GCE A LEVEL MARKING SCHEME

AUTUMN 2020

A LEVEL
PHYSICS – COMPONENT 1
A420U10-1

INTRODUCTION

This marking scheme was used by WJEC for the 2020 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

AUTUMN 2020 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

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
1	(a)	(i)		0.75 [±0.05] s		1		1	1	
		(ii)		68 m [±3 m]		1		1	1	
		(iii)		Figures correctly inserted into constant acc equation(s) at some chosen speed. For example, at 30 m s^{-1}, $0 = 30^2 + 2a \times 68$ [1] [Tolerate interchange of u and v and (for this mark only) stopping distance used instead of braking distance.] $a = -6.6\ \mathrm{m\ s^{-2}}$ [$\pm 0.6\ \mathrm{m\ s^{-2}}$; accept $6.6\ \mathrm{m\ s^{-2}}$; **ecf** on 68 m] [1] Deceleration correctly calculated at one more speed **and** sensible conclusion drawn **ecf** [1] **Alternative:** For at least two points, $\frac{v_1}{v_2}$ compared with $\left(\frac{x_1}{x_2}\right)^2$ or equiv. [1] Comparison carried out with clear results [1] Sensible conclusion drawn, implying that square law relation is equivalent to same acceleration throughout [1]			3	3	2	

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(b)			Quantitative use made of data in (a), e.g. from graph, stopping distance [on dry road at maximum legal speed] is $\approx 95\ \text{m}$. [1] Some conclusion, e.g. 95 m is rather greater than two gaps between chevrons [or equiv] so idea good or inadequate. [1] Critical/supporting remarks [1] could include: • Not enough distance if roads wet or icy, or no help in fog • Even longer distance needed if maximum legal speed exceeded **or** equiv • Should be ignored in a traffic jam • Meaning of notice not clear: 2 chevrons or 2 gaps apart? • Arguably use of chevrons too infrequent to save many accidents • Drivers could be distracted by looking at chevrons on road			3	3	2	
				Question 1 total	**0**	**2**	**6**	**8**	**6**	**0**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
2	(a)			$\frac{\text{final velocity - initial velocity}}{\text{time [taken to change]}}$ or equivalent [1]	1			1		
	(b)	(i)		[Distance gone per second] = $2\pi \times 0.25\ [\text{m}] \times 5.2 \times 10^6\ [\text{s}^{-1}]$ [1] = 8.2×10^6 [m s^{-1}] [1]	1	1		2	2	
		(ii)		$\text{acc} = \frac{(8.0\times10^6)^2}{0.25}\ [\text{m s}^{-2}]$ **or** $\frac{(8.17\times10^6)^2}{0.25}\ [\text{m s}^{-2}]$ [1] $= 2.6\ (\text{or } 2.7) \times 10^{14}\ \text{m s}^{-2}$ **unit mark** [1] South or towards circle centre. Accept downwards. [1]	1 1	1		3	1	
		(iii)		Time for half revolution = $\frac{1}{2} \times \frac{1}{5.2 \times 10^6}$ s $[= 9.62 \times 10^{-8}\ \text{s}]$ [1] Final velocity – initial velocity = 1.63×10^7 [m s^{-1}] [South] [1] Mean acc = $1.7 \times 10^{14}\ [\text{m s}^{-2}]$ **South** [Accept South for Δv] [1]		3		3	2	
	(c)			Adam is wrong because acc's (or force) *direction* keeps changing [1] Brian is right because final vel – initial vel = 0 or equiv [1]			2	2		
				Question 2 total	**4**	**5**	**2**	**11**	**5**	**0**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
3	(a)	(i)		Straight line through origin [1] Negative gradient [1] [1 mark for a whole answer like "Acceleration proportional to negative displacement" i.e. without referring to graph]	2			2		
		(ii)		0.024 [m]	1			1		
		(iii)		$\omega^2 = \frac{0.60}{0.024}$ [$= 25\ \mathrm{s}^{-2}$] [1] $T = \frac{2\pi}{5\ [s^{-1}]}$ **ecf on** ω^2 [1] T = 1.26 [s] **no ecf** [1]		3		3	3	
	(b)	(i)		No. l not measured to centre of sphere.			1	1		1
		(ii)		Graph gradient = $\frac{4\pi^2}{g}$ or equivalent [1] Correct division sum set up to calculate gradient from graph [1] Max gradient between 4.0 and 4.2 [$\mathrm{s}^2\ \mathrm{m}^{-1}$] [1] Min gradient between 3.7 and 3.9 [$\mathrm{s}^2\ \mathrm{m}^{-1}$] [1] $g = 9.9\ \mathrm{m\ s}^{-2}$ **ecf** on mean gradient [1] Uncertainty 5 % **ecf** on max and min gradients [1]			6	6	4	6
	(c)	(i)		Decreasing amplitude (or equivalent)	1			1		
		(ii)		Resistive or dissipative forces (or equivalent incl air res) [1] [Always] oppose motion **or** transfer energy from system/ball [1]	2			2		

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(d)			Body, displaced and released, returns to equilibrium without oscillating **or** without overshoot [1] Resistive force just large enough for this (or equiv) [1] Car suspensions (or other plausible example) Accept bridges [1]	3			3		
				Question 3 total	**9**	**3**	**7**	**19**	**7**	**7**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
4	(a)			Distance up ramp = $\frac{1.10\ \text{m}}{\sin 15°}$ [= 4.25 m or by implic] [1] Power in = $\frac{960\ \text{N} \times 4.25\ \text{m}}{35\ \text{s}}$ **ecf on 4.25 m** [1] = 117 [W] **no ecf** [1]		3		3	2	
	(b)			Grav PE gained by piano = 320 × 9.81 × 1.10 [J] [= 3.45 kJ] or by implication [1] Efficiency = $\frac{3453}{960 \times 4.25} \times 100\ \%$ **[ecf on top or bottom]** [1] or Efficiency = $\frac{99\ [\text{W}\}}{117\ [\text{W}\}} \times 100\ \%$ **[ecf on top or bottom]** = 85 [%] or 0.85 **no ecf** [1]		3		3	2	
	(c)			KE of piano ≅ $\frac{1}{2} \times 320 \times \left(\frac{4.25}{35}\right)^2 = 2.4\ \text{J}$ [1] Negligible compared with hauling work [or] GPE gained, so *not* a major cause of inefficiency [1] **Alternative answer** KE got back at the end of the process... [1] ... as piano comes to rest if hauling stopped a little before required height rise [1]			2	2	1	
				Question 4 total	**0**	**6**	**2**	**8**	**5**	**0**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
5	(a)	(i)		Mean KE = $\frac{3}{2} \times 1.38 \times 10^{-23} \times 1500$ [J] **or by impl** [1] = 3.11×10^{-20} [J] [1]	1	1		2	1	
		(ii)		$c^2{}_{\text{rms}} = \frac{3.11 \times 10^{-20}}{\frac{1}{2} \times 3.82 \times 10^{-26}}$ [i.e. transposed] **or by impl** [1] $\boldsymbol{c}_{\mathbf{rms}} = 1275\ \text{m s}^{-1}$ [1]		2		2	2	
	(b)	(i)		Any statement that shows knowledge of gas molecules [at a given temp] having a range of speeds [1] 6.40 km s^{-1} is a few [5] times greater than rms speed [1] Molecule could have acquired this speed through a succession of 'lucky' collisions [1]		3		3		
		(ii)		$m \times 6.40 + 0 = m \times 4.39 + m \times v$ **or equiv or by impl** [1] $v = 2.01\ \text{km s}^{-1}$ **to the East** [1]		2		2	2	
		(iii)		KE before = 7.82×10^{-19} [J] [1] KE after = 3.68×10^{-19} J + 0.77×10^{-19} J [1] [= 4.45×10^{-19} J] or equivalent (no need to include the $\frac{1}{2}m$ or 10^3] Inelastic as KE [= 3.37×10^{-19} J] has been lost [1] **Alternative** Considering relative velocities of approach and separation [1] $6.40 \times 10^3 > 4.39 \times 10^3 - 2.01 \times 10^3$ **or equiv** [1] Therefore KE lost **or** inelastic [1]		3		3	2	
		(iv)		The molecules exert equal and opp forces on each other	1			1		

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
		(v)		Photon momentum = $\frac{6.63 \times 10^{-34}\ \text{J s}}{589 \times 10^{-9}\ \text{m}}$ or by implication [1] = 1.1×10^{-27} **N s UNIT mark** [1] << either molecule's momentum, so insignificant effect [1]			3	3	1	
				Question 5 total	**2**	**11**	**3**	**16**	**8**	**0**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
6	(a)	(i)		Ice at 0 °C, boiling water at 100 °C or by implication [1] A correct strategy, e.g. comparing $\frac{131}{96}$ with $\frac{373}{273}$ [1] Convincingly carried through, e.g. $\frac{131}{96} = 1.36$, $\frac{373}{273} = 1.37$ [1] **Alternative:** $\frac{p}{T} = \frac{nR}{V}$ = constant if V of cylinder is constant (1) $\frac{96}{T} = \frac{131}{(T+100)}$ (1) So 35T = 9 600 and T = 274 [K] so absolute zero = –274 [°C] (1)	1	1 1		3	1	3
		(ii)		At absolute zero the energy of particles in a body is the lowest it can possibly be, or equivalent	1			1		
	(b)	(i)		pV is the same at A and C so temperature the same or equiv [1] $T = \frac{200000 \times 0.01}{0.85 \times 8.31}$ **transposed** or by impl [1] T = 283 [K] **no ecf** [1]		3		3	2	
		(ii)		Work over AB = 0. Work over BC = [–] 200 000 × 0.01 J or by implication [1] Work on gas = 2 000 [J] [1]		2		2	1	

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
		(iii)		A and C at same temp so [for ideal gas] $\Delta U = 0$ [1] So heat out = Work in **or** $Q = \Delta U + W = 0 + (-2000\text{ J})$ [1] So 2000 [J] of heat flows out [1]	1	 1 1		 3	 1	
				Question 6 total	**3**	**9**	**0**	**12**	**5**	**3**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
7				**Indicative content** **Heat** • No heat flow in or out of system as a whole • flows from A to B • flow rate decreases • eventually no flow **or** flow rate approaches zero **Internal energy** • A's decreases, B's increases • Rates of decrease or increase eventually approach zero. **Temperature** • A's decreases, B's increases • Temps of A and B approach [accept *reach*] a common value. **Motion of atoms** • Atoms are *vibrating*. • Motion correctly associated with temperature. Accept with internal energy.	6			6		

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
				5-6 marks Comprehensive account with all 4 areas covered i.e. heat, internal energy, temperature and motion of atoms. *There is a sustained line of reasoning which is coherent, relevant, substantiated and logically structured.* **3-4 marks** Comprehensive account of 2 or 3 areas i.e. heat, internal energy, temperature and motion of atoms or limited attempt of all 4. *There is a line of reasoning which is partially coherent, largely relevant, supported by some evidence and with some structure.* **1-2 marks** Comprehensive account of 1 area i.e. heat, internal energy, temperature and motion of atoms or limited attempt of 2 or 3 areas. *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	**6**	**0**	**0**	**6**	**0**	**0**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
8	(a)			Essentially $F = ma$ (1) $u\frac{\Delta m}{\Delta t}$ is rate of change of momentum for gases (1) Hence it is (equal & opposite to force on rocket (of mass m) (1)	3			3	1	3
	(b)			Mass will be (approximately) constant (1) u and $\frac{\Delta m}{\Delta t}$ constant from paragraph 3 (1) Mass m is large and $\frac{\Delta m}{\Delta t}$ is small (1)		3		3	1	3
	(c)	(i)		Unit is s^2 not s OR accept wrong unit for t^2	1			1		1
		(ii)		Subtracting 0.02 s (1) Due to electromagnet delay OR systematic error in t (1)		2		2		2
	(d)			$x=ut+0.5at^2$ quoted or its use implied (1) Leading to $t^2 = \frac{2xm}{F}$ OR equivalent (1) But $\frac{t^2}{m}$ = gradient and x = 1.4 so gradient = $\frac{2 \times 1.4}{F}$ (1)		3		3	2	3
	(e)			Multiplication implied and reference to equation or reference to rate of change of momentum		1		1		1

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(f)			Gradient equated to $\frac{2.8}{F}$ (1) Gives 4.41 [N] or 4.409 [N] and so correct (1) **Alternative:** **or** Gradient = $\frac{2.8}{4.4}$ (1) = 0.64 or 0.636 so consistent (1)			2	2	2	2
	(g)	(i)		Change in wavelength/frequency (1) Due to motion (of source relative to observer) (1)	2			2		
		(ii)		Point telescope/device at [Accept: observe] exhaust/gases (1) Spectral analysis/prism/diffraction grating [Accept: pick out one wavelength or equivalent] (1) Use Doppler equation or $\frac{\Delta\lambda}{\lambda} = \frac{v}{c}$ (1)			3	3		
				Question 8 total	**6**	**9**	**5**	**20**	**6**	**15**

A LEVEL COMPONENT 1: NEWTONIAN PHYSICS

SUMMARY OF MARKS ALLOCATED TO ASSESSMENT OBJECTIVES

Question	AO1	AO2	AO3	TOTAL MARK	MATHS	PRAC
1	0	2	6	8	6	0
2	4	5	2	11	5	0
3	9	3	7	19	7	7
4	0	6	2	8	5	0
5	2	11	3	16	8	0
6	3	9	0	12	5	3
7	6	0	0	6	0	0
8	6	9	5	20	6	15
TOTAL	**30**	**45**	**25**	**100**	**42**	**25**