GCE Physics - PH5

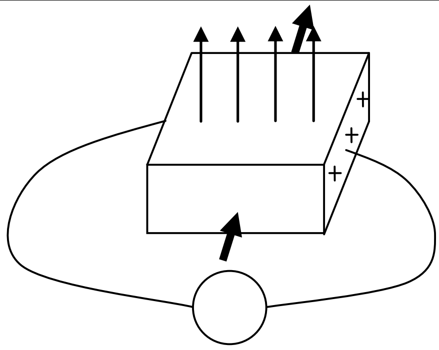
Question			Marking details	Marks Available
1.	*(a)*		Correct α or β absorber (1) If drop after α absorber, then α present (1) (Alpha is stopped by paper – award 2 marks) If **further** drop after β absorber then β present (1) If (significant) count after β absorber then γ present or equivalent (1)	4
	(b)	(i)	19×10^{15} [Bq]	1
		(ii)	Use of $\lambda = \frac{ln2}{T_{1/2}}$ (1) e.g. 0.0271 per day or $3.13 \times 10^{-7}\ s^{-1}$ (1) Or $A = \frac{A_0}{2^x}$ quoted Or $A = \frac{A_0}{2^x}$ used Substitutions of values (ignore wrong units or factors of ten slips) (1) Or $x = 14.26$ Correct answer 3.85×10^{12} [Bq] (1)	4
		(iii)	Attempt at using $A = \lambda N$ e.g. $76 \times 10^{15} = \lambda N$ (1) $N = 2.4 \times 10^{23}$ (1)	2
			Question 1 Total	**[11]**

Question			Marking details	Marks Available
2.	*(a)*		Attempt at LHS – RHS (1) (Difference = 0.0078)	
			Attempt at mass-energy conversion x 931 or $E = mc^2$ used (1)	
			Answer = 7.26 MeV (1.16 x 10^{-12} J) (1)*** **UNIT MARK*** **	3
	(b)		8.795 x number of nucleons attempted [545.29 MeV] (1)	
			Mass equivalent = 0.5857 [u] (1)	
			28 protons & 34 neutrons stated or implied (1)	
			Mass of 28p & 34n = 62.49828 (1)	
			Answer = 61.913 [u] (1) must be to 5 significant figures	5
			Question 2 Total	**[8]**

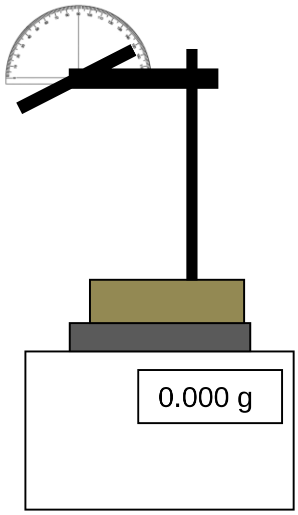
Question			Marking details	Marks Available
3.	*(a)*		$Q = CV$ (1)	
			212 [nC] (1)	2
	(b)		Taking logs e.g. $\ln Q = \ln Q_0 - \frac{t}{CR}$ (1)	
			Algebra e.g. $R = -\frac{t}{C\ln\frac{V}{V_0}}$ (1)	
			Substitution of correct values (1)	4
			Answer = 1.36 [MΩ] (1)	
	(c)		$C = \frac{\varepsilon_0 A}{d}$ used e.g. rearranged (1)	
			$A = x^2$ (or implied) $\rightarrow C = \frac{\varepsilon_0 x^2}{d}$ first two marks (1)	
			Answer =1.49 [m] (1)	3
	(d)		Dielectric between plates	1
			Question 3 total	**[10]**

Question			Marking details	Marks Available
4.	*(a)*		$Bev = \frac{mv^2}{r}$ (1) Convincing algebra (minimum of showing *v* cancelling then jumping to answer) i.e. $Be\cancel{v} = \frac{mv^{\cancel{2}}}{r} \rightarrow r = \frac{mv}{Be}$ (1)	2
	(b)		*r* stays constant (1) (accept to stop *r* from increasing) *m* and *e* can't be changed (accept $B \propto v$ or $\frac{v}{B}$ = constant or *m* increases and *e* is a constant) (1)	2
	(c)		Method e.g. $v = \frac{2\pi r}{T}$ or $v = \omega r$ and $\omega = 2\pi f$ or $v = 2\pi f r$ (1) $v = 3 \times 10^7$ [m s^{-1}] (1) $B = \frac{mv}{re}$ i.e. rearranged (1) *B* = 0.037 [T] (1) **ecf** on *v*	4
	(d)	(i)	*nI* needs to be very large (accept needs very large current) (1) Detail e.g. for *B* = 10 [T], *nI* = 8 000 000 (1) (don't accept *n*=1 but accept valid *n* and *I* calculation) or wires would melt before high *B* achieved or *n* needs thin wires but current needs thick wires etc.	2
		(ii)	Huge currents achievable or no heat dissipation (accept larger currents or large currents)	1
			Question 4 Total	**[11]**

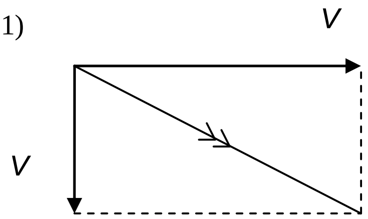
Question			Marking details	Marks Available
5.	*(a)*		The [induced] emf is proportional [or equal] to the rate of change [or cutting] of flux [linkage] or d*BAN*/d*t* and terms defined Nearly correct statements award 1 out of 2 marks e.g. The emf is equal to the change of flux The current is **proportional** to the rate of change of flux The emf is proportional to the cutting of flux *BAN*/*t* and terms defined Wrong statements get 0 The emf is equal/proportional to the flux linkage The current is **equal** to the rate of change of flux	2
			Lenz - the [induced] emf [or current] opposes [or tends to oppose etc.] the change [to which it is due]	1
	(b)	(i)	Clockwise (1) any 1 of FLHR(must have correct direction), FRHR, right hand grip rule (1)	2
		(ii)	Area increases ✓ at an increasing rate ✓ or cutting of flux ✓ inside the loop ✓ or *E*=*Blv* ✓ and *l* is increasing ✓	2
		(iii)	$V = \frac{BAN}{t}$ and $t = \frac{20.1}{31} (= 0.648\text{ s})$ or $E = Blv$ used (1) $A = \frac{1.8+2.9}{2} \times 20.1 [= 47.2]$ or mean l = 2.35 [m] (1) $I = \frac{V}{R}$ (1) Correct answer $I = 77$ [μA] (1)	4
			Question 5 Total	**[11]**

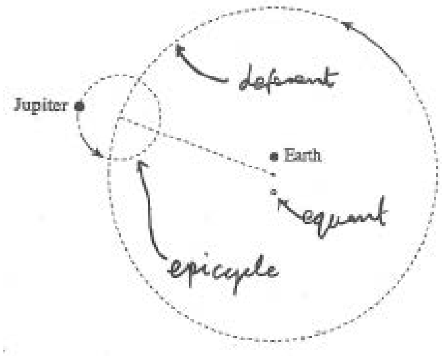
Question			Marking details	Marks Available
6.	*(a)*	(i)	+ve correct	1
		(ii)	voltmeter correct	1
				
	(b)		$V_H = Bvd$ or implied/$eE = Bev$ (1) $v = \frac{0.314\times10^{-3}}{0.168\times0.0043}$ (1) = 0.435 m s^{-1} (1) **or** $E=V/d$ (1) and ans (1)	3
	(c)		Force perpendicular to motion or no motion in direction of E_H or $P = IV$ (or $P = I^2R$) and $I = 0$ in that direction	1
	(d)		Use of $I = nAve$ e.g. $n = \frac{I}{Ave}$ or $V = \frac{BI}{nte}$ (1) Calculation of A or correct substitution (1) Answer $n = 1.16 \times 10^{24}\ \text{m}^{-3}$ *** **UNIT MARK** *** (1) **ecf** on *v*	3
			Question 6 Total	**[9]**

Question			Marking details	Marks Available
7.	*(a)*		Downward momentum given to air hence a force is applied (1) (N.B. downward can appear next to momentum or force) Newton's 3rd (or implied) force exerted on the plane by the air (1)	2
	(b)		Speed is greater at left side [due to conservation of mass] (1) (accept speed is decreasing) Air is decelerating or acceleration to the left or due to decrease in momentum(1)	2
	(c)		Lift component left is unbalanced (1) i.e. linking to resultant force Vertical component of lift is [slightly] less than weight (1) i.e. linking to direction Alternative: Good vector diagram (award 2 marks) The lift and weight added together give a resultant force acting downwards to the left. (award 1 mark only) Or resultant force is down and left (award 1 mark only) Or lift + weight is down and left (award 1 mark only)	2
	(d)		Air has high speed in tornados (1) (accept moving) This means a much lower pressure outside or much higher pressure inside (1) (N.B. much can also be implied by high speed in the 1st mark)	2
	(e)		Attempt at pressure difference (1) Pressure difference correct i.e. 155 [Pa] (1) Pressure difference 155 **ecf** x 850 [=130 kN] (1) (No marks for using the lift equation)	3

Question			Marking details	Marks Available
	(f)		All units correct award 2 marks 2 or 3 units correct award 1 mark LHS= $\mathrm{kg\,m\,s^{-2}}$ **and** $\mathrm{kg\,m^{-3}}$, $\mathrm{m\,s^{-1}}$ and $\mathrm{m^2}$ on RHS (2) Convincing algebra and method (1)	3
	(g)		Lift = weight or implied (accept 300 x g) (1) C_L = 0.90 (1) **ecf** on incorrect force	2
	(h)		  Hair dryer pointing at metal plate and plate attached to stand (1) Protractor set to measure angle of attack or angle labelled (1) Metal plate & attachment on digital balance (1) Labelling of 4/5 of hair dryer, stand / clamp, protractor, digital balance and metal plate (1)	4
			Question 7 Total	**[20]**

Question			Marking details	Marks Available
8.	*(a)*		Alternating current means an alternating *B*-field (needs a direct link) (1) [alternating] *B*-field transferred through core to secondary (1) Changing flux inside the secondary coil [gives emf] (1) (accept flux cuts the secondary coil but not flux goes through secondary coil)	3
	(b)		(needs design & loss method) Low resistance wires to reduce heat dissipation from wires (or equivalent) (1) Laminated core to reduce eddy currents (1) Suitable core alloy (or silicon steel etc.) to reduce magnetisation losses (or hysteresis **or to reduce leakage flux**/stray field etc.) (1)	3
	(c)	(i)	$\omega = 2\pi f = 24\,000$ [s^{-1}] (1) $\omega L = 88.7$ [Ω] (1) $\frac{1}{\omega C} = 88.7$ [Ω] (1)	3
		(ii)	Reactances are the same (accept impedances) (this can be stated regardless of a wrong answer to (i))	1
		(iii)	Answer = 6.5 [mA] (allow **ecf** if full method followed through) (i.e. using $Z = \sqrt{\left(\omega L - \frac{1}{\omega C}\right)^2 + R^2}$ etc.)	1

Question			Marking details	Marks Available
8.		(iv)	Ignore capacitance (or $\omega L - \frac{1}{\omega C}$ attempted) (1) Correct calculation for impedance e.g.. $\sqrt{887^2 + 2\,200^2}$ (1) Answer = $\frac{14.4}{2370}$ = 6.1 [mA] (1)	3
	(d)	(i)	**Attempt** at an explanation at low **and** high frequency (1) Correct variation of X_C with frequency (i.e. large at low frequency **or** low at high frequency) (1) Correct division of pd with respect to frequency (e.g. at high frequency R>>X_C so V_{OUT} is large **or** the opposite at low frequency) (1)	3
		(ii)	Phasor diagram drawn or implied (1)  $X_C = R$ or $V_C = V_R$ either derived or quoted (implies diagram correct) (1) Answer = 154 [Hz] (1)	3
			Question 8 Total	**[20]**

Question			Marking details	Marks Available
9.	*(a)*	(i)(I)	2 marks : 3 labels 1 mark : 2 labels 	2
		(II)	Prograde and motion on epicycle and deferent in same direction – or equivalent	1
		(III)	Brightness or size	1
		(ii)(I)	Either $\frac{2\pi}{T_{E/J}}\Delta t$ (1) represents angle swept out by Earth/Jupiter in time Δt (1) **OR** $\frac{\Delta t}{T_{E/J}}$ (1) represents fraction of a cycle swept out by Earth/Jupiter in time Δt Earth sweeps out extra angle 2π or one extra revolution (1)	2
		(II)	$\frac{1.092}{1} - \frac{1.092}{T_J} = 1$ (1) $1.092T_J - 1.092 = 1T_J$ $T_J = 11.9$ [years] (1)	2
	(b)	(i)	Nesting of: sphere of mercury / solid / sphere of Venus/solid (1) Didn't give quite correct orbital radii (1)	2

Question			Marking details	Marks Available
		(ii)	Mention of Plato or Pythagoras (1) Nature based on mathematics (or equivalent) (1)	2
	(c)	(i)	Path of body acted on by central force [towards S] Accept path of planet. (1) [Central] force applied at [just] these points (1)	2
		(ii)	Equal areas in equal times **OR** area swept out proportional to time	1
	(d)	(i)	Use of or by implication : (1) $\frac{v^2}{rg_{surf}}$ or $\frac{r\omega^2}{g_{surf}}$ =2.78 x 10^{-4} (1)	2
		(ii)	Attempt to evaluate $\left(\frac{r_E}{r_{MO}}\right)^2$ (1) = 2.75 x 10^{-4} (1)	2
		(iii)	Either: spherically symmetric **OR** behaves as if all at centre	1
			Question total	**[20]**

Question			Marking details	Marks Available
10.	*(a)*	(i)	Diameter[accept width/thickness do not accept radius/area]→ micrometer/digital calliper [accept vernier calipers but not vernier only] (1) Original [accept natural] length→ metre rule (1)	2
		(ii)	Take (one set of) *F* and *e* from graph **or** Measure gradient [or = $F/\Delta x$] Accept gradient = EA/l (1) Use value of $\pi d^2/4$ or πr^2 [explanation of how *A* is calculated required – can be awarded from (i)] (1) Insert in relevant equations (1) $Y = \frac{Fl_0}{A\Delta x}$ **or** $Y = grad \times \frac{l_0}{A}$ etc.	3
	(b)	(i)	$[e_{\text{iron}}] = \dfrac{Fl_0}{AE_{iron}}$ [must show $\dfrac{Fl_0}{A}$]	1
		(ii)	Attempt at $e_{\text{brass}} + e_{\text{iron}}$ (1) Correct manipulation/algebra (1)	2
		(iii)	CSA calculated: 7.9 x 10^{-7} [m^2] (1) Substitution (**ecf** on CSA) (1) W = 0.042 [J] (1) [-1 for slip in power of 10; -1 for use of diameter instead of radius]	3
		(iv)	1.8 mm **UNIT mark**	1

Question			Marking details	Marks Available
		(v)	Greater extension by brass [or smallest extension by iron] (1) e α 1/E (1) [link Young modulus to extension] All other factors same for both wires (1) Ratio 2:1 (1.2 mm:0.6 mm) (1) [Full marks may be obtained by calculation only].	4
	(c)	(i)	Melamine formaldehyde → thermosetting (1) Low density polyethylene → thermoplastic (1)	2
		(ii)	Melamine brittle – low max strain (1) **or** polythene not brittle – high max strain Melamine stiffer – higher Young modulus (1) **or** polythene less stiff – lower Young modulus [or accept low strain for high stress as explanation for stiffness of material]	2
			Question total	**[20]**

Question			Marking details	Marks Available
11.	*(a)*	(i)	Continuous background spectrum (1) Do not accept: a symmetric shape or touching x axis on LHS At least 1 line spectrum (1) Must be part of spectrum not placed on top Minimum wavelength not at 0,0 (1)	3
		(ii)	$eV = \frac{hc}{\lambda}$ (1) $E = \frac{hc}{\lambda}$ not enough Answer V = 41 250 [V] (1) 41 kV ok but do not accept 41 keV	2
		(iii)	Able to penetrate muscle but stopped by denser materials (1) Accept: body/flesh/tissue skin for muscle Accept: bone/harder materials for denser **Both needed** Expose photographic film (1)	2
		(iv)	Any 3x(1) from: –MRI (scan) If X-ray or ultrasound chosen 0 for whole question If PET chosen award maximum of 2 out of 3 marks –[high quality] images of *soft tissue* –Contrast can be controlled –X-rays are absorbed by bone/skull Accept: MRI not absorbed by skull Accept: X-rays cannot penetrate skull	3

Question			Marking details	Marks Available
	(b)	(i)	Z = Density x velocity [of ultrasound in the material] Must be in words as equation is given Do not accept speed of light for velocity	1
		(ii)	$Z_1 = 442$ **and** $Z_2 = 1\ 700 \times 10$ (1) f = approx 1 / 0.995 (1)	2
		(iii)	Almost all ultrasound reflected/ none able to enter the body (1) Need for a coupling gel/medium (1)	2
	(c)	(i)	Exposure: amount of radiation incident on the body (1) Do not accept: 'total radiation exposed to' as it is a rewrite of the question. absorbed dose: <u>energy</u> per unit mass absorbed by body (1)	2
		(ii)	Dose equivalent = dose x quality factor (1) Do not accept in terms of units Quality factor depends on ionization or alpha $Q = 20$ and gamma $Q = 1$(1) Greater for alpha than gamma (1)	3
			Question total	**[20]**

Question			Marking details	Marks Available
12.	*(a)*	(i)	Any 2 x (2) from Easily controllable Accept: no chain reaction (1) Because can switch off protons/hydrogen (1) **OR** No radioactive by-products or products are alpha particles (1) Any good relevant detail e.g. no storage costs for thousands of years Or alpha particles easily contained etc. (1) **OR** Fuel cheaper than fuel for fission (1) Detail e.g. per MJ output, H from the sea, no isotope enrichment needed, selling the He would help pay for the fuel (1) **OR** Fuel supplies would last longer than for fission (1) Detail: sensible remarks about U and H (1)	4
		(ii)	30 000 000 x 300 keV (in whatever units) (1) Conversion so that answer and reaction energy in the same units (i.e. 9 million MeV or equivalent e.g. $2.74\text{x}10^{-12}$ and $1.44\text{x}10^{-6}$ J) (1) Comment implying far less energy out than in (1)	3
		(iii)	7 x 1.66 x 10^{-27} seen (1) Answer [10^{16} / 7u] = $8.6\text{x}10^{41}$ (1)	2
		(iv)	Answer (iii) x 17.1 MeV (or its J equivalent 2.74 x 10^{-12}) (1) Tolerate slips in powers of 10; answer mark will be lost. previous answer / 5 x 10^{20} (regardless of mixed units) (1) Answer = $4.7\text{x}10^{9}$ (1)	3

Question			Marking details	Marks Available
	(b)	(i)	Area = 20 mm x 20 mm or implied (1) Including side-faces loses the mark. Temperature difference = 150 [°C] (1) Heat = 2 040 [W] (1) **ecf** on *A*, provided not a volume instead of an area	3
		(ii)	<u>Work</u> is done <u>on</u> the gas (1) Internal energy of the gas increases (no heat not required) (1) Freestanding mark i.e. accept if wrongly deduced, but only if link with temperature rise made.	2
		(iii)	Efficiency = $1 - \frac{T_2}{T_1}$ accept $\frac{Q_1 - Q_2}{Q_1}$ or $1 - \frac{Q_2}{Q_1}$ (1) T_1 is larger or $\frac{T_2}{T_1}$ is smaller Q_1 is larger or $\frac{Q_2}{Q_1}$ is smaller but these need an explanation e.g. because temperature is higher. If done by putting temperatures into formula, they must be in K. (1) Efficiency is greater in equation (not an independent mark i.e. valid earlier argument needed, ignoring °C instead of K) (1)	3
			Question total	**[20]**