GCE A LEVEL MARKING SCHEME

SUMMER 2024

A LEVEL
PHYSICS – COMPONENT 3
A420U30-1

About this marking scheme

The purpose of this marking scheme is to provide teachers, learners, and other interested parties, with an understanding of the assessment criteria used to assess this specific assessment.

This marking scheme reflects the criteria by which this assessment was marked in a live series and was finalised following detailed discussion at an examiners' conference. A team of qualified examiners were trained specifically in the application of this marking scheme. The aim of the conference was to ensure that the marking scheme was interpreted and applied in the same way by all examiners. It may not be possible, or appropriate, to capture every variation that a candidate may present in their responses within this marking scheme. However, during the training conference, examiners were guided in using their professional judgement to credit alternative valid responses as instructed by the document, and through reviewing exemplar responses.

Without the benefit of participation in the examiners' conference, teachers, learners and other users, may have different views on certain matters of detail or interpretation. Therefore, it is strongly recommended that this marking scheme is used alongside other guidance, such as published exemplar materials or Guidance for Teaching. This marking scheme is final and will not be changed, unless in the event that a clear error is identified, as it reflects the criteria used to assess candidate responses during the live series.

GCE A LEVEL PHYSICS

COMPONENT 3 – LIGHT, NUCLEI AND OPTIONS

SUMMER 2024 MARK SCHEME

GENERAL INSTRUCTIONS

The mark scheme should be applied precisely and no departure made from it.

Recording of marks

Examiners must mark in red ink.

One tick must equate to one mark (except for the extended response questions).

Question totals should be written in the box at the end of the question.

Question totals should be entered onto the grid on the front cover and these should be added to give the script total for each candidate.

Marking rules

All work should be seen to have been marked.

Marking schemes will indicate when explicit working is deemed to be a necessary part of a correct answer.

Crossed out responses not replaced should be marked.

Credit will be given for correct and relevant alternative responses which are not recorded in the mark scheme.

Extended response question

A level of response mark scheme is used. Before applying the mark scheme please read through the whole answer from start to finish. Firstly, decide which level descriptor matches best with the candidate's response: remember that you should be considering the overall quality of the response. Then decide which mark to award within the level. Award the higher mark in the level if there is a good match with both the content statements and the communication statement.

Marking abbreviations

The following may be used in marking schemes or in the marking of scripts to indicate reasons for the marks awarded.

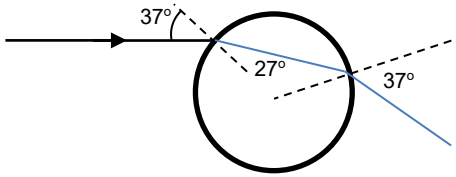
cao = correct answer only
ecf = error carried forward
bod = benefit of doubt

SECTION A

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
1	(a)		$c = f \times \lambda$ used (1) Wavelength calculated = $\frac{342}{550}$ = 0.62 [m] (1) Larger than gaps **OR** no solution to $n\lambda = d \sin \theta$ (1) Little amplitude transmitted **OR** waves not passing through small gaps **OR** wave is reflected (1) ACCEPT = full 180° diffraction ACCEPT = fairly constant intensity for all angles Treat "no diffraction" as neutral			4	4	2	
	(b)		Wavelength calculated = $\frac{342}{5550}$ = 0.062 [m] (1) Use of $n\lambda = d \sin \theta$ **OR** just calculating $\frac{d}{\lambda}$ **OR** $n_{\max}$ = 2.3 **OR** equivalent e.g. checking n = 2 and n = 3 (1) So n = -2, -1, 0, 1, 2 **OR** clear in diagram (1) Accept 2n+1 if n = 0 clear in (c) Accept 1 central and 2 either side statement	1	1 1		3	2	
	(c)		0° (1) $n\lambda = d \sin \theta$ rearranged e.g. $\sin \theta = \frac{n\lambda}{d}$ (1) 26° **AND** 60° (1)	1	1 1		3	3	
	(d)		**Any 2 × (1):** • Sound waves are longitudinal • Cannot be polarised • Only transverse can be polarised • Microwaves are transverse Correct conclusion on polariser based on some good physics e.g. "hence, nonsense" with one of the above points (1) Accept for 1 mark – "even though similar to microwave polariser, it won't work"			3	3		
			Question 1 total	**2**	**4**	**7**	**13**	**7**	**0**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
2	(a)		Sound {reflected / bounced} off wall **OR** 2 waves travelling in opposite direction (1) Interference / superpose (1) Waves similar amplitude **OR** same {frequency / wavelength} **OR** coherent **OR** identical waves (1)		3		3		
	(b)		Nodal separation is $\frac{\lambda}{2}$ (1) can be implied 25 nodal separations (1) Wavelength = 1.244 [m] (1) Frequency = 275 [Hz] (1) 286 [Hz] – 3 marks (26 separations) 550 [Hz] – 2 marks 572 [Hz] – 1 mark N.B. any attempt at $f = \frac{342}{\lambda}$ award 1 mark	1	1 1 1		4	2	
	(c)		**Indicative content** **Energy** Progressive propagates or equivalent Stationary confined / stores energy Progressive transfers energy Without transferring matter Stationary does not transfer energy **Amplitude** Progressive amplitude constant **OR** decreases with distance Stationary amplitude varies Stationary min / zero at node Stationary max at antinode Stationary amplitude doubles with constructive interference	6			6		

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
			Phase Progressive, lag / phase increases with distance Lag relationship with distance = $\frac{2\pi x}{\lambda}$ Stationary – all in phase within "loop" Stationary – adjacent "loops" in antiphase Nodes separated by $\frac{\lambda}{2}$ **5-6 marks** Comprehensive description of all 3 areas. *There is a sustained line of reasoning which is coherent, relevant, substantiated and logically structured.* **3-4 marks** Basic description of all 3 **OR** comprehensive description of 2 **OR** comprehensive of 1 and basic / limited of the other 2. *There is a line of reasoning which is partially coherent, largely relevant, supported by some evidence and with some structure.* **1-2 marks** Basic description of 1 or 2 **OR** comprehensive description of 1 *There is a basic line of reasoning which is not coherent, largely irrelevant, supported by limited evidence and with very little structure.* **0 marks** *No attempt made or no response worthy of credit.*						
			Question 2 total	**7**	**6**	**0**	**13**	**2**	**0**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
3	(a)	(i)	Use of Snell's Law (1) Not 1.33 sin 37 27° (26.9°) (1)	1	1		2	1	
		(ii)	 1st refracted ray (1) 2nd refracted ray (1) no ecf on bad physics Angles correctly labelled i.e. 2nd 37° and one 27° (1)		3		3		
	(b)	(i)	$\text{angle} = 81.3°$ (1) Correct substitution into Snell's **OR** correct substitution to obtain critical angle (1) (using sin 8.7 loses both these first marks) i.e. $1.56 \sin 81.3$ (**ecf**) $= 1.49 \sin X$ **OR** $1.56 \sin X = 1.49 \sin 90$ Impossible because >1 **OR** impossible because greater than critical angle (72.8°) (1) N.B. not $\theta_2 > \theta_C$ must be incident angle Accept θ_2 = Math error	1	1 1		3	2	
		(ii)	Zig-zag path longer than straight through (1) i.e. **Distance** point [Different routes] taking different times [to pass through fibre] (1) i.e. **time** point Pulses will spread / overlap (1) Accept – data in wrong order / muddled up Not – "dispersion", messed up, distorted	3			3		
		(iii)	Thin optical fibres [~ λ] (1) Only one propagation direction / single mode / monomode propagates along axis (1)	2			2		
			Question 3 total	**7**	**6**	**0**	**13**	**3**	**0**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
4	(a)			Greater intensity linked to more <u>photons</u> (1) Greater intensity linked to more [emitted] electrons **OR** more photons linked to more electrons (1) Current is rate of flow of charge **OR** just linking the electron emission to the current (1) Beware reverse argument valid: Greater current – means more electrons (1) More electrons produced by more photons (1) More photons produced by greater intensity (1)	1	1 1		3		
	(b)			Wavelength / frequency / photon energy (1) Pd / voltage (1) Accept: background lighting / darkness Don't accept temperature			2	2		2
	(c)	(i)		Use of $E = \frac{1}{2}mv^2$ (6.9×10^{-20} J or 0.43 eV) (1) Substitution into Einstein's equation (1) Correct answer = 2.6 [eV] **or** 4.2×10^{-19} J (1) **unit mark**	1 1	1		3	3	
		(ii)		Assumption e.g. all / % of photons providing conduction electrons **OR** any reference to quantum efficiency (1) Photon energy = 4.85×10^{-19} [J] (1) Current = 0.12 μ[A] (or 0.12 μ[A] × efficiency (1) Use of photon energy = 4.2×10^{-19} J leading to 0.14 μ[A] gets 1 of the last 2 marks		3		3	2	
	(d)			Reference to wave-particle duality or equivalent (1) Duality has been adopted (1) Huge body of evidence / [many] more experiments (1) (not just repeats)			3	3		
				Question 4 total	**3**	**6**	**5**	**14**	**5**	**2**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
5	(a)		Throw all / the coins (1) Count all heads (or tails / converse / obverse) (1) Remove the unwanted coins (1) Throw again a number of times (1)	4			4		4
	(b)	(i)	1 [throw]		1		1	1	1
		(ii)	Taking logs e.g. $\ln N = \ln N_0 - \lambda T$ (1) accept taking logs of other valid equations Comparing with $y = mx + c$ and gradient is $-\lambda$ (1) And $\lambda = \frac{\ln 2}{T} = \ln 2$ (1) i.e. showing that $\lambda = \ln 2$		3		3	3	3
	(c)		Straight line (1) Through all error bars (1) accept through all points Gradient (closely agrees with) -$\ln 2$ (1) Intercept linked to $\ln N_0$ **OR** using final equation (1) $e^{9.1913} = 9811$ **OR** $e^{8.5339} = 5084$ **OR** comparing equation with table (1) Intercept agrees (quite well) (1)			6	6	3	6
	(d)	(i)	Attempt at using $4 \times \sqrt{\text{activity}}$ (1) = 49.5 (1)	1	1		2	2	2
		(ii)	Calculating one point of error bar (middle, top or bottom) e.g. $e^{5.29} = 198$, $e^{5.3} = 200$, $e^{5.28} = 196$, $e^{4.6} = 99$, $e^{4.95} = 141$ **OR** $\frac{49}{153}$ (1) Calculating 2nd point of error bar **OR** ± 0.32 (1) Conclusion correct e.g. about right **OR** slightly out (1)			3	3	2	3
		(iii)	Decrease in size (1) Because A or $\sqrt{A}$ decreases **OR** calculating 2nd uncertainty (1)			2	2	1	2
			Question 5 total	**5**	**5**	**11**	**21**	**12**	**21**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
6			Baryon number: 26 +0 = 26 (1) Charge number: 13 -1 = 12 (1) **not** 13-13-1 = 12-12 Lepton number wrong **or** 0+1 = 0 (1) **not** 13+1 = 12 Must have [electron] neutrino on RHS but accept anti-electron neutrino on LHS (1) Must be weak force (1) **If both:** Charge: 13-13-1 = 12-12 Lepton: 13+1 =12 Only penalise once If reduced to uud + e = udd, 1st 3 marks: Baryon: 1+0 = 1 (1) Charge: 1-1 = 0 (1) Lepton: 0+1 = 0 (1) If reduced to u + e = d, 1st 3 marks: Baryon: $\frac{1}{3}+0=\frac{1}{3}$ (1) Charge: $\frac{2}{3}-1=-\frac{1}{3}$ (1) Lepton: 0+1 = 0 (1)		5		5		
			Question 6 total	**0**	**5**	**0**	**5**	**0**	**0**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
7	(a)		Use of $B = \mu_0 nI$ (1) $n = \frac{22\,000}{0.430}$ (1) Answer = 0.905 [A] (1) Award 1 mark for 2.1 [A], 4.9 [A]	1	1 1		3	3	
	(b)	(i)	Force on {charge carriers / electrons} in mag field **OR** FLHR **OR** B-field implied as reason for force on electrons (1) {Charge carriers / electrons} move to one side linked to pd **OR** E-field i.e. charge buildup linked to pd or E (1) Force is up (can be implied by electron build up on top surface) **OR** equilibrium between electric and magnetic forces (1)	3			3		
		(ii)	$eE = Bev$ **OR** $V = Blv$ **OR** $E = Bv$ **OR** similar valid start point (1) Answer = 44 μ[V] (4.4×10^{-5} [A]) (1)		2		2	2	
		(iii)	**Any 2 × (1) from:** • Place probe at centre • Orientate for max pd **OR** orientate so that face perpendicular to B-field • Allow [re-]calibrate the probe			2	2		2
			Question 7 total	**4**	**4**	**2**	**10**	**5**	**2**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
8	(a)		Change of flux in tube **OR** magnetic field lines cut by tube (1) EMF induced (1) Current induced (1) Field due to current opposes motion **OR** equivalent Lenz comment (1) Magnetic force equal [and opposite] to <u>weight</u> (1)		5		5		
	(b)		Area = $\pi r_2{}^2 - \pi r_1{}^2$ (1) Substitution into: mass = density × volume (1) Mass = 0.263 [kg] (1) N.B. award 2 marks for 1.05 kg (using diameter instead of radius)	1	1 1		3	3	
	(c)		Substitution for GPE : 0.325 × 9.81 × 1.205 (1) $mgh = mc\Delta\theta$ (1) (allow even if slight mix-up in the masses) Temperature rise = 0.038 [K] (1) **ecf** on mass (expect 0.0094 K for 1.05 kg for full marks) N.B. $mg = mc\Delta\theta$ can't gain any marks	1	1 1		3	2	
			Question 8 total	**2**	**9**	**0**	**11**	**5**	**0**

SECTION B

Option A – **Alternating Currents**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
9	(a)	(i)	Use of $P_{\text{mean}} = \frac{V_0 I_0}{2}$ [or by implication] (1) V_0 = 4.0 [V] **and** I_0 = 5.0 m[A] [reading from graph] (1) P_{mean}= 10 m[W] [= 0.010 W] (1) **Alternative 1** Use of $P_{\text{mean}} = I_{\text{rms}} \times V_{\text{rms}}$ [or by implication] (1) V_{rms} = 2.8[3] [V] **or** I_{rms} = 3.4[3] m[A] (1) P_{mean} = 10 m[W] [= 0.010 W] (1) **Alternative 2** Use of $P_{\text{mean}} = I_{\text{rms}}^2 R$ [or by implication] (1) I_{rms} = 3.4[3] m[A] **or** R = 800 [Ω] P_{mean}= 10 m[W] [= 0.010 W] (1) **Alternative 3** Use of $P_{\text{mean}} = \frac{V_{\text{rms}}^2}{R}$ [or by implication] (1) V_{rms} = 2.8[3] [V] **or** R = 800 [Ω] P_{mean}= 10 m[W] [= 0.010 W] (1)	1	1 1		3	3	
		(ii)	Use of $E = Pt$ (1) $E = 0.01 \times 0.02 = 2 \times 10^{-4}$ [J] (1) (allow **ecf** on P)	1	1		2	1	

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
		(iii)	Use of $f = \frac{1}{T}$ (1) [gives 50 Hz] (or equivalent method) $\times$ 2 to give final answer of 100 (because it occurs twice per cycle) (1)	1	1		2	2	
	(b)		Current lags voltage by $\frac{\pi}{2}$ **OR** voltage leads current by $\frac{\pi}{2}$ (also accept 90°, $\frac{T}{4}$ or $\frac{1}{4}$ cycle)			1	1		
	(c)	(i)	Vectors at right angles (1) X_L **OR** V_L leading $\frac{\pi}{2}$ (1) Z labelled (or Pythagoras stated) OR clear algebra seen using pds and cancelling out the current (1)	3			3		
		(ii)	Adding inductor changes / increases Z (1) Changes / decreases I_{rms} (1) $P = I^2R$ or implied (1) Power changed / decreased ∴ Morgan is incorrect (1) **Alternative:** Adding inductor changes / decreases V_R (1) Because not V_{supply} any longer or something equivalent (1) $P = \frac{V^2}{R}$ or implied (1) Power changed / decreased and Morgan is incorrect (1) **Alternative:** At low frequency reactance is small (1) Hence Morgan is correct (at low frequency) (1) At high frequency reactance is large (1) Power decreased and Morgan wrong (1)			4	4		

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
	(d)	(i)	$I = \frac{12}{110}$ (1) = 0.11 [A] (1)		2		2	2	
		(ii)	$X_C = \frac{24}{0.11} = 220\ [\Omega]$ (1) **ecf** on current from d(i) $X_C = \frac{1}{2\pi fC}$ (1) $C = 1.21 \times 10^{-5}\ [\mathrm{F}]$ (1) N.B. **ecf** on 2nd and 3rd marks for use of 16 V		3		3	2	
			Question 9 total	**6**	**9**	**5**	**20**	**10**	**0**

Option B – **Medical Physics**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
10	(a)	(i)	Electrical to internal/heat (1) Electrical to KE (1) Heat/internal and X-rays at the target (accept light for X-ray) (1)	3			3		
		(ii)	$c = f\lambda$ rearranged to $f = \frac{c}{\lambda}$ (1) f = 6.25 × 10^{18} [Hz] (1)		2		2	2	
		(iii)	E_{max} = eV (1) E_{max} = 4 ×10^{-15} [J] (1)	1	1		2	2	
		(iv)	Rearrange $hf = eV$ to $h = \frac{eV}{f}$ (1) **ecf** h = 6.4 × 10^{-34} [J s] (1)		2		2	2	
	(b)		X – ray no as they do not image soft tissue (1) MRI could be used but expensive / time consuming (1) Ultrasound yes quick to use and Doppler shift will detect change in rate of blood flow (1) Fluoroscopy will show up clots and is (relatively) inexpensive / quick OR needs iodine/contrast medium (1) CT scans not good at detecting soft tissue/moderate definition of soft tissue (1)			5	5		

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
	(c)		Activity of I-125 does not change OR HSA is thoroughly mixed **and** dilution factor = $\frac{160}{0.020}$ = 8 000 (1) Volume of blood = 8 000 × 0.6 = 4 800 [ml] (1)		2		2	2	
	(d)	(i)	Equivalent dose (H) = DW_R where W_R is the radiation weighting factor and D is the energy absorbed per unit mass (1) effective dose = HW_T where W_T is the tissue weighting factor (1)	2			2		
		(ii)	Rearrangement: $W_T = \frac{E}{H}$ or $W_T = \frac{2.2 \text{ x } 10^{-3}}{0.22}$ (1) = 0.01 (1)		2		2	2	
			Question 10 total	**6**	**9**	**5**	**20**	**10**	**0**

Option C – **The Physics of Sports**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
11	(a)	(i)	Legs apart / wide base (1) Low centre of gravity (1)	2			2		
		(ii)	Using drag force F = $\frac{1}{2}C_D\rho Av^2$(1) Assume $C_D\rho$ or C_D remains constant or equivalent e.g. other factors won't change much as skier crouches a little lower (1) 0.85×1.25^2 or equivalent seen (1) $1.33 \times$ increase (1)	1	1 1 1		4	3	
		(iii)	Using $F = \frac{mv-mu}{t}$ (1) Therefore the force exerted by the barrier on the skier = 2 000 (or 2 022) [N] (1)	1	1		2	1	
	(b)	(i)	Using rotational kinetic energy $= \frac{1}{2}I\omega^2$ (1) MoI (= $0.5 \times 0.160 \times (0.04)^2$ =) 0.000128 [kg m^2] (1) Final answer = 143 [rad s^{-1}] (1)	1	1 1		3	2	

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
		(ii)	Vertical comp = 9.72 [m s^{-1}] **or** horizontal = 20.8 (1) OR implied Applying $s = ut + ½\,at^2$ (1) OR implied Time to reach goal = $\frac{15}{20.8}$ = 0.72 [s] OR calculating times to reach 1.2m (0.130 and 1.847s)(1) Height = $9.72 \times 0.72 - 0.5 \times 9.81 \times 0.72^2$ = 4.45 [m] OR obtaining horizontal distances at these times (2.70m and 38.5m) (1) Allow **ecf** on t (Far) too high for the goal of height 1.2 [m] (1)			5	5	4	
	(c)		Angular momentum $= I\omega$ (or word equivalent) (1) Moment of inertia is reduced [as skater pulls in his arms] (1) Cons. of angular momentum applied correctly (or stated) (1) Angular velocity increases hence correct (1)	1	1 1 1		4		
			Question 11 total	**6**	**9**	**5**	**20**	**10**	**0**

Option D – **Energy and the Environment**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
12	(a)	(i)		'Object wholly or partially immersed' **OR** 'object in a fluid' (1) 'force upwards / upthrust / buoyancy force equal [and opposite] to weight of the fluid displaced' (1)	2			2		
		(ii)		Weight of ice cube = $\rho\, V_{\text{total}}\,[g] = 920 \times V \times [9.81]$ (1) Upthrust = $1020 \times V_{\text{immersed}} \times [g]$ (1) $\frac{V_{\text{immersed}}}{V_{\text{total}}} = 0.90$ (1)		3		3	3	
	(b)	(i)		$\frac{154}{P_{\text{max from wind}}} \times 100 = 42\%$ leading to $P_{\text{max from wind}}$ = 367 k[W] (1) allow tolerance of ± 2 kW on output power Use of $P = \frac{1}{2}\rho A v^3$ (1) A = 612 [m^2] (1) **ecf** on P d = 28 [m] (1) **ecf** on A	1	1 1 1		4	3	
		(ii)		**Any 2 × (1) from:** • Not all KE of incoming wind transferred rotor / turbine • Exiting air has KE • Friction [of mechanical parts] in the turbine or equivalent		2		2		
		(iii)		$\frac{59\times10^6}{200\times10^3} = 295$ wind turbines		1		1		
		(iv)		High temperatures needed to allow nuclei to {overcome repulsion / allow strong force interaction} (1) High particle density for large collision rate / increased collisions (1) A long enough [confinement] time to allow fuel to maintain internal energy (1)	3			3		

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(c)			$\frac{\Delta Q}{\Delta t}$ same through 3 layers (1) Use of $\frac{\Delta Q}{\Delta t} = [-]\, KA\frac{\Delta\theta}{\Delta x}$ e.g. $\frac{0.18\times[A]\times(7.0-\Delta\theta_{\text{brick}})}{30[\times10^{-3}]} = \frac{0.55\times[A]\times\Delta\theta_{\text{brick}}}{110[\times10^{-3}]}$ or $\frac{0.18\times[A]\times(\Delta\theta_{\text{plaster}})}{30[\times10^{-3}]} = \frac{0.55\times[A]\times(7-\Delta\theta_{\text{plaster}})}{110[\times10^{-3}]}$ or equivalent (1) Calculation of suitable $\Delta\theta$ i.e. $\Delta\theta_{\text{brick}}$ = 3.8 °C or $\Delta\theta_{\text{plaster}}$ = 3.2 °C for 2 layers or 1.6 °C for 1 layer (1) $\frac{\Delta Q}{\Delta tA}$ for brick $= \frac{0.55\times3.82}{110\times10^{-3}}$ or $\frac{\Delta Q}{\Delta tA}$ for plaster $= \frac{0.18\times3.2}{30\times10^{-3}}$ or $= \frac{0.18\times1.6}{15\times10^{-3}}$ (1) = 19 [W m^{-2}] so Charlene is correct (1) **Alternative 1:** $\frac{\Delta Q}{\Delta t}$ same through 3 layers (1) can be implied $\frac{K}{\Delta x}$ or $\frac{\Delta x}{K}$ calculated for 1 layer (1) ($\frac{K}{\Delta x}$ =12, 5, 12 [W m^{-2} K^{-1}] or $\frac{\Delta x}{K} = \frac{1}{12}, \frac{1}{5}, \frac{1}{12}$ [W^{-1} m^2 K^1]) U = 2.7 or $R = 0.37$ (1) $\frac{\Delta Q}{\Delta tA} = U\Delta\theta$ = 2.7 × 7 or equivalent (1) = 19 [W m^{-2}] so Charlene is correct (1) **Alternative 2:** $\frac{\Delta Q}{\Delta t}$ same through 3 layers (1) can be implied Use of 19 in $\frac{\Delta Q}{\Delta tA} = K\frac{\Delta\theta}{\Delta x}$ for plaster or brick (1) Temperature difference across plaster = 1.6 [°C] (1) Temperature difference across brick = 3.8 [°C] (1) Add temperature differences i.e. 1.6 + 3.8 + 1.6 = 7.0 [°C] so Charlene is correct (1)			5	5	4	
				Question 12 total	**6**	**9**	**5**	**20**	**10**	**0**

A LEVEL COMPONENT 3: LIGHT, NUCLEI and OPTIONS

SUMMARY OF ASSESSMENT OBJECTIVES

Question	AO1	AO2	AO3	TOTAL MARK	MATHS	PRAC
1	2	4	7	13	7	0
2	7	6	0	13	2	0
3	7	6	0	13	3	0
4	3	6	5	14	5	2
5	5	5	11	21	12	21
6	0	5	0	5	0	0
7	4	4	2	10	5	2
8	2	9	0	11	5	0
9	6	9	5	20	10	0
10	6	9	5	20	10	0
11	6	9	5	20	10	0
12	6	9	5	20	10	0
TOTAL	**36**	**54**	**30**	**120**	**49**	**25**