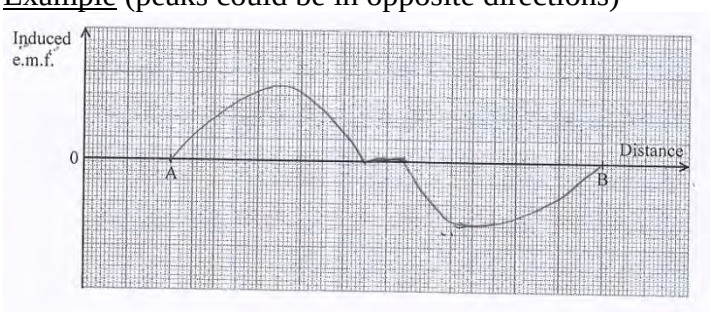
Question Number	Answer		Mark
1*(a)	(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate) **Max 6 from** Reference to changing/cutting of field/flux Induced e.m.f. proportional to rate of change/cutting of flux (linkage) (accept equation) Initial increase 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**
1(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 <u>Example</u> (peaks could be in opposite directions)  	**(1)** **(1)** **(1)** **(1)**	**4**
	Total for question		**10**

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

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 (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) Flux (linkage) changes / flux is cut (1) Mention of induced 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	**8**

Question Number	Answer		Mark
4(a)	Force on (charged) particles at right angles to motion Causes circular motion [not spiral / curved] OR force/acceleration is centripetal [credit first mark if clear from diagram]	(1) (1)	**2**
4(b)(i)	Momentum: $p=mv$ or $r = mv/Be$ $v = 2\pi r/T$ or $v = r\omega$ or $\omega = Be/m$ Use of $f = 1/T$ or $\omega/2\pi$ [allow q for e] Example of calculation $Ber = mv$ $Ber = m2\pi r/T$ $Be = m2\pi f$	(1) (1) (1)	**3**
4(b)(ii)	(Protons) accelerated / given energy, in the gaps / between D's/from one D to the other Every half rotation/semicircle later (polarity of D's) needs a change	 (1) (1)	**2**
4(b)(iii)	Relativistic effect / v approaching c/mass increases so frequency decreases [second mark consequent on first]	(1) (1)	**2**
4(c)	must be accelerating due to circular motion (Speed constant but) direction/velocity changing	(1) (1)	**2**
	Total for question		**11**

Question Number	Answer	Mark
5	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**