

Mark Scheme All Magnetic Field Questions

Jan 2002—Jan 2010 (old spec)

Question 4

Q4 Jan 2005

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

(b)(i) $N\Delta\Phi (= NBA - 0) = 850 \times 6.93 \times 10^{-4} \checkmark$
 $= 0.59 \text{ (Wb turns)} \checkmark$ (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 $(= N \frac{\Delta\Phi}{\Delta t}) = \frac{0.589}{0.12} \checkmark$
 $= 4.9 \text{ V} \checkmark$ (4.91 V)
 (allow C.E. for value of Wb turns from (i)) (4)
(6)

3

(a) deflects one way \checkmark
 then the other way \checkmark (2)

Q3 Jan 2004

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

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

(c) magnet now falls at acceleration g \checkmark
 emf induced \checkmark
 but no current \checkmark
 no energy lost from circuit \checkmark
 [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 ✓	<p style="text-align: right;">Q5 Jan 2007</p> <p style="text-align: right;">7</p> <p style="text-align: right;">max 4</p>
	(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) ✓	
	(iii)	$BQv = \frac{mv^2}{r} \quad \checkmark \quad \therefore d = 2r = \frac{2mv}{BQ} \quad \checkmark$	
(b)		$\frac{Q}{m} \left(= \frac{2v}{Bd} \right) = \frac{2 \times 7.5 \times 10^4}{0.34 \times 0.110} \quad \checkmark = 4.0 \times 10^6 \text{ C kg}^{-1} \quad \checkmark$	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

3(a) $\theta = 90^\circ$ (or 270° or $\frac{\pi}{2}$ or $\frac{3\pi}{2}$) ✓ **Q3 Jun 2002** (1)

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

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

4(a) induced fission: (large) nucleus splits into two (smaller nuclei) ✓
 brought about by bombardment or collision ✓
 thermal neutrons have low energies or speeds ($< 1 \text{ eV}$) ✓ (3)

(b)(i) $N = 3$ ✓

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

(iii) $\Delta m = 234.99333 - (91.90645 + 140.88354) - (2 \times 1.00867)$ ✓
 $= 0.186 \text{ u}$ ✓

(if last term in Δm omitted or incorrect number of neutrons used in calculation, treat answer as C.E.)

energy released = $0.186 \times 931 = 173 \text{ MeV}$ ✓

(allow C.E. for Δm)

(5)

(8)

3

- (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 ✓

Q3 Jun 2003 (2)

- (b)(i) mass of bar, $m = (25 \times 10^{-3})^2 \times 8900 \times l$ ✓ (= 5.56l)
 weight of bar (= mg) = 54.6l ✓
 $mg = BIl$ 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] ✓

$$BQv = \frac{mv^2}{r} \quad \checkmark$$

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

$$= 0.91(4) \text{ m} \quad \checkmark$$

max (5)

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

- (ii) radius increased ✓
 doubled ✓
 [or radius is doubled ✓✓]

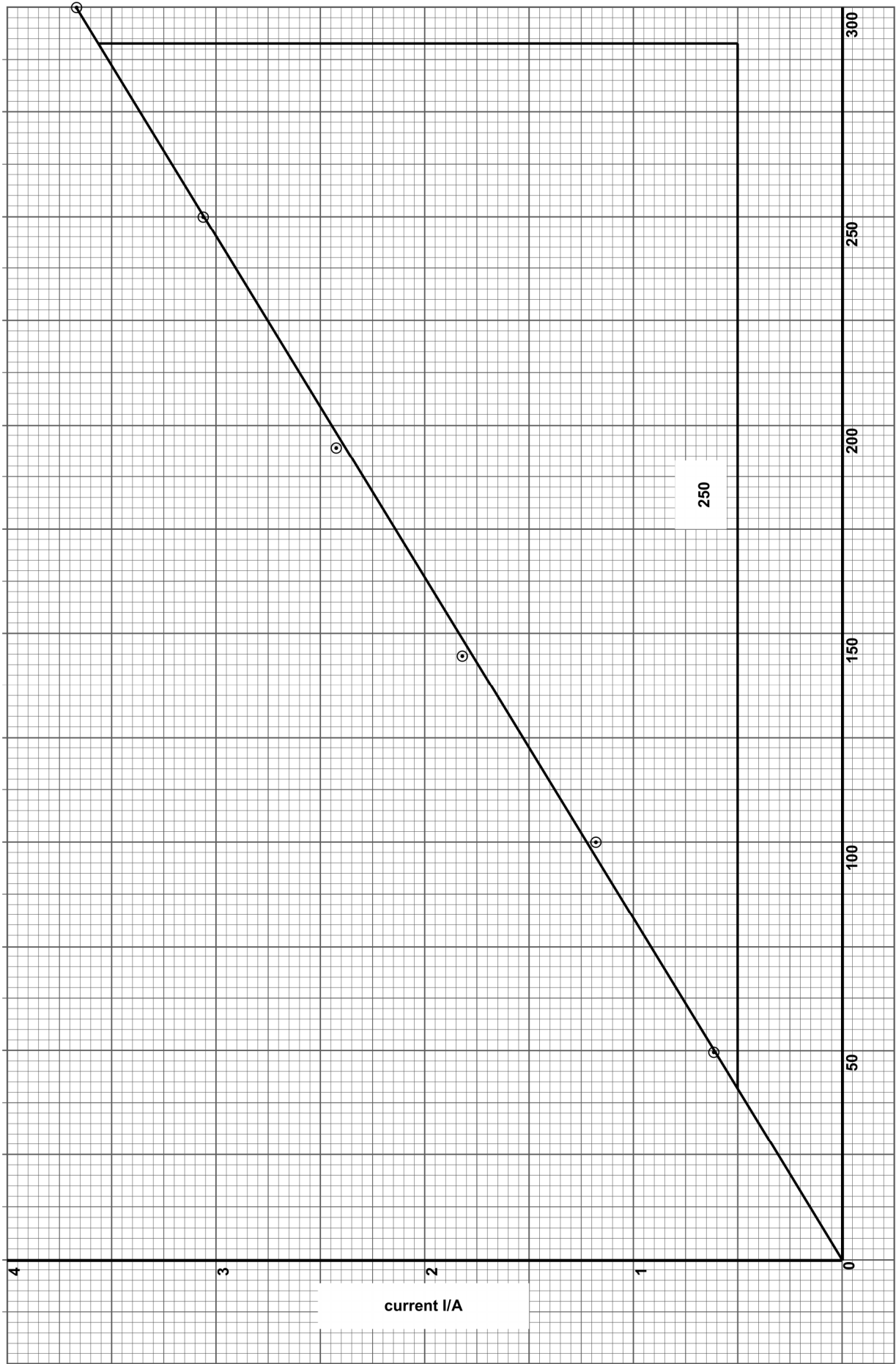
max (3)

(8)

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] ✓ $\text{emf} \propto \text{rate of change of flux (linkage)} \checkmark$ [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) area swept out, $\Delta A = lv\Delta t \checkmark$ (ii) $\Delta\Phi (= B \Delta A) = Blv \Delta t \checkmark$ $\epsilon \left(= (N) \frac{\Delta\Phi}{\Delta t} \right) = \frac{Blv\Delta t}{\Delta t}$ gives result ✓	Q4 Jun 2006 3
(c)	(i) $\omega (= 2\pi f) = 2\pi \times 16 \checkmark$ $= 101 \text{ rad s}^{-1} \checkmark$ (ii) $v (= r\omega) = 32 \times 10^{-3} \times 101 = 3.2(3) \text{ m s}^{-1} \checkmark$ (allow C.E. for value of ω from (i)) (iii) $\epsilon (= Blv) = 28 \times 10^{-3} \times 64 \times 10^{-3} \times 3.23 \checkmark$ $= 5.7(9) \times 10^{-3} \text{ V} \checkmark$ (allow C.E. for values of v from (ii)) (solutions using $\epsilon = Bf\pi r^2$ to give $5.7(6) \times 10^{-3} \text{ V}$ acceptable)	5
Total		11

Question 4		
(a)	current $I \left(= \frac{F}{Bl} \right) = \frac{1.4 \times 10^{-3} \times 9.81}{45 \times 10^{-3} \times 40 \times 10^{-3}} \checkmark = 7.6(3) \text{ A} \checkmark$	2
(b)	(i) magnetic flux change $\Phi (= BA)$ $= 45 \times 10^{-3} \times 40 \times 10^{-3} \times 20 \times 10^{-3} \checkmark$ $= 3.6 \times 10^{-5} \text{ Wb} \checkmark$ Q4 Jun 2008 (ii) use of $\epsilon = \frac{\Delta\Phi}{\Delta t} \checkmark$ gives time taken $\Delta t = \frac{3.6 \times 10^{-5}}{0.15 \times 10^{-3}} \checkmark$ $= 0.24 \text{ s} \checkmark$ [alternative for (ii)] $v \left(= \frac{\epsilon}{Bl} \right) = \frac{0.15 \times 10^{-3}}{45 \times 10^{-3} \times 40 \times 10^{-3}} \checkmark = 8.33 \times 10^{-2} \text{ (m s}^{-1}) \checkmark$ $\Delta t = \frac{l}{v} = \frac{20 \times 10^{-3}}{8.33 \times 10^{-2}} = 0.24 \text{ s} \checkmark$	5
Total		7

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



length of tape x/mm

current I/A