Question Number	Answer		Mark
1(a)	Disc/metal/cathode is heated (by a current) Thermionic emission (allow use of extremely high pd **and** a vacuum for 2 marks)	**(1)** **(1)**	**2**
1(b)	See $F=mv_{(v)}/t$ **Or** $F=ma$ and $v_{(v)}=at$ See $F= eE$ (accept F = EQ) See (time in field is) $t= l/v$ (This needs to be three clear statements) (Do not credit a units method)	**(1)** **(1)** **(1)**	**3**
1(c)	Find/measure horizontal distance from plates to screen Find/measure vertical displacement from centre of screen Use tan θ (this mark can be awarded if velocities are used rather than distances)	**(1)** **(1)** **(1)**	**3**
1(d)	Tan θ = vertical velocity / horizontal velocity **Or** v_v/v $v_v = \frac{Ee}{m} \times \frac{l}{v}$ and $v_H = v$ (conditional mark) (Do not credit a units method) .	**(1)** **(1)**	**2**
1(e)(i)	Magnetic rather than electric <u>force</u> **Or** *Bev/BQv* is the magnetic force **Or** *F = Bev/BqV* (do not credit just *eE = Bev*)	**(1)**	**1**
1(e)(ii)	Mark for appreciation of magnetic force e.g. Force/acceleration now centripetal **Or** (causes) circular motion **Or** force/acceleration not vertical **Or** force/acceleration is not always in the same direction **Or** vertical force/acceleration not constant **Or** force/acceleration is at right angles to direction of motion, Mark for consequence Horizontal velocity no longer constant **Or** l/v = t not true	**(1)** **(1)**	**2**
	Total for question 1		**13**

Question Number	Answer		Mark
2(a)	Use of $f = 1/T$ with 10 or 10×10^{-3} on the denominator f = 100 Hz Example of calculation $f = 1/T = 1/(10 \times 10^{-3}\ s) = 100$ Hz	**(1)** **(1)**	**2**
(b)	See or use $(N)\Phi = NBA$ B = 0.016 T Example of calculation $N\Phi = NBA$ $B = N\Phi/NA = 2 \times 10^{-2}$ Wb / ($500 \times 2.5 \times 10^{-3}\ m^2$) B = 0.016 T	**(1)** **(1)**	**2**
(c)	tangent drawn at 2.5, 7.5 or 12.5 ms **Or** linear section of graph used ±0.5 vertical scale Value(s) substituted into $\varepsilon = \Delta(N\Phi)/\Delta t$ $\varepsilon = (\pm)12.5\ V - 14.0\ V$ [common error is to find average value over half a cycle →8 V scores MP2 only] **Or** Use of $\varepsilon = BNA\omega$ (ecf B from(b) and f from (a)) Use of $\omega = 2\pi f$ ε = 12.6 V	**(1)** **(1)** **(1)** **(1)** **(1)** **(1)**	**3**
	Total for Question		**7**

Question Number	Answer	Mark
3(a)*	(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate) There is a changing (magnetic) flux (linkage) **Or** the coil cuts (magnetic) field / flux (lines) (1) Inducing an emf (across the ends of the coil/wire) (1) Generating a current because there is a closed circuit **Or** generating a current because coil is in a circuit (1)	**3**
3(b)	Current produced is a.c. / alternating **Or** the battery needs d.c. (1)	**1**
3(c)	(As rate of rotation of wheels reduces) the rate of change of (magnetic) flux(linkage) reduces **Or** rate of cutting field lines decreases (1) e.m.f. is proportional to the rate of change of flux (linkage) **Or** $\varepsilon = \frac{(-)d N \varphi}{dt}$ (1) (induced) e.m.f. decreases (steadily) (1)	**3**
	Total for question 3	**7**

Question Number	Answer	Mark
***4(a)**	(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate) (Alternating current in charger coil produces) alternating/varying magnetic field **(1)** Idea that magnetic flux in charger coil linked to coil in watch **Or** Lines of flux cutting coil in watch **Or** varying flux in coil in watch **(1)** e.m.f. <u>induced</u> in watch circuit **(1)** current since complete/closed circuit **(1)**	**4**
4(b)	direct current required/produced **Or** otherwise it would be alternating current **(1)** (accept dc for direct current or ac for alternating current)	**1**
	Total for question 4	**5**

Question Number	Answer		Mark
5(a)	**Either** Use of Pythagoras to find length of wire perpendicular to field [6.1 cm] Use of $F = B \times I \times$ length of wire perpendicular to field using $F = 0.0037$ N **Or** Use of $\cos\theta = a/h$ **Or** use of $\sin\theta = o/h$ **Or** measures an angle from diagram as 73°± 1° **Or** measures an angle from diagram as 17°± 1° Use of $F = BIl\sin\theta$ using correct angle $F = 0.0037$ N (accept $F = 0.0040$ N if measured angle of 73° used) <u>Example of calculation</u> cos θ = 3.2 cm / 6.9 cm $\theta = 62.4°$ $F = 0.074$ T × 0.82 A × 0.069 m × sin 62.4° = 0.074 T × 0.82 A × 0.069 m × 0.89 $F = 0.0037$ N Using measured angle: $\theta = 73°$ $F = 0.074$ T × 0.82 A × 0.069 m × sin 73° = 0.074 T × 0.82 A × 0.069 m × 0.96 $F = 0.0040$ N	**(1)** **(1)** **(1)** **(1)** **(1)** **(1)**	**3**
5(b)	Direction into page Using (Fleming) LHR	**(1)** **(1)**	**2**
	Total for question 5		**5**