way ✓
then the other way ✓ *(2)*

(b)(i) acceleration is less than g [or reduced] ✓
suitable argument ✓ (e.g. correct use of Lenz's law)

(ii) acceleration is less than g [or reduced] ✓
suitable argument ✓ (e.g. correct use of Lenz's law) *(4)*

(c) magnet now falls at acceleration g ✓
emf induced ✓
but no current ✓
no energy lost from circuit ✓
[or no opposing force on magnet,
or no force from magnetic field
or no magnetic field produced] *(3)*
(9)

Question 5			
(a)	(i)	into plane of diagram ✓ **Q5 Jan 2007**	7
	(ii)	magnetic field is perpendicular to velocity ✓ force is perpendicular to both magnetic field and velocity ✓ (or Fleming's left hand rule) (hence) force acts perpendicular to velocity ✓ force changes direction of velocity but not its magnitude ✓ force remains perpendicular to velocity as direction changes ✓ reference to centripetal force (or force acts towards a fixed point) ✓ **max 4**	
	(iii)	$BQv = \frac{mv^2}{r}$ ✓ $\therefore d = 2r = \frac{2mv}{BQ}$ ✓	
(b)		$\frac{Q}{m} \left(= \frac{2v}{Bd}\right) = \frac{2 \times 7.5 \times 10^4}{0.34 \times 0.110}$ ✓ $= 4.0 \times 10^6$ C kg^{-1} ✓	2
(c)	(i)	ions have different mass ✓ diameter of path $d \propto m$ ✓ isotopes ✓ **or** mutual repulsion of ions ✓ because ions are all positively charged ✓ causes smearing of spot around R ✓	max 3
	(ii)	ions are doubly ionised ✓ diameter of path $d \propto 1/Q$ ✓	
		Total	**12**

Q3 Jun 2002

3(a) $\theta = 90^\circ$ (or 270° or $\frac{\pi}{2}$ or $\frac{3\pi}{2}$) ✓ (*1*)

(b) $\Phi = BA\cos\theta$ ✓
$= 2.5 \times 10^{-3} \times 35 \times 10^{-3} \times 20 \times 10^{-3} \times \cos 30^\circ = 1.5 \times 10^{-6}$ Wb ✓ (*2*)

(c) $\Phi_{max} = 2.5 \times 10^{-3} \times 35 \times 10^{-3} \times 20 \times 10^{-3}$ (Wb) ✓ $(= 1.75 \times 10^{-6})$
flux linkage $= 650 \times 1.75 \times 10^{-6} = 1.1(4) \times 10^{-3}$ (Wb turns) ✓ (*2*)
(*5*)

4(a) induced fission: (large) nucleus splits unto two (smaller nuclei) ✓
brought about by bombardment or collision ✓
thermal neutrons have low energies or speeds (< 1 eV) ✓ (*3*)

(b)(i) $N = 3$ ✓

(ii) released neutrons have high(er) energies or speeds ✓

(iii) $\Delta m = 234.99333 - (91.90645 + 140\ 88354) - (2 \times 1.00867)$ ✓
$= 0.186$ u ✓
(if last term in Δm omitted or incorrect number of neutrons used in calculation, treat answer as C.E.)
energy released $= 0.186 \times 931 = 173$ MeV ✓
(allow C.E. for Δm) (*5*)
(*8*)

3

Q3 Jun 2003

(a) units: F - newton (N), B - tesla (T) or weber metre^{-2} (Wb m^{-2}),
I - ampere (A), l - metre (m) ✓
condition: I must be perpendicular to B ✓ (2)

(b)(i) mass of bar, $m = (25 \times 10^{-3})^2 \times 8900 \times l$ ✓ ($= 5.56l$)
weight of bar ($= mg$) $= 54.6l$ ✓
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$mg = BIl$ or weight = magnetic force ✓
$54.6l = B \times 65 \times l$ gives $B = 0.840$ T ✓

(b)(ii) arrow in correct direction (at right angles to I, in plane of bar) ✓ (5)
(7)

2

Q2 Jun 2004

(a)(i) out of plane of diagram ✓

(ii) circular path ✓
in a horizontal plane [or out of the plane of the diagram]✓

$$BQv = \frac{mv^2}{r} \quad ✓$$

radius of path, $r\left(=\dfrac{mv}{BQ}\right) = \dfrac{1.05 \times 10^{-25} \times 7.8 \times 10^5}{0.28 \times 2 \times 1.6 \times 10^{-19}}$ ✓

$= 0.91(4)$ m ✓ max (5)

(b)(i) radius decreased ✓
halved ✓
[or radius is halved ✓✓]

(ii) radius increased ✓
doubled ✓
[or radius is doubled ✓✓] max (3)
(8)

Q4 Jun 2006

Question 4			
(a)		greater flux (linkage) or more flux lines (at same distance) [or stronger magnet produces flux lines closer together] ✓ greater rate of change of flux (linkage) [or more flux lines cut per unit time] ✓ emf $\propto$ rate of change of flux (linkage) ✓ [or using $\epsilon = N\frac{\Delta\phi}{\Delta t}$, where $\Delta\phi = A\,\Delta B$, v and Δt are the same ✓ ΔB is larger since magnet is stronger ✓ N and A are constant, $\therefore \epsilon$ is larger ✓]	**3**
(b)	(i) (ii)	area swept out, $\Delta A = lv\Delta t$ ✓ $\Delta\Phi\ (= B\,\Delta A) = Blv\,\Delta t$ ✓ $\epsilon \left(= (N)\frac{\Delta\Phi}{\Delta t}\right) = \frac{Blv\Delta t}{\Delta t}$ gives result ✓	**3**
(c)	(i) (ii) (iii)	$\omega\,(= 2\pi f) = 2\pi \times 16$ ✓ $= 101\ \text{rad s}^{-1}$ ✓ $v (= r\omega) = 32 \times 10^{-3} \times 101 = 3.2(3)\ \text{m s}^{-1}$ ✓ (allow C.E. for value of ω from (i)) $\epsilon (= Blv) = 28 \times 10^{-3} \times 64 \times 10^{-3} \times 3.23$ ✓ $= 5.7(9) \times 10^{-3}\ \text{V}$ ✓ (allow C.E. for values of v from (ii)) (solutions using $\epsilon = Bf\pi r^2$ to give $5.7(6) \times 10^{-3}$ V acceptable)	**5**
		Total	**11**

Q4 Jun 2008

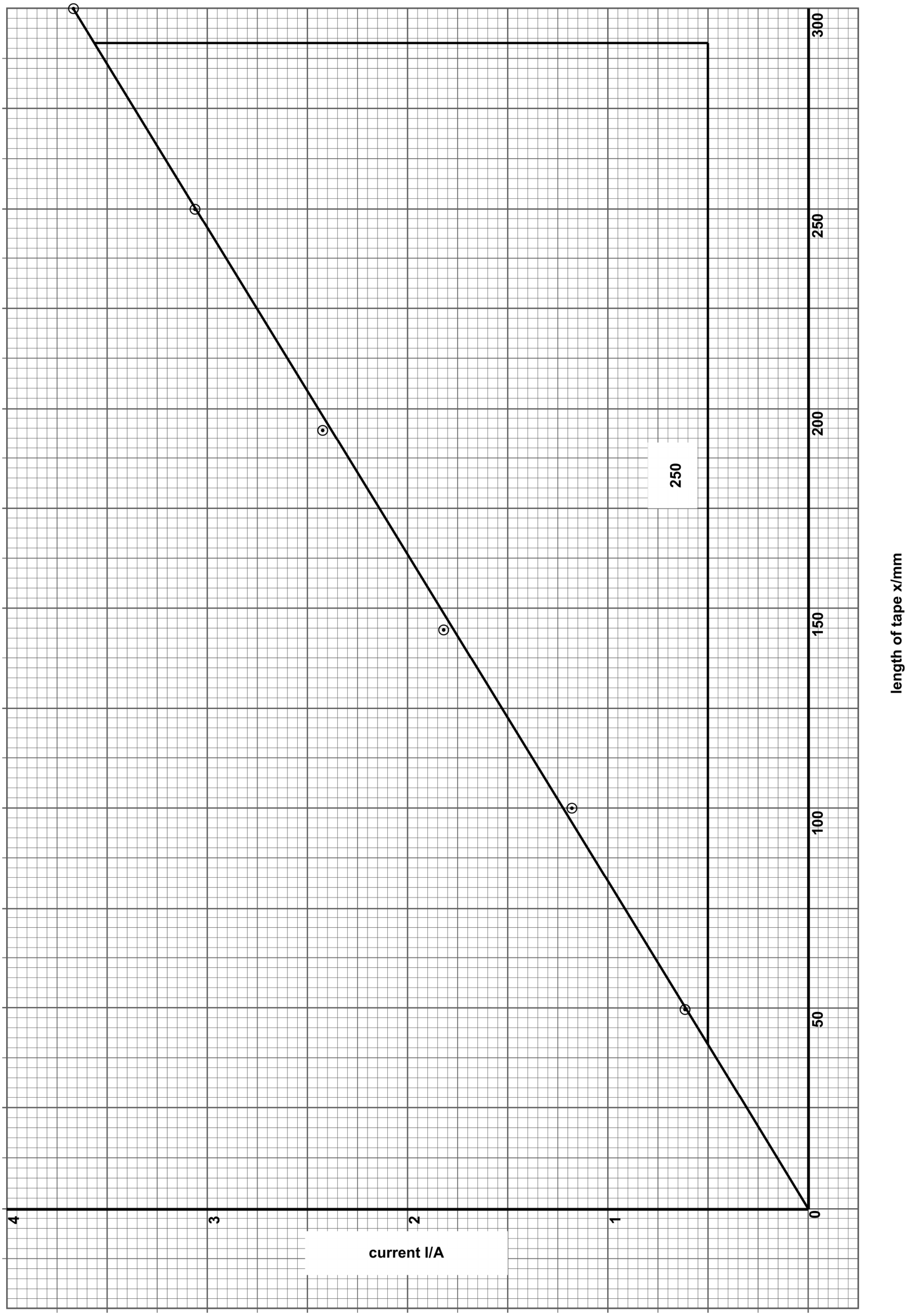
Question 4			
(a)		current $I\left(=\frac{F}{Bl}\right) = \frac{1.4\times10^{-3}\times9.81}{45\times10^{-3}\times40\times10^{-3}}$ ✓ = 7.6(3) A ✓	**2**
(b)	(i) (ii)	magnetic flux change Φ (= BA) = 45 × 10-3 × 40 × 10^{-3} × 20 × 10^{-3} ✓ = 3.6 × 10^{-5} Wb ✓ use of $\epsilon = \frac{\Delta\Phi}{\Delta t}$ ✓ gives time taken $\Delta t = \frac{3.6\times10^{-5}}{0.15\times10^{-3}}$ ✓ = 0.24 s ✓ **[alternative for (ii)** $v\left(=\frac{\epsilon}{Bl}\right) = \frac{0.15\times10^{-3}}{45\times10^{-3}\times40\times10^{-3}}$ ✓ = 8.33 × 10^{-2} (m s^{-1}) ✓ $\Delta t = \frac{l}{v} = \frac{20\times10^{-3}}{8.33\times10^{-2}}$ = 0.24 s ✓]	**5**
		Total	**7**

Q4 Jan 2009

Question 4			
(a)		*four factors to list (in any order):* flux density of magnetic field speed of movement (**not** time to remove) area of coil (**not** magnetic field) initial angle between plane of coil and magnetic field 4 factors listed ✓✓ 2 or 3 factors listed ✓	**2**
(b)	(i)	area of coil A = 60 × 10^{-3} × 35 × 10^{-3} = 2.1 × 10^{-3} (m^2) ✓ $\frac{\Delta B}{\Delta t} = \left(\frac{80\times10^{-3}}{50\times10^{-3}}\right)$ = 1.6 (T s^{-1}) ✓ $\frac{\Delta \Phi}{\Delta t} = \left(A\frac{\Delta B}{\Delta t}\right)$ = 2.1 × 10^{-3} × 1.6 ✓ = 3.3(6) × 10^{-3} Wb s^{-1} ✓ [**alternatively**, the four marking points in this calculation are: area of coil ✓ change of flux ✓ rate of change of flux ✓ answer with unit ✓]	**6**
	(ii)	induced emf $\in = N\frac{\Delta \Phi}{\Delta t}$ = 48 × 3.36 × 10^{-3} ✓ = 0.16(1) V ✓	
		Total	**8**

Q6 Jan 2010

Question 6			
(a)	(i)	arrow labelled **M** directed towards PS ✓	**3**
	(ii)	current I = $\left(= \frac{F}{Bl}\right) = \frac{0.16}{0.25 \times 0.12}$ 5.3 A ✓ (5.33)	
	(iii)	(PQ/RS are parallel to B) and so experience no magnetic force ✓ [accept PQ/RS have equal and opposite forces on them]	
(b)	(i)	*see graph on page 7*, graph drawn to have axes labelled and large scales ✓ five or more points plotted correctly ✓ a suitable straight line through the origin ✓	**7**
	(ii)	magnetic force = weight of rider ∴ $B\,I\,l = mg$ ✓ combined with $m = \mu x$ gives $I = \left(\frac{\mu g}{Bl}\right)x$ ✓	
	(iii)	gradient from large triangle $G = \frac{3.57 - 0.50}{250 \times 10^{-3}}$ = 12.3 (± 0.3) (A m^{-1}) ✓ $B \left(= \frac{\mu g}{Gl} = \frac{0.65 \times 10^{-3} \times 9.81}{12.3 \times 0.12}\right)$ = 4.3 (± 0.1) × 10^{-3} T ✓	
		Total	**10**



gradient = $\frac{3.57 - 0.50}{250 \times 10^{-3}}$ = 12.3 (± 0.3) (A m^{-1})