A Level OCR Physics

Chapter 22 Electromagnetism

Question	Answers	Extra information	Mark	AO Spec reference
1(a)	Reading will increase because the magnet will experience a downwards force/an equal and opposite force from the current (according to Newton's third law)		1 1	3.5.1 6.3.1 AO2
(b)	Any three from: • Use a variable resistor to change the current and ammeter to measure • Record the change in mass on the balance • Record length of wire in magnetic field – measure using 15 cm ruler/callipers Accuracy: • wire must be clamped securely so that it cannot move • wire should be perpendicular to field • tare the balance before experiment begins Safety: • wire may become hot – take readings quickly and turn off between each reading	Full marks only if safety/accuracy point included.	Max 3	6.3.1 AO2 × 1 AO1 × 2
(c)	Evidence of large triangle – or clear data points taken from graph e.g. (1.7 − 0.6)/(4.6 − 1.6) = 0.37 ± 0.1 g A^{-1} or $3.7 \pm 0.1 \times 10^{-4}$ kg A^{-1}	Allow either	1 1 1	1.1.3 AO2
(d)	Use of $F = BIl$ or $F = mg$ $mg = BIl$ $m = Bl/g \times I$ gradient = Bl/g B = gradient × g/l = $3.7 \pm 0.1 \times 10^{-4} \times 9.81/ 0.05 = 0.073$ T	Possible follow through from value of gradient in part **1(c)** Accept ecf from part (c)	1 1 1	6.3.1 AO3

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2(a)	Max 3 from • a.c. current in wire produces changing/alternating magnetic flux • this induces a changing magnetic field in the iron core/iron core becomes magnetised • the changing magnetic flux linkage in the coils induces emf/Faraday's law applied		Max 3	AO3 6.3.3
(b)	emf induced is proportional to the rate of change of flux linkage/Faraday's law $/\varepsilon = N\Delta\Phi/\Delta t$ Larger current means larger *B*/greater change in magnetic flux linkage per second		1 1	AO2 6.3.3
(c)	Cable to lamp contains more than one wire / live and neutral Current in opposite directions so magnetic fields cancel out.		1 1	6.3.3 AO3
(d)	Resolution refers to the smallest difference/change in the current it can give in this case 0.1 mA Accuracy is how close to true value so if reading 100 A the actual value could be 98 or 102		1 1	2.2.1 AO2
(e)	Detects the Earth's magnetic field/zeroing it allows magnetic flux due to current only to be detected flux density depends on angle between clamp and the earth's magnetic field.		1 1	6.3.1 AO2
3(a)	Electric field provides force to the <u>right</u> Force due to E field = qE Magnetic field provides force to the <u>left</u> force due to B field = Bqv when forces are equal the ion can enter/ion undeflected $qE = Bqv$ $v = E/B$		1 1 1 1	6.3.2 AO2

Question	Answers	Extra information	Mark	AO Spec reference
(b)	$v = E/B$ $E = vB = 0.1 \times 4.2 \times 10^5$ $E = V/d$ $d = V/E = 400 / 0.1 \times 4.2 \times 10^5$ $d = 0.0095$ m (0.01 m)		1 1	6.3.2 AO2
(c)	$F = mv^2/r$ or $F = Bqv$ $mv^2/r = Bqv$ $mv/r = Bq$ $r = mv/Bq$		1 1	5.2.2 6.3.2 AO2
(d)	$r = mv/Bq$ $\Delta r = (43.9 - 39.9) \times (1.661\times10^{-27}$ kg $\times 4.2\times10^4 / 1.1 \times 1.6\times10^{-19})$ $\Delta r = 0.016$ m Separation = 2 × radius = 0.032 m		1 1	6.3.2 AO2
4(a)	Angle between search coil and magnetic field • protractor/protractor card fixed to surface • sensible method of reducing parallax errors – e.g. use of clamp to hold protractor beneath search coil/ruler and set square arrangement Emf induced from the oscilloscope screen • choose suitable scale to maximise trace • peak to peak reading divided by 2 • multiply number of divisions by volts/div scale		1 1 1 1	6.3.3 AO3
(b)	Any two from: • The search coil is detecting induced emf in the coils. • There must be a changing magnetic flux linkage • a.c. current in large coil means a changing magnetic field.		Max 2	6.3.3 AO2

Question	Answers	Extra information	Mark	AO Spec reference
	• Mention of Faraday's law			
(c)	Graph of emf versus cos θ with suitable line of best fit axes labelled with units suitable scales chosen (data should be at least half graph paper)	If emf versus θ plotted lose one mark	1 1 1	1.1.3 AO3
(d)	Need to determine intercept to check relationship – gradient = (155 − 128)/(0.97 − 0.79) = 150 ± 4 Intercept: $y = mx + c$ 155 – (150 × 0.97) = c c = 9.5 Conclusion: this does prove the relationship as this is a straight line through the origin but there must be a systematic error Or this does not prove the relationship as there is not a straight line through the origin	If θ graph drawn allow one mark for stating it is cosine graph Allow either conclusion with justification ie what they are looking for	1 1 1	1.1.3 1.1.4 AO3
5(a)	Use of $s = ut + 1/2\,at^2$ and $u = 0$ $t = \sqrt{\frac{2s}{a}} = \sqrt{\frac{2 \times 0.32}{9.81}}$ = 0.26 s		1 1	3.1.2 AO2
(b)	The falling magnet causing a changing flux in the copper pipe/conductor/changing flux linkage This induces an e.m.f. in the copper pipe the emf is induced so that the current flows in a way to oppose the change that caused it.		1 1 1	6.3.3 AO2
(c)	Weight causes the magnet to accelerate downwards, the downward movement induces the force that slows it down' as it slows the magnetic force decreases. The forces acting on the magnet must be balanced/zero resultant force./weight =		1 1 1	3.5.1 6.3.3 AO3

Question	Answers	Extra information	Mark	AO Spec reference
	magnetic force		1	
(d)	Any four marks from: • the a.c. current produces an changing/alternating magnetic field/magnetic flux • this magnetises the iron clamp stand • induces an alternating/changing emf in the aluminium disc • the current flows so magnetic field opposes the change that caused it • repels the changing magnetic field of the coil so it hovers		Max 4	6.3.3 AO3
(e)	d.c. the magnetic flux linkage would not change / magnetic flux is constant/need changing magnetic flux linkage to induce emf in the disc.		1	6.3.3 AO2
(f)	Nothing happens / stays still although there is changing magnetic flux linkage there is not a complete conductor.	Allow no induced current as not complete conductor	1	6.3.3 AO2
6(a)	$f = 1/T$ = 1/0.02 = 50 Hz		1	4.4.1 AO1
(b)	$\Phi = BA\cos\theta$ $\Phi_{max} = BA = 3\times10^{-4}/330 = 9.1\times10^{-7}$ Wb $A = \Phi/B = 9.1\times10^{-7} / 0.06 = 1.52\times10^{-5}$		1 1	6.3.3 AO3
(c)	Tangent drawn at steepest negative gradient (e.g. at 0.01 s) Gradient = 0.089 V	Could also use $\varepsilon = BAN\omega \sin \omega t$	1 1	6.3.3 AO2
(d)	$P = V^2/R = 0.089^2/75$ $= 1.05\times10^{-4}$ W	ECF?	1 1	4.2.5 AO2
7(a)	Area = $\pi r^2 = \pi \times 0.9\times10^{-2}$ $\Phi = BA = 5.0\times10^{-3} \times (\pi \times 0.9\times10^{-2})^2$ $\Phi = 1.3\times10^{-6}$ Wb or webers		1 1 1	6.3.3 AO2

Question	Answers	Extra information	Mark	AO Spec reference
(b)	$\Phi = BA \cos\theta = 5.0\times10^{-3} \times (\pi \times 0.9\times10^{-2})^2 \cos 10$ $\Phi = 9.0\times10^{-7}$ (Wb)		1	6.3.3 AO2
(c)	$\varepsilon = N\Delta\Phi/\Delta t$ $\varepsilon = 5000 \times (1.3\times10^{-6} - 9.0\times10^{-7})/ 0.2$ $\varepsilon = 0.01$ V		1 1	6.3.3 AO2
(d)	A large emf would be induced in the coil (larger than in part 7(c)) rapid change in magnetic flux linkage $\varepsilon = N\Delta\Phi/\Delta t$		1 1	6.3.3 AO3
8(a)	Micrometer/digital calliper measuring several places along length and finding mean		1 1	1.1.2 AO1
(b)	$\rho = M/V$ $M = \rho \times V = 2700 \times 15 \times 10^{-3} \times 50 \times 10^{-3} \times 0.02\times10^{-3}$ $m = 4.05\times10^{-5}$ kg		1 1	3.2.4 AO2
(c)	Use of $F = BIl$ or $W = mg$ $I = mg/Bl = 4.05\times10^{-5}$ kg $\times 9.81/(0.03 \times 0.05)$ $I = 0.26$ A		1 1	6.3.1 AO2
(d)	Diagram showing field perpendicular to current Direction and current such that foil feels upwards force.		1 1	6.3.1 AO1