Electromagnetic Effects MS1

Question Number	Answer	Mark
1	Current in coil generates magnetic field **(1)** Current drops/decreases **(1)** Change of flux [accept flux cut] **(1)** Rapid/quick/short time **(1)**	
	Large emf/200 V <u>induced</u>**(1)** Field/flux linkage large due to many turns **(1)**	**4 max.**
	Total for question	**4**

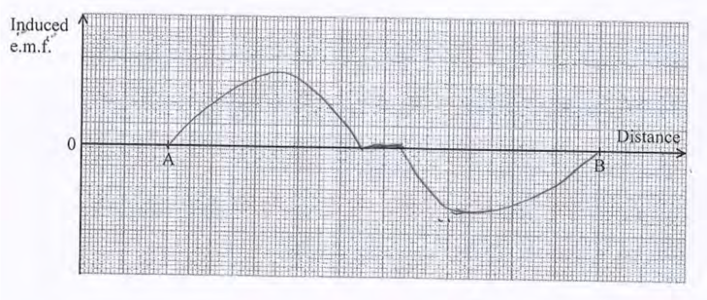
Question Number	Answer	Mark
2(a)(i)	measured thickness of lead 4-5 mm **(1)** measured radius 32 - 38 mm **(1)** Value between 38 – 57 mm **(1)** Eg actual radius = 35 mm x 6 mm/4.5 mm	**3**
(a)(ii)	Use of $p = Bqr$ [any two values sub] **(1)** Answer range 9.1×10^{-21} - 1.4×10^{-20} N s or kg m s^{-1} [allow ecf]**(1)**	**2**
(b)	Track gets more curved above lead / r smaller above lead **(1)** Must be slowing down / less momentum / loses energy **(1)** Up [dependent on either answer above] **(1)**	**3**
(c)	Into page **(1)** [ecf out of page if down in b]	**1**
(d)(i)	Division by 9.11×10^{-31} kg **(1)** Answer range 1.0 – 1.6 $\times 10^{10}$ m s^{-1} **(1)**	**2**
(d)(ii)	greater than speed of light **(1)** (impossible) so mass must have increased **(1)**	**2**
	Total for question	**13**

Question Number	Answer	Mark
3(a)	Indication of vertical force(s) on sides AB or CD (1) [up or down is equivalent to vertical] Opposite vertical forces on AB and CD (1) Indication of anticlockwise rotation (1) [Allow full credit for a written description] (Commutator) switches current direction (1)	**4**
3(b)*	(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate) <u>Flux</u> (linkage) changes / <u>flux</u> is cut (1) Mention of <u>induced</u> e.m.f [allow induced voltage] (1) E.m.f increases with speed (1) Mention of Lenz's Law (1) (e.m.f./voltage) opposes current [not "reduces"] (1)	**Max 4**
	Total for question 3	**8**

Question Number	Answer	Mark
***4**	(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate) Current in a wire produces a magnetic field **(1)** Identifies direction of B field around either wire **(1)** Eg Around wire so that it is into the page at the bottom of wire **Or** clockwise when looking from left (Each) wire is in the magnetic field of the other wire **(1)** A current-carrying wire in a magnetic field experiences a force **(1)** Mention of Fleming's left hand rule (accept motor rule) **Or** identifies neutral point between wires. **(1)** (Marks 1 and 2 and a labelled neutral point could be communicated using the diagram. For neutral point accept 'fields cancel' but not 'fields in opposite directions')	**5**
	Total for question 4	**5**

Question Number	Answer		Mark
5(a)	Reference to magnetic flux (linkage) Magnet vibrates/moves Flux/field through the coil changes <u>Induces</u> emf / pd	**(1)** **(1)** **(1)** **(1)**	**4**
5(b)(i)	Use of $T = 2\pi/\omega$ for a revolution ω = 3.5 rad s^{-1} <u>Example of Calculation</u> ω= 33 × 2π rad/ 60 s ω = 3.5 rad s^{-1}	**(1)** **(1)**	**2**
5(b)(ii)	ω / T / f remains constant $v = r\omega$ **Or** $C = 2\pi r$ So as the stylus moves towards the centre (tangential/linear) speed/velocity **Or** path length (per rotation) gets less	**(1)** **(1)** **(1)**	**3**
	Total for question15		**9**

Question Number	Answer		Mark
6*(a)	(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate) **Max 6 from** Reference to changing/cutting of field/flux Induced e.m.f. proportional to rate of change/cutting of flux (linkage) (accept equation) Initial increase in e.m.f. as the magnet gets closer to the coil Identifies region of negative gradient with magnet going through the coil Indication that magnet's speed increases as it falls Negative (max) value › positive (max) value (this mark is dependent on awarding marking point 5) Time for second pulse shorter (this mark is dependent on awarding marking point 5) The areas of the two parts of the graph will be the same (since Nφ constant)	**(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)**	**6**

6(b)	Two sequential pulses (if **not** two sequential pulses, scores zero) Pulses same height (+/- 3 mm squares) and width (by eye) Pulses in opposite directions Region of zero e.m.f. in the middle Example (peaks could be in opposite directions) 	**(1)** **(1)** **(1)** **(1)**	**4**
	Total for question 6		**10**

Question Number	Answer		Mark
***7**	**(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate)** Curvature at Q greater than at P, therefore slower at Q **Or** radius at Q smaller than at P, therefore slower at Q (accept less momentum or kinetic energy for slower) Particle travels P → Q **Or (**left) to right Force is: upwards/ towards A / towards centre of curvature **Or** current is Q → P **Or** current to the left Particles have negative charge (consistent with their direction) (Candidates who say charge is +ve can score MP4 if they say the direction is Q → P)	**(1)** **(1)** **(1)** **(1)**	**4**
	Total for Question 7		**4**

Question Number	Answer		Mark
8(a)	$B_v = 4.0 \times 10^{-5}$ T <u>Example of calculation</u> $B_v = 4.4\times 10^{-5}$ T $\times \cos 25^o$ $B_v = 3.99 \times 10^{-5}$ T	**(1)**	**1**
8(b)(i)	Conductor/wing moving at an angle to magnetic field **Or** the vertical component is at right angles to the wing) Hence force on electrons (in conductor) is at right angles to both direction of motion and magnetic field **Or** Reference to cutting / change of (magnetic) flux So an e.m.f. is induced	**(1)** **(1)** **(1)** **(1)**	**2**
8(b)(ii)	X on the right hand wing when looking at the diagram	**(1)**	**1**
8(b)(iii)	The build-up of charge creates an electric field This creates a force in the opposite direction to the magnetic force (A statement that the rate of change of flux is constant so that the e.m.f. is constant scores 1 mark)	**(1)** **(1)**	**2**
8(b)(iv)	(Magnetic) field will be parallel to the wings **Or** motion of plane at right angles to (magnetic) field **Or** reference to $F=BIl\sin\theta$ with $\sin\theta = 0$ So no force acts (in the direction of the wings) on the (free) electrons **Or** wings not cutting flux, so no e.m.f. across wing tips.	**(1)** **(1)**	**2**
	Total for Question 8		**8**

Question Number	Answer		Mark
9(a)(i)	$v_v = 7.5 \times 10^6$ m s^{-1} <u>Example of calculation</u> $v_v = 8.0 \times 10^6$ m s^{-1} × cos 20º $v_v = 7.5 \times 10^6$ m s^{-1}	**(1)**	**1**
(a)(ii)	$v_h = 2.7 \times 10^6$ m s^{-1} (apply ue only once in (i) and (ii)) <u>Example of calculation</u> $v_h = 8.0 \times 10^6$ m s^{-1} × cos 70º $v_h = 2.7 \times 10^6$ m s^{-1}	**(1)**	**1**
(a)(iii)	Circular motion in the vertical plane/direction No force is horizontal direction **Or** uniform motion in horizontal direction **Or** constant velocity in horizontal direction (For these marks, candidates must refer to vertical/perpendicular and horizontal/parallel)	**(1)** **(1)**	**2**
(b)(i)	See $BQr = mv$ Use of perpendicular component of velocity from (a)(i) $r = 2.8 \times 10^{-3}$ (m) <u>Example of calculation</u> $r = mv^2/Bev = mv/Be$ $r = (9.11 \times 10^{-31}$ kg × 7.5×10^6 m s^{-1})/ (0.015 T × 1.6×10^{-19} C) $r = 2.8 \times 10^{-3}$ m	**(1)** **(1)** **(1)**	**3**
(b)(ii)	Use of $T = 2\pi r/v$ ecf r from (b)(i) $T = 2.3 \times 10^{-9}$ s (show that gives 2.5×10^{-9} s) [use of 8.0×10^6 m s^{-1} is incorrect and can score 1 for 'use of'] <u>Example of calculation</u> $T = (2\pi \times 2.8 \times 10^{-3}$ m) / 7.5×10^6 m s^{-1} $T = 2.3 \times 10^{-9}$ s	**(1)** **(1)**	**2**
(b)(iii)	Use of distance = speed × time **with** v_h from (a)(ii) and T from (b)(ii) Distance = 6.2×10^{-3} m (use of 2.5×10^{-9} s gives 6.8×10^{-3}) <u>Example of calculation</u> Distance = 2.7×10^6 m s^{-1} × 2.3×10^{-9} s Distance = 6.2×10^{-3} m	**(1)** **(1)**	**2**
(c)	The circles would have a smaller radius Distance between adjacent loops would increase	**(1)** **(1)**	**2**
	Total for Question		**13**