GCE A LEVEL MARKING SCHEME

SUMMER 2019

A LEVEL
PHYSICS - COMPONENT 1
A420U10-1

INTRODUCTION

This marking scheme was used by WJEC for the 2019 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.

A LEVEL COMPONENT 1 – NEWTONIAN PHYSICS

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.

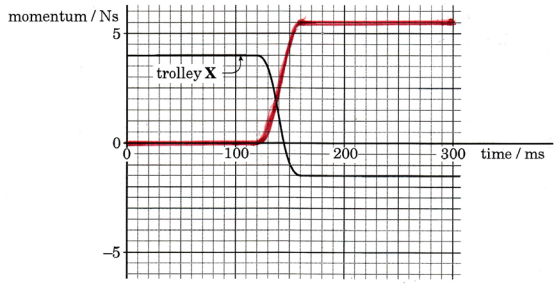
cao = correct answer only
ecf = error carried forward
bod = benefit of doubt

SECTION A

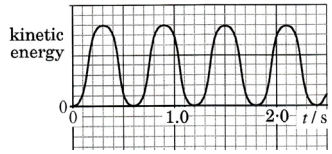
Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
1	*(a)*	(i)		Constant horizontal velocity if/because no horizontal force [1] That is if air resistance ignored **or** air resistance would/will make horizontal velocity decrease [1]	2			2		
		(ii)		From horiz motion, e.g. $t = \frac{6.0}{9.0}$ = 0.667 [s] [1] So from vertical motion, $y = \frac{1}{2} 9.81 \times \left(\frac{6.0}{9.0}\right)^2$ = 2.18 [m] **ecf on *t*** [1] Conclusion consistent [1] **Alternative:** From vertical motion, e.g. $t = \sqrt{\frac{2 \text{ x } 2.2}{9.81}}$ = 0.67[0] [s] **ecf on *t*** [1] From horiz motion, $v_h = \frac{6.0}{0.67}$ = 8.96 [m s^{-1}] **ecf on *t*** **or** x = 9.0 × 0.67 = 6.03 [m] [1] Conclusion consistent [1] **Alternative**: Time from horiz motion = 0.67 [s] [1] Time from vertical motion = 0.67 [s] [1] Conclusion consistent [1]			3	3	2	

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(b)			Vertical velocity component, v_v = 6.5 [m s^{-1}] or 6.6 [m s^{-1}] [1] Diagram showing v_v, v_h and v_{res} **or by implication if correct answer** [1] Angle to horiz = 36° or angle to vertical = 54° [1] **ecf** on v_v Magnitude of velocity = 11 [m s^{-1}] [1] **ecf** on v_v		4		4	3	
				Question 1 total	**2**	**4**	**3**	**9**	**5**	**0**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
2	*(a)*			Zero distance from Sun to line of action of force **accept** zero perpendicular distance **or** [line of action of] force is straight through [centre of] Sun		1		1		
	(b)			Work = $2.15 \times 10^{16} \times 2.0 \times 10^{12} \times \cos 64°$ [1] = 1.88×10^{28} J **unit mark** [1]	1	1		2	2	
	(c)			Work = ΔE_k declared as strategy **or** implied by conclusion **ecf** from (b) provided comment made [1] Intermediate step: $E_{kA} = 9.94 \times 10^{28}$ [J] **or** $E_{kB} = 1.18 \times 10^{29}$ [J] **or** $v_B^{\,2} - v_A^{\,2} = 2.24 \times 10^6$ [m^2 s^{-2}] or correct substitution into $\frac{1}{2}mv_B^{\,2} - \frac{1}{2}mv_A^{\,2}$ [1] $E_{kB} - E_{kA}$ = 1.86×10^{28} [J] **clearly arrived at** [1]			3	3	2	
				Question 2 total	**1**	**2**	**3**	**6**	**4**	**0**

Question				Marking details		Marks available				
					AO1	AO2	AO3	Total	Maths	Prac
3	*(a)*			Vector sum of momenta [**or** total momentum] of [a number of] bodies is constant [1] provided no forces act from outside [that number] [1]	2			2		
	(b)	(i)		Δp_X = [–] 5.5 [N s] **or equiv or by imp** [1] Δp_Y = [+] 5.5 [N s] **or equiv or by imp** [1] **ecf** Y's velocity after collision = [+] 2.3 [m s^{-1}] [1] **ecf** on 5.5 [N s]		3		3	2	
		(ii)		Up to about 120 ms, straight line along time axis [1] After 120 ms upward sloping line followed by horizontal line after 160 ms [1] Horizontal line after 160 ms at 5.5 [N s] [1]  		3		3	2	
		(iii)		Change of momentum in a Δt of 40 ms [**Accept** any Δt between 30 ms and 40 ms] [1] Mean force on X = (–)140 N; **ecf** on (–)5.5 N s and 40 ms [1]		2		2	2	
				Question 3 total	**2**	**8**	**0**	**10**	**6**	**0**

Question				Marking details		Marks available				
					AO1	AO2	AO3	Total	Maths	Prac
4	*(a)*	(i)	I	Use of $\omega = 2\pi f$ even if f is still in revs per minute **or by impl** [1] ω = 0.859 [rad s^{-1}] [1]	1	1		2	1	
			II	Use of $v = r\omega$ [= 3.26 m s^{-1}] **or equiv or by impl.** [1] Time = 3.06 [s] [1] **ecf**	1	1		2	1	
			III	Use of $a = \frac{v^2}{r}$ or $a = r\omega^2$ **or by implication** [1] a = 2.80 [m s^{-2}] [1] **ecf**	1	1		2	1	
		(ii)	I	Correct substitutions in $mg = T\cos\theta$ (or after transposition) or by implication [1] 2.76 [N] [1] [2.55 N indicates error of principle]		2		2	1	
			II	[Horizontal component of] tension provides centripetal force [1] T sin 16° evaluated [0.761 N **ecf on** T] or used in calculation [1] Conclusion clearly based on calculation e.g. Either $\frac{2.76 \sin 16^\circ}{0.270}$ = 2.82 [m s^{-2}] **or** 2.80 **ecf** from (a)(i)III $\times$ 0.270 kg = 0.756 [N] **and** agreement noted **ecf** [1]			3	3	2	
	(b)			Example defined e.g. bends in roads or rail lines, spin-drier... [1] One factor affecting centripetal acceleration considered in context e.g. bends in roads or tracks must not be too sharp, or spin speed must be high enough... [1] Another factor considered e.g. vehicle speed warnings, drum size limited **or** more intricate measures e.g. banking of tracks [1]			3	3		
				Question 4 total	**3**	**5**	**6**	**14**	**6**	**0**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
5	*(a)*			[Motion such that] acceleration proportional to displacement from a fixed point [1] but in opposite direction **or** directed towards that point [1] **or** $a = -\omega^2 x$ with a = acceleration and x = displacement [1] ω [or ω^2] constant [1]	2			2		
	(b)	(i)		T = 1.2[0] s (from graph) or by implication [1] Correct re-arrangement $k = \frac{4\pi^2 m}{T^2}$ at any stage **or by impl.** [1] k = 4.80 N m^{-1} **unit mark** [1]		3		3	2	
		(ii)		Correct use of $v_{max} = A\omega$ [= 0.209 m s^{-1}] **or by implic** [1] Correct use of $E_k = \frac{1}{2}mv^2$ **ecf** on slips in v_{max} [1] $E_{k\,max}$ = 3.8 × 10^{-3}J [1]	1 1	1		3	2	
		(iii)		 Zeros at t = 0, 0.6 s, 1.2 s, 1.8 s, 2.4 s [1] KE never negative with equal peaks [1] Smooth (sinusoidal) curve [1]	1 1	1		3	2	

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(c)			Reasonable straight line of best fit drawn [1] Straight line expected as equation equivalent to $\ln A = \ln A_0 - \lambda t$ [1] Some comment about scatter of points – either supporting or casting doubt on straight line [1] λ = –gradient **or by impl.** [1] Gradient calculated correctly e.g. 0.014 [s^{-1}] No *second* penalty for mishandling minus sign [1]			5	5	3	5
				Question 5 total	**6**	**5**	**5**	**16**	**9**	**5**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
6	*(a)*	(i)		ρ correctly calculated ignoring sig figs, units, factors of 10^n [1] $\rho = 8.9 \times 10^3$ [kg m^{-3}] Accept $\rho = 8.87 \times 10^3$ [kg m^{-3}] [1] Percentage (or fractional) unc =0.07[2] (or 7[.2]%)] **or by implic** [1] $\rho = (8.9 \pm 0.6$ [or 0.7]) $\times 10^3$ [kg m^{-3}] **accept** $\rho = (8.87 \pm 0.64) \times 10^3$ [kg m^{-3}] [1]	1	1 1 1		4	2	4
		(ii)		Division of density by atomic mass even if error in units [1] 8.4×10^{28} [m^{-3}] **ecf** on ρ, no sig fig penalty [1]		2		2	1	2
	(b)	(i)	I	Correct transpos'n at any stage of $pV=nRT$ **or** $pV = NkT$ [1] Correct insertion of data, including T = 288 K in $pV = NkT$ **or** in $pV = nRT$ giving n = 42[.2] [mol] **or by implic** from N [1] N = 2.5[4] $\times 10^{25}$ [m^{-3}] [1]		3		3	2	
			II	Gas mainly empty space (between molecules) [but atoms packed/bonded together in solid] [1] Gas molecules are moving about at high speeds [so could be said to take up more space than vibrating atoms in solid] **or** molecules themselves are of comparable size [1]	1		1	2		
		(ii)	I	Correct use of $\frac{1}{2}mc_{\text{rms}}^2 = \frac{3}{2}kT$ or equivalent [1] Convincing algebra [1]	1	1		2		
			II	$\frac{c_{\text{rms}} \text{ for nitrogen}}{c_{\text{rms}} \text{ for oxygen}}$ **=**1.07 **or equiv or by implic** [1] 7 % [1]			2	2	1	
				Question 6 total	**3**	**9**	**3**	**15**	**6**	**6**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
7	*(a)*			Energy [entering system] [1] by virtue of a temperature difference [or equivalent] [1]	2			2		
	(b)	(i)		Correct substitutions (ignoring power of 10) into $W = p\Delta V$ [1] $W =$ 1.20 k[J] [1]	1	1		2		
		(ii)		**Indicative content:** **AB** Gas does work [or W positive] **and** internal energy rises [or ΔU positive] since temp rises [as gas expands at constant pressure]. So heat flows in [or Q positive] **BC** Gas has work done on it [or W negative]. No change in internal energy [or ΔU =0] so heat out [or Q negative] **CA** No work [or W = 0] but internal energy falls [or ΔU negative] so heat out [or Q negative] **ABCA** Net work done on gas [or W negative], no change in internal energy [or ΔU =0] so heat out [or Q negative] **5-6 marks** They have considered Q, W and ΔU well for all stages. *There is a sustained line of reasoning which is coherent, relevant, substantiated and logically structured.* **3-4 marks** They have considered 2 of Q, W and ΔU well for all stages. Or they have attempted to consider Q, W and ΔU for most stages. *There is a line of reasoning which is partially coherent, largely relevant, supported by some evidence and with some structure.*	6			6		

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
				1-2 marks They have considered Q, W and ΔU well for all stages. Or they have attempted to consider 2 of Q, W and ΔU for most stages. *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	**9**	**1**	**0**	**10**	**0**	**0**

SECTION B

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
8	*(a)*			Nebula, protostar, mid star, red giant, planetary nebula, white dwarf, black dwarf		1		1		
	(b)			Radiation/light not absorbed by atmosphere			1	1		
	(c)			Any one of these 4 marked [with a cross]. If more than one marked then follow the rule 1 right + 1 wrong = zero 		1		1		
	(d)			Photons collide with matter in star (or equivalent) [1] Force is rate of change of momentum [1] Light has momentum (or $p = \frac{h}{\lambda}$) [1]	1 1	1		3		
	(e)			More massive linked to greater gravitational force [hence density greater] [1] Greater density linked to increased [rate of] fusion [1] Reference to energy released <u>by fusion</u> e.g. more energy released [1]		3		3		

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(f)	(i)		$\lambda = \frac{0.0029}{T}$ used [1] Answer = 145 n[m] or $\frac{0.0029}{20\,000}$ seen (accept 17 000 K to 22 000 K from the graph) [1]	1	1		2	1	
		(ii)		Better to use UV or more radiation in UV or peak emission is not in visible range [1] [But] hot stars also emit visible light [more than colder stars] [1]			2	2		
	(g)			Choice of equation 1 e.g. $0.23 \times 0.2^{2.3}$ (=0.0057) [1] In (approximately) correct place (don't allow as a guess) [1]			2	2	2	
	(h)			Correct use of equation 3 e.g. $1.5 \times 10^{3.5}$ or 4 743 [1] Stated that luminosity or power or rate of use of fuel is 5 000× or 4 743× greater [1] Relevance of factor of 10 understood [1] Factor of 10 $M_\odot$ and 5 000 $L_\odot$ combined for a conclusion [1] e.g. $\frac{10}{5\,000}$ seen or $\frac{10}{4\,743}$ or worded answer e.g. although burning 5 000× faster, it has 10× more fuel so 500× less lifetime		4		4	2	
	(i)			As mass increases radius decreases or vice versa	1			1		
				Question 8 total	**4**	**11**	**5**	**20**	**5**	**0**

A LEVEL COMPONENT 1: NEWTONIAN PHYSICS

SUMMARY OF MARKS ALLOCATED TO ASSESSMENT OBJECTIVES

Question	AO1	AO2	AO3	TOTAL MARK	MATHS	PRAC
1	2	4	3	9	5	0
2	1	2	3	6	4	0
3	2	8	0	10	6	0
4	3	5	6	14	6	0
5	6	5	5	16	9	5
6	3	9	3	15	6	6
7	9	1	0	10	0	0
8	4	11	5	20	5	0
TOTAL	**30**	**45**	**25**	**100**	**41**	**11**