GCE A LEVEL MARKING SCHEME

SUMMER 2022

A LEVEL
PHYSICS – COMPONENT 1
A420U10-1

INTRODUCTION

This marking scheme was used by WJEC for the 2022 examination. It was finalised after detailed discussion at examiners' conferences by all the examiners involved in the assessment. The conference was held shortly after the paper was taken so that reference could be made to the full range of candidates' responses, with photocopied scripts forming the basis of discussion. The aim of the conference was to ensure that the marking scheme was interpreted and applied in the same way by all examiners.

It is hoped that this information will be of assistance to centres but it is recognised at the same time that, without the benefit of participation in the examiners' conference, teachers may have different views on certain matters of detail or interpretation.

WJEC regrets that it cannot enter into any discussion or correspondence about this marking scheme.

GCE A LEVEL PHYSICS

COMPONENT 1 – NEWTONIAN PHYSICS

SUMMER 2022 MARK SCHEME

GENERAL INSTRUCTIONS

Recording of marks

Examiners must mark in red ink.

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

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)	(i)		Vertical arrow with tail near, or passing through, centre of plank	1			1		
		(ii)		Taking moments about B or equivalent stated (1) [Anticl] moment of wt = $1.00\ \text{m} \times \cos 55° \times 232\ \text{N} = [133\ \text{N m}]$ or by implication from moments equation below (1) $2.00\ \text{m} \times \sin 55° \times H = 1.00\ \text{m} \times \cos 55° \times 232\ \text{N}$ or equiv (1) $H = 81$ [N] (1)	1 1 1	1		4	3	
		(iii)		Horiz comp = 81 (or 80) N [left], Vert comp = 232 N [up] (1) Magnitude of P = 245 [N] [or 246 N] **ecf** (1) Direction = 71° [or 109°] to horizontal or equivalent **ecf** (1)		3		3	2	
	(b)			232 [× 1.00] cos 45° = H [× 2.00] sin 45° **or** equiv **or** by implic(1) H = 116 [N] (1) so [friction of] 116 [N] (**ecf**) needed and e.q. impossible (**ecf**) (1) **Alternative:** $90\,\text{N} \times 2\,\text{m} \times \sin\theta = 232\,\text{N} \times \frac{2\text{x}\cos\theta}{2}$ (1) $\theta = 52°$ (1) A smaller angle would need more friction than 90 N (1)	1	1 1		3	2	
				Question 1 total	**5**	**6**	**0**	**11**	**7**	**0**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
2	(a)			$F = Ma$ in which $F = mg$ (1) or equivalent Accept $mg = Ma$		1		1		1
	(b)			Lines of greatest and least gradient drawn (accept inaccuracies) and gradients calculated (accept inacc) (1) Maximum gradient between 6.55 and 6.95 [m s^{-2} kg^{-1}] (1) Minimum gradient between 5.80 and 6.20 [m s^{-2} kg^{-1}] (1) [Accept 2 or more significant figures.] Mean gradient = 6.4 [m s^{-2} kg^{-1}] **ecf and** ± 5 % **ecf** or by implic from M and unc in M (1) M = (1.53 (1) ± 0.09 (1)) [kg] **ecf** or (1.5 ± 0.1) [kg] **ecf** 1 mark penalty to cover all sig fig faults in answers			6	6	4	6
	(c)			Release trolley from rest and time how long it takes to travel a measured distance, x (1) Use clock started by interruption of one light beam and stopped by another. Accept stopwatch (1) Use $a = \frac{2x}{t^2}$. Accept $x = \frac{1}{2}at^2$ (1) **Alternative** Release trolley from rest and determine velocity after travelling distance x, or after time t (1) Determine velocity with card of length Δl interrupting light beam for time Δt so $v = \frac{\Delta l}{\Delta t}$ Accept use of a light gate (1) Calculate acceleration from $a = \frac{v^2}{2x}$ or equiv or $a = \frac{v - 0}{t}$ (1)	3			3		3
				Question 2 total	**3**	**1**	**6**	**10**	**4**	**10**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
3	(a)	(i)		The [vector] sum (or total) of [interacting] bodies' momenta remains constant (1) provided no external forces act on them / isolated system (1)	2			2		
		(ii)	I	$0.150 \times 2.40 = 0.300 \times 1.40 + 0.150\ v$ **or** equiv **or** by impl. (1) $v = -0.40$ [m s^{-1}] (1) Statement that 0.150 kg disc reverses direction or equiv **ecf** (1)	1	1 1		3	2	
			II	Gain in KE = $\frac{1}{2} \times 0.15 \times 0.40^2 + \frac{1}{2} \times 0.30 \times 1.40^2 - \frac{1}{2} \times 0.15 \times 2.40^2$ (1) **or** equivalen**t or** by implication, **ecf** on 0.40 m s^{-1} = -0.126 [J] (1)	1	1		2	1	
			III	[Kinetic] energy 'lost' to internal (accept thermal, heat) or e.q. (1) Internal (or thermal) in discs or heat to surroundings (1)	2			2		
	(b)			**Energy method**: Grav PE lost = $mgl \sin 25°$ (1) $mgl \sin 25° = \frac{1}{2}mv^2$ with either v = 2.40 m s^{-1} or l = 0.7 m (1) [**or Force method**: Force [comp't] down slope = $mg \sin 25°$ or by implication (1) so $v^2 = 2lg \sin 25°$ with either v = 2.40 m s^{-1} or l = 0.7 m (1)] If v = 2.40 m s^{-1} then l = 0.69 m (1) [**or** if l = 0.7 m then v = 2.40 m s^{-1}] A *longer* descent needed because of [energy wasted as work is done against] friction **or** 0.7 m is fine if slope is smooth (1)			4	4	2	4
				Question 3 total	**6**	**3**	**4**	**13**	**5**	**4**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
4	(a)			Object is accelerating [or velocity changing] because direction [of travel] [continuously] changing (1) [Resultant] force needed to give object an acceleration **or** a velocity change [or $F = ma$ cited] (1)	2			2		
	(b)	(i)		Force = $450 \times 10^6 \times \pi \times 0.0006^2$ [N] (1) [Tolerate slips in powers of 10 or factors of 2 or 4 for this mark only] = 509 N or 510 N [N] (1)	1	1		2	1	
		(ii)		Insertion of values for F, m, and r into $F = \frac{mv^2}{r}$ **or** $F = mr\omega^2$ or by implication (1) $v = \sqrt{\frac{509 \times 0.250}{0.200}}$ [= 25.2 m s^{-1}] **or** $\omega = \sqrt{\frac{509}{0.200 \times 0.250}}$ [= 101 rad s^{-1}] or by implication (1) f = 16 [Hz] **ecf** on v or ω (1)	1 1	1		3	2	
		(iii)	I	Mass of rod ignored **or** stretching of rod ignored [or any other significant assumption or factor ignored]		1		1		
			II	Mass of rod makes greatest rotation rate smaller **or** more stress on [inner part] of rod [for a given rotation rate] **or** stretching makes greatest rotation rate smaller **or** more stress for a given rotation rate.			1	1		
				Question 4 total	**5**	**3**	**1**	**9**	**3**	**0**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
5	(a)			Spring constant for two in series = $\frac{k}{2}$ (1) or by implication $T_2 = 2\pi\sqrt{\frac{2m}{k/2}}$ **or** equiv seen (1) **ecf** on k or $2k$ instead of $\frac{k}{2}$ $\frac{T_2}{T_1} = 2$ or equiv (1) [*No* ecf and *not* freestanding]	1	1 1		3	2	
	(b)	(i)		$\omega = \frac{2\pi}{1.20}$ [s^{-1}] = 5.24 s^{-1}or by impl (1) $v_{\max} = 0.030\ [\text{m}] \times 5.24\ [\text{s}^{-1}]$ (1) [$= 0.16\ \text{m s}^{-1}$]		2		2	2	2
		(ii)		Sinusoid of period 1.2 s and peak value 0.16 m s^{-1} (1) Correct phase: inverted sine (1) N.B. one complete wave is sufficient	1	1		2	1	1
		(iii)		$v = -A\omega\sin\omega t = -0.157\sin\left(\frac{2\pi}{1.20} \text{ x } 3.50\right)$ (1) v = 0.079 [m s^{-1} upwards] (1) [Accept 0.08 m s^{-1}] **Alternative:** $v = -0.03 \times \frac{2\pi}{1.20} \times \sin\left(\frac{2\pi}{1.20} \times 3.50\right)$ [m s^{-1}] or equv or by impl(1) v = 0.079 [m s^{-1} upwards] (1) [Accept 0.08 m s^{-1}] **Alternative:** Speed the same as at 1.1 s and 2.3 s (1) Speed = 0.08 [m s^{-1}] **ecf** on graph (1)	1	1		2	1	1

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
		(iv)		1.67 Hz shown to be twice the oscillation frequency or equivalent (1) This is right because v^2 has two [equal] positive peaks per oscillation cycle **or** equivalent (1)			2	2		2
	(c)	(i)		Attach piece of paper or similar. Accept surround with liquid			1	1		1
		(ii)		At least one ratio of successive amplitudes evaluated correctly (0.80, 0.79, 0.79 **or** 1.25, 1.26, 1.27) (1) Ratios compared and reasonable conclusion drawn (1) **Alternative:** Logs taken to any base (1) Δ (log A) shown to be almost equal (1)			2	2	2	2
	(d)			Car suspensions: suppresses [number of] oscillations (accept bounces) [caused by bumps etc in road surface] (1) Suspension bridges: Reduces amplitude of oscillations caused by pedestrians walking [Accept wind] (1) Further detail: e.g. bridge resonance with footfalls **or** car: mainly free oscs; but bridge: mainly forced oscs or critical damping reference for the car (1)			3	3		
				Question 5 total	**3**	**6**	**8**	**17**	**7**	**9**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
6	(a)			$\text{Pressure} = \frac{\text{[magnitude of normal]] force}}{\text{area [over which force acts]}}$	1			1		
	(b)	(i)		Ratio = 1.00 (accept 1) (or pressures are the same) (1) [Freestanding mark unless reasoning clearly wrong] Reasoning spelt out, e.g. because n, V, T the same in $pV = nRT$ or equivalent (1)		2		2		
		(ii)		Ratio = 0.94 [Accept 0.93 or 0.935 or $\sqrt{\frac{7}{8}}$ or equivalent] (1) Reasoning clearly based on $\frac{1}{2}m\overline{c^2} = \frac{3}{2}kT$ or $\left(\frac{1}{2}m\overline{c^2}\right)_{O2} = \left(\frac{1}{2}m\overline{c^2}\right)_{N2}$ (1)		2		2	1	
	(c)	(i)		$\overline{c^2} = \frac{3\times2.5\times10^{16}}{1.6\times10^{5}}$ [$= 4.69 \times 10^{11}$ m^2 s^{-2}] (1) [transp & subst] c_{rms} = 6.8 × 10^5 [m s^{-1}] (1)		2		2	1	
		(ii)		**Any 2 × (1) from:** • Particles take up space **or** little space between particles • Forces between particles not negligible • More than one sort of particle present **or** accept: no molecules at the centre of the Sun • Collisions likely to be inelastic	2			2		
				Question 6 total	**3**	**6**	**0**	**9**	**2**	**0**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
7	(a)			$T_{\mathrm{A}} = \frac{120000 \times 0.020}{0.90 \times 8.31}$ [K] **or** $T_{\mathrm{X}} = \frac{120000 \times 0.060}{0.90 \times 8.31}$ [K] (1) or by impl $T_{\mathrm{A}} = 321$ K (1) $T_{\mathrm{X}} = 963$ K (1) **unit (max penalty–1)**	1	1 1		3	2	
	(b)			W = 120 000 × 0.040 J (1) [Tolerate wrong powers of 10] W = 4.8 k[J] (1)	1	1		2	1	
	(c)			**Indicative content:** **AY compared to AX** **WORK -** Less work done by the gas as area under curve smaller. ***U*** - No change in *U* as temperature constant ... whereas for AX *U* increases as temperature increases. **HEAT -** Heat input less than for AX from first law of thermodynamics. Specifically because both W and ΔU less than for AX **AZ compared to AX** **WORK -** Less work done by the gas as area under curve smaller. Even less work than for AY ***U*** - *U* decreases according to 1st law of thermodynamics, specifically because work is done but no heat in. [But for AX, *U* increases, as temp increases]. Decrease in *U* corresponds to *drop* in temperature	2	4		6		

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
				5-6 marks Comprehensive description of both AY and AZ *There is a sustained line of reasoning which is coherent, relevant, substantiated and logically structured.* **3-4 marks** Comprehensive description of either AY or AZ **OR** limited description of both AY and AZ *There is a line of reasoning which is partially coherent, largely relevant, supported by some evidence and with some structure.* **1-2 marks** Limited description of either AY or AZ. *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 7 total	**4**	**7**	**0**	**11**	**3**	**0**

SECTION B

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
8	(a)		$\lambda \propto \frac{1}{f}$ **OR** $\lambda = \frac{c}{f}$ (1) As frequency increases, wavelength decreases (implies 1st mark) **OR** $\Delta\lambda$ and Δf must be opposite sign (1)		2		2	1	
	(b)	(i)	Photon is blue shifted to higher frequency (456 000.6 GHz) can be implied by calculation (1) Which is right for (resonant) absorption / correct frequency (1)		2		2		
		(ii)	Red-shifted away from correct frequency		1		1		
		(iii)	Only photons that slow the atoms down are absorbed / only atoms that collide head on will slow down		1		1		
	(c)		Substitution into $\frac{v}{c} = \frac{\Delta\lambda}{\lambda}$ i.e. $\frac{1350}{3\times10^8} = \frac{\Delta\lambda}{587.56148}$ (1) $\Delta\lambda = 0.00264[4]$ nm no s.f. penalty (1) Good attempt at modifying the wavelength (i.e. even accept decreasing wavelength i.e. 587.56148 - 0.002644 = 587.55884 nm) (1) $\lambda = 587.56412$ nm (all correct & needs 8 s.f.)) (1)	1	1 1 1		4	3	
	(d)		Wavelength obtained (658 nm) or implied by final answer (1) Momentum of photon obtained (1.01×10^{-27}) or implied (1) Conservation of momentum applied correctly e.g. $400 \times 40u - p_{photon} = 40u \times v$ (accept $\frac{1.01\times10^{-27}}{40\,u}$) (1) Answer correct 0.015177 or 399.9848 (1) Penalise single arithmetic slip by 1 mark only		4		4	3	

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
	(e)		Attempt at dividing by 10^{-9} e.g. $\frac{10^{-3}}{10^{-9}} = 10^{6}$ absorptions possible **OR** even 10^{9} absorptions per second OK **OR** mean time between photons if 26 000 in 1 ms = 38 ns (1) Comparison/calculation of with $\frac{50\,\text{mW}}{hf}$ (1.65×10^{17} photons / s) (1) Hence, seems feasible i.e. conclusion linked to a number of absorptions **or** the short lifetime **or** the large number of photons per second (1) 3rd mark is **independent** as long as link is made e.g. this seems possible because the lifetime is so short.			3	3	2	
	(f)		Substitute 1.5 cm s^{-1} into equation 2 (1) Temperature answer i.e. $T = \frac{m\overline{c^2}}{3k} = 0.36\ \mu\text{K}$ (1) Conclusion linked to correct answer (1)			3	3	1	
			Question 8 total	**1**	**13**	**6**	**20**	**10**	**0**

A LEVEL COMPONENT 1: NEWTONIAN PHYSICS

SUMMARY OF MARKS ALLOCATED TO ASSESSMENT OBJECTIVES

Question	AO1	AO2	AO3	TOTAL MARK	MATHS	PRAC
1	5	6	0	11	7	0
2	3	1	6	10	4	10
3	6	3	4	13	5	4
4	5	3	1	9	3	0
5	3	6	8	17	7	9
6	3	6	0	9	2	0
7	4	7	0	11	3	0
8	1	13	6	20	10	0
TOTAL	**30**	**45**	**25**	**100**	**40**	**23**