GCE A LEVEL MARKING SCHEME

SUMMER 2018

A LEVEL
PHYSICS - COMPONENT 1
A420U10-1

INTRODUCTION

This marking scheme was used by WJEC for the 2018 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

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
1	*(a)*		Normal force and frictional force shown by arrows in correct directions. Labelling not required nor 'correct' positions, length irrelevant	1			1		
	(b)	(i)	Multiplication of m by 9.81 [N kg^{-1}] apparent (1) Multiplication by cos 70° **or** sin 20° apparent (1) [→ 208 / 210 N]	1	1		2	1	
		(ii)	[Because no acceleration normal to surface] $N = W$ cos 20° or by implication (1) N = 570 N or 572 N [Accept 571 N] (1)		2		2	2	
	(c)		Correct use of $x = \frac{1}{2}at^2$ (1) **One of:** 101 m in 9.0 s **or** 8.9[4] s for 100 m **or** 100 m in 9.0 s requires an acceleration of 2.47 m s^{-2} (1) Calculation predicts that he is right, but not decisive [**or** actually the wrong prediction] owing to [increasing] air resistance, **or** unevenness of snow **or** not enough s.f. in data **or** recognition that acceleration may not be uniform (1)			3	3	2	
			Question 1 total	2 **2**	**3**	**3**	**8**	**5**	**0**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
2	*(a)*	(i)	$\omega = \frac{\text{angle swept out}}{\text{time taken}}$ [or in words] **Or** angle [accept: number of radians] swept out per unit time [or per second]	1			1		
		(ii)	Clear use of $\omega = \frac{v}{r}$ or equivalent (1) Convincing algebra (1)	1	1		2	1	
	(b)	(i)	Substitution into: $F = m\frac{v^2}{r}$ or equivalent either before or after rearrangement (1) v = 1.35 km s^{-1} (1)	1	1		2	1	
		(ii)	$\frac{GMm}{r^2} = \frac{mv^2}{r}$ or equivalent with M and m correctly identified (1) m cancels so speed of moon of twice the mass would be the same as that of Deimos. [Must be supported by argument even if argument not clear enough to give first mark.] (1) **or** in words, e.g. Equivalence of gravitational and inertial mass however expressed, [e.g. the force would be double and the mass is doubled] (1) Hence speed the same (1) **or** Another identical moon next to the existing one will orbit at the same speed (1), so the composite moon [of double the mass] will orbit at that speed (1).		2		2		
			Question 2 total	**3**	**4**	**0**	**7**	**2**	**0**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
3	*(a)*		Rate of change of momentum proportional to [**or** equals] force(1) Context or detail: **either** *resultant* force [..... *body's* rate of change of momentum] **or** *and takes place in the direction of the [resultant] force* (1)	1 1			 2		
	(b)	(i)	Tangent drawn at t = 10.0 s (tolerate errors of judgement) (1) Clear calculation of gradient (1) Resultant force = 0.15 [±0.03] N Accept 3sf (1)		 3		 3	 2	
		(ii)	*Resultant force = weight – air resistance* (or equivalent) used (1) 0.34 N or 0.35 N **ecf** (1)		1 1		 2	 1	
		(iii)	0.49 N [accept 0.5 N or 0.50 N] [accept '= weight']	1			1		
			Question 3 total	**4**	**4**	**0**	**8**	**3**	**0**

Question				Marking details		Marks available				
					AO1	AO2	AO3	Total	Maths	Prac
4	*(a)*			Total energy [of a closed system] stays constant [or equivalent] (1) but energy can be stored [or calculated] in different ways [**accept** can be converted from one form to another or equivalent] (1).	2			2		
	(b)	(i)	I	Substitution of data from one point on the curved graph **or** by implication (1) Re-arrangement at any stage of $E = \frac{1}{2}kx^2$ (1) k = 40 N m^{-1} **unit** Accept equivalent unit such as J m^{-2} (1)	1	1 1		3	2	
			II	Substitution of data from one point on straight line **or** by implication (1) 0.20 kg (1)	1	1		2	1	
			III	Total energy (including at x = 0.050 m) is zero **or** by implication (1) KE = 0.050 J (1) 'Correct' answer from $\frac{1}{2}mv^2 = \frac{1}{2}kx^2 \rightarrow 0$ marks		2		2	1	
		(ii)		Graph passes through (0, 0), (0.05, 0.05), (0.1, 0) [1] rises and falls smoothly [1]		2		2	2	
	(c)			Attach **different** masses, m, drop, and measure x_{max} each time (1) Any one relevant experimental detail (e.g. measure x_{max} with metre rule **or** repeat readings **or** take precautions against parallax). (1) Plot x_{max} against m [or m against x_{max}] **or** for each pair of readings calculate $\frac{x_{max}}{m}$ [or $\frac{m}{x_{max}}$] (1) Straight line through origin **or** constancy of calculated quotient will verify relationship. (1)			4	4	2	4
				Question 4 total	**4**	**7**	**4**	**15**	**8**	**4**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
5	*(a)*	(i)		Correct substitution of data (1) $\ell = 1.43$ m (1)	1	1		2	2	2
		(ii)	I	Recognisable cosine graph of amplitude 0.050 m (1) Zeros at approximately 0.6 s, 1.8 s, 3.0 s, that is correct period [even if –cosine graph] (1)		2		2	1	2
			II	x [/m] $= 0.050 \cos 2\pi\frac{1.6}{2.4}$ or equivalent or by implication (1) x = – 0.025 m (1) If no working given, 0 marks for any incorrect answer (e.g. –0.24 m)		2		2	2	2
			III	v [/m s^{-1}] $= -0.050 \times \frac{2\pi}{2.4} \sin 2\pi\frac{1.6}{2.4}$ or equivalent (1) v = 0.11 m s^{-1} (1) For tangent method on sketch graph, award the second mark for 0.11 ± 0.03 m s^{-1}		2		2	2	2
			IV	2.0 s		1		1		1

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(b)			**A: Meaning of resonance** A1 Term applies to forced oscillations. A2 Forced oscillations occur when a system is subjected to a periodic driving force. A3 Resonance occurs at a particular frequency of driving force… A4 .. which is the same frequency as the system's natural frequency A5 At resonance the amplitude of the oscillations is a maximum [for a given amplitude of driving force]. **B: How effects can be lessened** B1 System mentioned where resonance is a nuisance (e.g suspension bridge). B2 A little information given about the oscillations and/or the driving force for this system. B3 Increasing the damping will lessen the amplitude of the oscillations. B4 Making sure the forcing frequency avoids the system's natural frequency (e.g. by shifting system's natural frequency) will also lessen amplitude	6			6		

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
				5-6 marks **Expect**: A2 + A4 + A5, B1 + B2 + (B3 or B4) There is a sustained line of reasoning which is coherent, relevant, substantiated and logically structured. **3-4 marks** **Expect**: (A1 or A2) + (A3 or A4) + A5 B1 + (B3 or B4) There is a line of reasoning which is partially coherent, largely relevant, supported by some evidence and with some structure. **1-2 marks** **Expect** 3 points with at least 1 point made from each of A and B. 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 5 total	**7**	**8**	**0**	**15**	**7**	**9**

Question		Marking details	Marks available					
			AO1	AO2	AO3	Total	Maths	Prac
6	*(a)*	It equates [opposing] moments of [weights of] m and M (1) when multiplied each side by g [or equivalent]. (1) 0.150 m is distance of rule's C of G from pivot – <u>could be shown on diagram</u> (1) [Absence of *g* penalised by 1 only] **Or** (Derivation of equation using PoM) Distance of C of G from pivot = [0.500 – 0.350] = 0.150 m (1) ACM of mg abount the pivot = mgz And CM of Mg about pivot = $Mg\times0.150$ (1) $\therefore$ By <u>PoM</u> $mgz = Mg\times0.150$ followed by simplification (1)	1	1 1		3		3
	(b)	Reasonable **best fit** line drawn (1) Gradient 0.0175 [±0.005] [kg m] or equivalent (point chosen on line of best fit) (1) [i.e. 0.017(0) – 0.018(0)] Gradient = M × 0.150 [m] or equivalent used (1) M = 0.117 kg **ecf** from gradient [0.11 – 0.120]. Answer given to 2 or 3 s.f (1) [Give max of 2 marks for method (1) and answer (1) based on a single ***plotted*** data point.]			4	4	4	4
	(c)	From graph (or equation) 0.050 kg has to be at about z = 0.34 m. [Accept 0.32 m based on plotted point.] (1) Lower values of m would need larger z, but z < 0.350 m so significantly lower values of m not possible (1) **or** for largest possible value of z (0.35 m), m = 0.049 kg (1) So values of m significantly lower than 0.050 kg not pos. (1)			2	2	1	2
		Question 6 total	**1**	**2**	**6**	**9**	**5**	**9**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
7	*(a)*			**Two × (1) from:** • Molecules [themselves] occupy negligible volume • Molecules exert negligible forces on each other except during collisions **or** move in straight lines between collisions • There is no preferred direction of molecular velocity **or** [directions of] motion are random **or** equivalent • Collisions are elastic [on average] • Collisions take negligible time or equiv, e.g. molecules are hard spheres	2			2		
	(b)	i		$\rho = \frac{2.2\times0.0399\ [\text{kg}]}{0.050\ [\text{m}^3]}$ or by implication (1) $c_{\text{rms}} = \sqrt{\frac{3p}{\rho}}$ or by implication (e.g. re-arrangement after data inserted). Mark can be given even if ρ is wrong (1) $c_{\text{rms}} = 654\ \text{m s}^{-1}$ (1) Slips in $10^x \rightarrow -1$; incorrect $N_A \rightarrow 1_{max}$	1	1 1		3	2	
		ii	I	$\frac{1}{2}m\overline{c^2} = \frac{3}{2}kT$ used **or** KE proportional to T **or** equiv **or** by imp (1) c_{rms} goes up by [factor of] $\sqrt{2}$. (1) Accept $\sqrt{2} \times 654\ \text{m s}^{-1}$ **or** $924\ \text{m s}^{-1}$	1	1		2	1	
			II	Yes, c_{rms} depends only on temperature, or equivalent		1		1		
				Question 7 total	**4**	**4**	**0**	**8**	**3**	**0**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
8	*(a)*	(i)	pV evaluated (or equivalent) at two or more points, at least one of which isn't at an extreme end of the curve (1) Conclusion correctly argued (for example, constant pV implies constant temperature) or simply finding equal temps from two points. [For this mark accept both extremes, A and B.] (1) T = 362 K (1)			3	3	2	
		(ii)	Reasonable method used to find 'area' under graph (1) W = 230 [± 50] kJ (1)	1	1		2	1	
		(iii)	Internal energy doesn't change [as temp doesn't change significantly] , [accept $\Delta U = 0$] (1) But an amount of heat flows <u>into</u> the system equal to work done [by the gas] (1)			2	2		
	(b)		1 mark each for up to two 'isolated' points such as • Compressed air car can't go as far per 'fill' / lower range • Compressed air car won't pollute [locally] [accept cleaner power source] • Car may be quieter running off compressed air 1 extra mark available for developing the first bullet eg ... Car has to do work against resistive forces (and sometimes against pull of gravity) hence use of fuel, compressed air etc. Car won't go [nearly] as far on *same volume* of compressed air as petrol or much larger compressed air storage vessel will be needed than petrol tank for car to be able to go as far. 1 extra mark available for developing the second bullet... Car won't pollute But work (or energy) needed to compress the gas Probably involves burning fuel in a power station			3	3		
			Question 8 total	**1**	**1**	**8**	**10**	**3**	**0**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
9	*(a)*		Without – [fast] random motion **or** motion with collisions (1)] mean velocity zero **or** no preferred direction (1) With (any 2 of) random motion still present (1) [can be implied] but (slight) acceleration between collisions (1) drift velocity (1)	4			4		
	(b)		Algebra, that is $T = \frac{m\overline{v^2}}{3k}$ (1) 220 K (1)		2		2	2	
	(c)		**Either** Equating $qE = ma$ Extra detail in explanation, for example $q = e$ or $m = m_e$ or stating that resultant force = electric force. (1) **Or** $F = ma$ and $F = qE$ (1) Where $q = e$ or $m = m_e$(1)		2		2	1	
	(d)		Re-arrangement for E as subject (1) $E = 0.071\ \text{V m}^{-1}$ or N C^{-1} **UNIT** (1) Slips in powers of 10: –1		2		2	1	
	(e)		Comparison with $R = \frac{\rho\ell}{A}$ with eq 8 or equivalent substitution (1) $d = \ell$ [or by implication] and convincing algebra / brief explanation (1)		2		2	1	
	(f)		Re-arrangement to make $\tau = \frac{2m_e}{ne^2\rho}$ (1) $\tau = 50$ fs (1)		2		2	2	

	(g)		time $= \frac{d}{v}$ (1) [$v = c_{rms}$] $\rho \propto \frac{1}{time} \propto v$ (1) $v^2 \propto T$ (kinetic theory) (1) $\rho \propto v \propto \sqrt{T}$ (1)			4	4	2	
	(h)		positive (1) excess electrons either side / because electrons are attracted (1)		2		2		
			Question 9 total	**4**	**12**	**4**	**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	2	3	3	8	5	0
2	3	4	0	7	2	0
3	4	4	0	8	3	0
4	4	7	4	15	8	4
5	7	8	0	15	7	9
6	1	2	6	9	5	9
7	4	4	0	8	3	0
8	1	1	8	10	3	0
9 (comprehension)	4	12	4	20	10	0
TOTAL	**30**	**45**	**25**	**100**	**46**	**22**