Question Number	Answer		Mark
1(a)	Use of $\Phi = BA$ Converts cm to m Or mT to T $\Phi = 1.1 \times 10^{-4}$ Wb Example of calculation $\Phi = 6.0 \times 10^{-2}$ m $\times$ 2.4×10^{-2} m $\times$ 74×10^{-3} T $\Phi = 1.07 \times 10^{-4}$ Wb	**(1)** **(1)** **(1)**	**3**
1(b)	Use of $\mathcal{E} = \Delta\Phi/\Delta t$ Use of time = distance/speed $\mathcal{E}$ = 5.3 mV (5.0 mV or 5.5 mV depending on value of Φ used, ecf value of Φ from (a)) **Or** Quotes $\mathcal{E} = Blv$ $l = 6.0 \times 10^{-2}$m used $\mathcal{E}$ = 5.3 mV Example of calculation Time = 0.024 m / 1.2 m s^{-1} t = 0.020 s $\mathcal{E} = 1.1 \times 10^{-4}$ Wb / 0.02 s = 5.5 mV	**(1)** **(1)** **(1)** **(1)** **(1)** **(1)**	**3**
1(c)	Use of $I = V/R$ Use of $F = BIl$ $F = 9.8 \times 10^{-5}$ N (ecf value of $\mathcal{E}$ from (b)) This force is too small to be felt. (this comment must be consistent with their value of force) Example of calculation I = 5.5 mV/ /0.25 Ω = 0.022 A $F = 74 \times 10^{-3}$ T $\times$ 0.022 A $\times$ 0.060 m $F = 9.8 \times 10^{-5}$ N	**(1)** **(1)** **(1)** **(1)**	**4**
	Total for question		**10**

Question Number	Answer		Mark
2(a)	Use of $N\Phi = NBA$ $\Phi = 1.2 \times 10^{-3}$ Wb (accept T m^2) Example of calculation $\Phi = 200 \times 3.0 \times 10^{-2}$ T× 2.0×10^{-4} m s^{-1} $\Phi = 1.2 \times 10^{-3}$ Wb	**(1)** **(1)**	**2**
2(b)(i)	Time = 0.125 (s) **Or** Time = 1/8 (s) Use of $\varepsilon = (-)d(N\Phi)/dt$ $\varepsilon = (-)9.6 \times 10^{-3}$ V (ecf $N\Phi$ from (a)) Example of calculation $\varepsilon = 1.2 \times 10^{-3}$ Wb /0.125 s $\varepsilon = 9.6$ mV	**(1)** **(1)** **(1)**	**3**
2(b)(ii)	Maximum values when coil is horizontal **Or** maximum values when the coil is parallel to the magnetic field **Or** minimum value when coil vertical **Or** minimum value when the coil is perpendicular to the magnetic field e.m.f. determined by rate of change of flux **Or** see $\varepsilon = (-)d(N\Phi)/dt$ Greatest rate of change of flux as coil goes through horizontal **Or** greatest rate of change of flux occurs when $\theta=90°$ **Or** least rate of change of flux as it goes through vertical **Or** least rate of change of flux occurs when $\theta=0°$	**(1)** **(1)** **(1)**	**3**
2(b)(iii)	Peaks would be smaller amplitude **Or** maximum e.m.f. smaller Rate of change of flux (linkage/cutting) less	**(1)** **(1)**	**2**
2(c)(i)	Energy required to turn generator Transferred from kinetic energy of the car	**(1)** **(1)**	**2**
2(c)(ii)	Greater rate of kinetic energy transfer/loss at high(er) speeds At slower/low speeds there is less/negligible braking effect (so car would not fully stop)	**(1)** **(1)**	**2**
	Total for question		**14**

Question Number	Answer		Mark
3(a)	(Magnetic) force acts at right angles to ion motion/current Force is the centripetal force **or** causing centripetal acceleration **or** direction of acceleration/force is to centre (of circle)	**(1)** **(1)**	**2**
3(b)	See $F = BQv$ **or** $r = p/BQ$ $F = mv^2/r$ **or** $p = mv$ $f = v/2\pi r$ **or** $f = \omega/2\pi$ **or** $T = 2\pi r/v$ **or** $T = 2\pi/\omega$	**(1)** **(1)** **(1)**	**3**
3(c)(i)	Identifies positive (field) above **and** below (the ion) which repels the ion	**(1)** **(1)**	**2**
3(c)(ii)	$3 \times 32.0645 / 10 \times (10^6)$ $= 0.0000096$(u)	**(1)** **(1)**	**2**
3(c)(iii)	Convert MeV to J Convert J to kg Convert kg to u Mass loss = 0.0024(u) (and this is more than 0.00001u) <u>Example of calculation</u> mass loss = 2.2 MeV x 1.6 x 10^{-13} J J to kg 3.52 x10^{-13} / 9 x 10^{16} kg kg to u 3.91 x 10^{-30} / 1.66 x 10^{-27} u	**(1)** **(1)** **(1)** **(1)**	**4**
	Total for question		**13**