GCE A LEVEL MARKING SCHEME

AUTUMN 2021

A LEVEL
PHYSICS – COMPONENT 1
A420U10-1

INTRODUCTION

This marking scheme was used by WJEC for the 2021 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 COMPONENT 1 – NEWTONIAN PHYSICS

AUTUMN 2021 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)*			Sum of clockwise moments about any point = Sum of anticlockwise moments about that point [1] Vector sum of forces on body = 0 [1] (**or** no resultant force on body)	2			2		
	(b)	(i)	I	Moment = $12.0 \times 9.81 \times 0.40 \cos 33°$ [1] or by implic = 39.5 N m **unit mark** [1]		2		2	1	
			II	$R \times 0.74 = 39.5$ [1] or equivalent **ecf** R = 53.4 [N] [1] **ecf** [Only 1 mark penalty for 0.80 m]		2		2	1	
			III	$53.4 \times \cos 57°$ [1] **ecf** = 29 [N] [1] **ecf** [e.g. 27 [N] if R = 50 N used]		2		2	1	
		(ii)	I	Vertical line drawn upwards from centre of trap-door, and intersection with line of action of R labelled P		1		1		
			II	R and weight have no moment about P [1] Therefore hinge force can have no moment about P, so line of action of hinge force must pass through P and Darren is correct [1]			2	2		
				Question 1 total	**2**	**7**	**2**	**11**	**3**	**0**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
2	*(a)*			Suitable straight line graph labelled with at least two of u, v, t [1] Area (x) under line given in terms of u, v, t **or** u, a, t [1] $a = \frac{v-u}{t}$ used to eliminate v (accept by implication in labelling of graph), and given equation deduced [1]	3			3	2	
	(b)			Reasonable best straight line drawn, avoiding lowest point [1] Values inserted into $m = \frac{\Delta y}{\Delta x}$ tolerating small slips [1] Gradient correctly calculated from line drawn [1] Theoretical gradient [exactly] 2, so actual too high, or close to theoretical, **or** actual gradient suggests e.g. $h = \frac{1}{2}gt^{2.1}$ [1] Intercept = 1.48 [± 0.04] [1] [or equivalent found by substituting $\ln h$ and $\ln t$ for a representative point, and the actual or theoretical gradient.] Theoretical intercept =1.59 **or** actual gives g = 8.8 m s^{-2} (or what follows from actual gradient) so poor/fair/good agreement with expected value [1]			6	6	4	6
				Question 2 total	**3**	**0**	**6**	**9**	**6**	**6**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
3	*(a)*	(i)		Energy cannot be created or destroyed but can be transferred from one form to another	1			1		
		(ii)		Δh = 0.75 [m] – 0.75 [m] × cos 21° or by implic [1] Δh = 0.050 [m] or by implic [1] $\frac{1}{2}[m]v^2 = [m]gh$ or equiv or by implic [1] v =0.99 [m s^{-1}] **ecf** on Δh [1] **or:** Angle small enough for SHM [approx.] [1] $A = 0.75\ \text{m} \times \sin 21°$ [1] or 0.269 m by implic $\omega = \sqrt{\frac{g}{l}}\,[1]$ **or** $\sqrt{\frac{9.81\ [\text{m s}^{-2}]}{0.75\ [\text{m}]}}$ or $3.62\ [\text{rad s}^{-1}]$ $\boldsymbol{v} = 17.5\ [\text{m s}^{-1}]$[1]	1	1 1 1		4	3	
	(b)			0.36 v = 6.36 × 0.99 [1] or by implic v = 17.5 [m s^{-1}] [1] [1 mark for using 6.00 instead of 6.36, leading to 16.5 m s^{-1}] or for incorrect addition of masses]	1	1		2	1	
	(c)			Staple's change of momentum is greater [1] So more momentum given to block, which rises higher, so Charlotte is right [1] **or**: For a given (or greater) momentum given to it [1] the lighter block (without staple) will move off faster, so Charlotte is right [1]			2	2		
				Question 3 total	**3**	**4**	**2**	**9**	**4**	**0**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
4	*(a)*			$\Delta v = 8.0\sqrt{2}\,[\mathrm{m\,s^{-1}}]\ [= 11.3\ \mathrm{m\,s^{-1}}]$ or by implic [1] a = 4.5 [m s^{-2}] [1] South West **or** bearing of 225° [1]		3		3	2	
	(b)	(i)		Very large [for an atom]. Accept definite orbit not possible	1			1		
		(ii)		$\frac{m_e v^2}{r} = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{r^2}$ or by implic [1] $v = \sqrt{\frac{1}{4\pi\varepsilon_0}\frac{e^2}{m_e r}}$ **or** $v = \sqrt{9.0\times10^9\ \frac{(1.60\times10^{-19})^2}{9.11\times10^{-31}\times0.37\times10^{-3}}}\ \mathrm{m\,s^{-1}}$ or by implic [1] v = 827 [m s^{-1}] [1]		3		3	2	
		(iii)		$f = \frac{827}{2\pi\times0.37\times10^{-3}}$ [Hz] or equiv or by implic [1] f = 3.6 [or 3.4] × 10^5 Hz [**or** s^{-1}] **unit mark** [1]	1	1		2	1	
				Question 4 total	**2**	**7**	**0**	**9**	**5**	**0**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
5	*(a)*	(i)		**Either** $k = \frac{0.200 \times 9.81}{0.090}$ [N m^{-1}] [1] [= 21.8 N m^{-1}] or by implic giving $T = 2\pi\sqrt{\frac{0.200}{21.8}}$ [s] **ecf** [1] or by implic giving T = 0.60(2) [s] [1] From graph T = 0.60 [s] with comment e.g. 'very close' [1] **Or:** From graph T = 0.60 [s] [1] $k = \frac{4\pi^2 m}{T^2}$ [1] transposed at any stage, or by implic giving $k = \frac{4\pi^2 \times 0.200}{0.60^2}$ [N m^{-1}] [1] [= 21.9 N m^{-1}] or by implic giving eq ext $\left[= \frac{0.200 \times 9.81}{21.9}\ \text{m}\right]$ = 0.90 [m] with comment [1] [**or** k values obtained both from T and from 90 mm + comment]			4	4	3	
		(ii)	I	Either of the two lowest points marked		1		1	1	
			II	$a = \frac{21.8 \text{ or } 21.9}{0.200} \times 0.080$ **or** $\left(\frac{2\pi}{0.60}\right)^2 \times 0.080$ or by implic [1] a = 8.7 m s^{-2} [or 8.8] [m s^{-2}] full **ecf on** k or T [1]	1	1		2	1	
		(iii)	I	$v = -0.080 \times \frac{2\pi}{0.60} \times \sin\left(\frac{2\pi}{0.60} \times 0.10\right)$ [m s^{-1}] or equv or by impl[1] v = [–] 0.726 [m s^{-1}] or by implic [1] $E_k = \left[\frac{1}{2} \times 0.20 \times 0.726^2 \text{ J} =\right]\ 0.053$ [J] [1] **ecf on** v		3		3	2	
			II	Elastic PE gained as well as KE [1] Because spring extension increases **or** KE = grav PE [lost] – Elastic PE [gained] [1]		2		2		

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(b)	(i)		Forced: system acted on by periodic [driving] force [1] Natural: system disturbed and released [1]	2			2		
		(ii)		Correct curve, with non-zero amplitude at $f = 0$ [1] Resonance frequency of 1.6 Hz or 1.7 Hz [1] Marked on axis under peak [1]	1 1	1		3		
	(c)			3 out of 4 of the following [3] • Energy dissipation implies a temperature rise that might be hazardous **or** wastes energy. Accept reduces efficiency or damps desired oscillations • But amounts of energy involved usually too small to matter • A maximum of two examples when damping is useful, e.g. in car suspensions, suspension bridges, soft-closure systems [Accept up to 2 examples for separate marks]			3	3		
				Question 5 total	**5**	**8**	**7**	**20**	**7**	**0**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
6	*(a)*			**Indicative content:** **Using the apparatus** • Cool with ice cubes, then heat [gradually] to 100 °C • Heat with Bunsen **or** immersion heater • Record temp and length, *l*, of trapped gas, • at roughly equal temperature intervals • Stir • Allow to reach equilibrium **Determining absolute zero** • Plot *l* against [Celsius] temperature, • with temperature axis extending down to –300 °C • Draw [best] straight line through points • Where line cuts temperature axis is absolute zero [in °C] A sketched graph might be presented to support answer; check that each bullet above is explicitly covered. **5-6 marks** Comprehensive description of both the method and the analysis. *There is a sustained line of reasoning which is coherent, relevant, substantiated and logically structured.* **3-4 marks** Comprehensive description of either the method or the analysis or a limited description of both. *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 the method or the analysis. *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.	6			6		6

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(b)	(i)		**Any 2 × (1) from:** • Forces between molecules negligible [except during collisions] **or** molecules travel in straight lines between collisions • Molecules occupy a negligible volume • Collisions are [on average] elastic - Collisions take negligible time	2			2		
		(ii)	I	Correct handling of N, m and V, for example to produce $\rho = \left[\frac{20.0\times32.0\times10^{-3}}{0.050}\ \text{kg m}^{-3}\right]$ [= 12.8 kg m^{-3}] or by implication [1] Transposition: $\overline{c^2} = \frac{3p}{\rho}$ or equivalent) [1] c_{rms} = 484 [m s^{-1}] [1]		3		3	2	
			II	$p = \frac{nRT}{V}$ and everything on the right is the same (or equiv) [1] Therefore Ciaran is right about *pressure* [not free-standing] [1] $\frac{1}{2}m\overline{c^2} = \frac{3}{2}kT$ [1] Right hand side same, but m smaller for He, so c_{rms} must be larger. Accept calculation of the new speed. Ciaran wrong. [1] **Alternative answer for c_{rms}** For the He, p is the same but ρ is smaller in $\overline{c^2} = \frac{3p}{\rho}$ or $c_{rms} = \sqrt{\frac{3p}{\rho}}$ [1] So c_{rms} is larger and Ciaran is wrong over this [1] Penalise absence of right/wrong only once.			4	4	1	
				Question 6 total	**8**	**3**	**4**	**15**	**3**	**6**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
7	*(a)*		$T_A = \frac{300\times10^3\times0.001}{0.125\times8.31}$ [K] **or** $T_B = \frac{50\times10^3\times0.003}{0.125\times8.31}$ [K] or by implication [1] $T_A = 289$ K [1] $T_B = 144$ K [1] **ecf** if *same* slip		3		3	2	
	(b)		Squares under graph counted or area under graph calculated by some other method, tolerating slips, e.g. in factor of 10^3 [1] 230 J [±30 J] [1]		2		2	1	
	(c)		Gas does work, no heat comes in, so internal energy drops **or** $\Delta U = Q - W$ with $Q = 0$ and $W > 0$ [1] Drop in internal energy implies drop in temperature [for an ideal gas] [1]		2		2	1	
			Question 7 total	**0**	**7**	**0**	**7**	**4**	**0**

SECTION B

Question		Marking details	Marks available					
			AO1	AO2	AO3	Total	Maths	Prac
8	*(a)*	Resistance is proportional to length (1) So linear relationship between R and strain (1)	2			2		
	(b)	Resistance decreases because shorter (1) More pd across SG1 or less pd across SG2 (1) Hence potential at B greater than A (1)	1	1 1		3		
	(c)	Resistance not temperature dependent (1) So unaffected by resistors/gauges at different temperatures (1)			2	2		
	(d)	A&C - small change/little change or increases (1) B - decreases (1) Either A&C little change in length or increase in length **OR** B shorter (1)		3		3		
	(e)	[F]LHR (1) Top right current into **OR** bottom left current out (1) Both forces shown in diagram **OR** described in words (1)	1	1 1		3		
	(f)	$F = BIL$ mentioned (1) So force proportional to current (1) But Hooke's law is force proportional to deflection linked to deflection proportional to current (1)	1	1 1		3		
	(g)	Critical (1) Equilibrium reached most quickly without oscillations (1)	2			2		

Question		Marking details	Marks available					
			AO1	AO2	AO3	Total	Maths	Prac
	(h)	Method for a calculation e.g. $I = \frac{V}{R}$(1) Value & conclusion e.g. $\frac{10\text{ V}}{1000}$= 10 000 μA so Andrea correct (1) Accept: the resistor should be megohm so Andrea is correct for both marks			2	2	1	
		Question 8 total	**7**	**9**	**4**	**20**	**1**	**0**

A LEVEL COMPONENT 1: NEWTONIAN PHYSICS

SUMMARY OF MARKS ALLOCATED TO ASSESSMENT OBJECTIVES

Question	AO1	AO2	AO3	TOTAL MARK	MATHS	PRAC
1	2	7	2	11	3	0
2	3	0	6	9	6	6
3	3	4	2	9	4	0
4	2	7	0	9	5	0
5	5	8	7	20	7	0
6	8	3	4	15	3	6
7	0	7	0	7	4	0
8	7	9	4	20	1	0
TOTAL	**30**	**45**	**25**	**100**	**33**	**12**