GCE A LEVEL MARKING SCHEME

SUMMER 2017

A LEVEL (NEW)
PHYSICS - COMPONENT 1
A420U10-1

INTRODUCTION

This marking scheme was used by WJEC for the 2017 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.

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)	[lantern moment] $0.9 \times 9.81 \times 0.8$ [= 7.06] [N m] or by implication (1) [bar moment] $1.8 \times 9.81 \times 0.55$ [= 9.70] [N m] or by implication (1) Total = 17 N m **UNIT** (1) accept 16.8 and 16.7 Give 1 mark if g omitted and answer given as 1.7 with or without any unit.	1 1	1		3	3	
		(ii)	[Anticlockwise] torque due to wire = $T \times 1.1$ m $\times \sin 35°$ or by implic (1) T = 27 [N] **ecf on (a)(i)** (1)			2	2	2	
		(iii)	Tension must increase (1) Convincing brief explanation e.g. reducing angle decreases [perpendicular] distance **or** reduces component of tension perpendicular to bar (vertical component **or** tension must increase to compensate **or** so that [total] clockwise moment is still balanced (1) **Accept** numerical demonstration using a specific angle smaller than 35° for both marks (First mark for demonstration, second for conclusion)			2	2		
	(b)		1.4 [m s^{-1}]		1		1		
			Question 1 total	**2**	**2**	**4**	**8**	**5**	**0**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
2	*(a)*	(i)	Acceleration = $\frac{0.16}{2.0}$ [=0.08] [m s^{-2}] or by implication (1) Force = 1.2 × [$\frac{0.16}{2.0}$] [N] (**ecf** on acc for this mark only) (1) Force = 0.096 [N] (1) [Deduct only 1 if wrong answer clearly due to arithmetical slip.] **Alternative:** **Don't award individual marks unless overall method clear** s =1.04 [m] (1) v^2-u^2 = 0.166 [$m^2 s^{-2}$] **or** ΔE_k = 0.0988 [J] (1) Force = 0.096 [N] (1)	1	1 1		3	3	
		(ii)	Distance = (½)(0.60 + 0.44) × 2.0 [= 1.04 m] **or** equiv **or** by imp (1) Work = 0.096 × [calculated distance] [J] **ecf on (a)(i)** (1) Work = 0.10 [J] (1) **Alternative solution:** Final KE = (½) 1.2 × 0.44^2 [= 0.11616 J] **or** by imp (1) Initial KE = (½) 1.2 × 0.60^2 [= 0.216 J] **or** by imp (1) Work = 0.10 [J] (1)	1	1 1		3	3	
		(iii)	Momentum of system before collision = 1.2 × 0.44 [= 0.528 N s] [or by implic] (1) Momentum of A after collision = –1.2 × 0.14 [= – 0.168 N s] (1) 1.2 × 0.44 = –1.2 × 0.14 + 3.0 v **or** equivalent **or** by implic (1) v = 0.23 [m s^{-1} to the right] (1) Penalty for failure to take account of A's velocity being to the left after collision (gives v = 0.12 [m s^{-1}]) is 2 marks if all else correct. 1 mark penalty for taking A's initial velocity as 0.60 [m s^{-1}]	1 1	1 1		4	4	
		(iv)	Initial KE = (½) 1.2 × 0.44^2 [= 0.116 J] **or** by imp (1) Final KE = (½) 1.2 × 0.14^2 + (½) 3.0 × 0.232^2 [= 0.092 J] **ecf** (1) [KE lost] so inelastic **ecf** (1) **ecf** on A's initial velocity = 0.60 [m s^{-1}]			3	3	2	

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
2	*(b)*		**3 valid points made - 3rd mark can be a follow-up of one of the points** Examples of 'follow-ups' are preceded by dashes (-) below. Better traction or equivalent May reduce damage to cars in collisions - Metal less likely to deform [under given stress, though stress likely to be greater!] More damage to objects hit by cars May increase damage to passengers during collisions - Thicker metal likely to [decrease collision time and] increase accelerations during collisions Would increase fuel consumption - More energy used to accelerate **or** more energy dissipated in tyres. More metal used [per car] [uses up resources faster] Makes manufacture more difficult Makes cars harder to repair if damaged			3	3		
			Question 2 total	**4**	**6**	**6**	**16**	**12**	**0**

Question				Marking details		Marks available				
					AO1	AO2	AO3	Total	Maths	Prac
3	*(a)*	(i)		Units of a, v, r given as $m\,s^{-2}$, $m\,s^{-1}$, m (1) Convincing algebra **must see** $m^2\,s^{-2}$ (1)	1	1		2	1	
		(ii)		[According to equation] a becomes smaller **or** zero (1) [Sensible because] body's path [almost] straight **or** equivalent (1)			2	2		
	(b)	(i)		$v = \frac{2\pi x\ 200}{52}$ [= 24.2 m s^{-1}] or ω = 0.121 [rad s^{-1}](1) $F_{centrip}$ = 1 150 × ($\frac{2\pi x\ 200}{52}$)^2 ÷ 200 [N] or equivalent or by implic(1) $F_{centrip}$ = 3 360 [N] **or** 3 400 [N] **Accept** 3 358 [N] or 3 300 [N] (1)		3		3	3	
		(ii)	I	$F_{centrip} = F \sin\theta$ **or** 3 360 (or 3 000) = 5 500 $\sin\theta$ **or** equiv **or** by implic **ecf** on $F_{centrip}$ (1) θ = 37.6°(or 38°) (1)		2		2	2	
			II	Forward component of F must balance D (**or** must be equal and opposite to D) **or** since car is travelling at constant speed (1) $D = F\cos\theta$ or equiv **ecf on** θ (1) D = 4 360 [N] (1)	1	1 1		3	2	
				Question 3 total	**2**	**8**	**2**	**12**	**8**	**0**

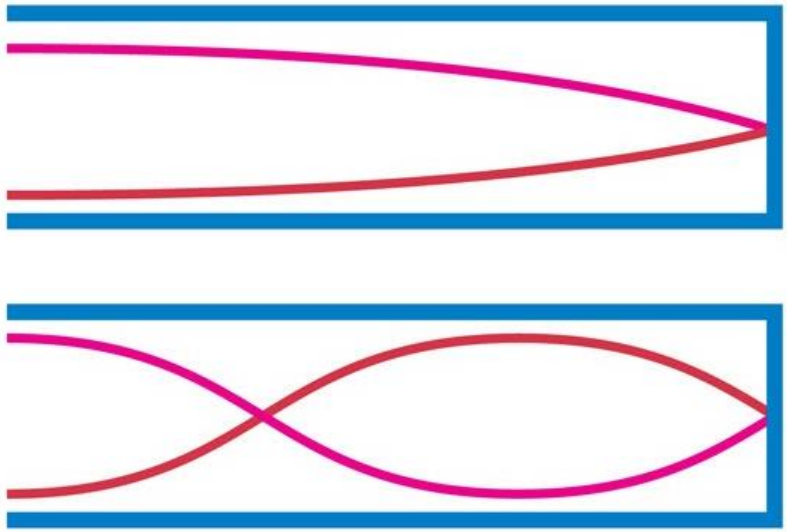
Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
4	*(a)*		Falling amplitude (1) [Air] resistance **or** dissipative forces **or** equivalent (1)	2			2		
	(b)		$T = 2\pi\sqrt{\frac{0.200}{22.0}}$ [s] (1) = 0.599 [s] (1) T read from graph = 0.60 [s] (1) Prediction convincing [no significant difference] (1)			4	4	2	
	(c)		Point at 0.15 s marked – no tolerance (first displacement zero) (1) $v_{\max} = 0.020 \times \frac{2\pi}{0.60}$ $\left[\text{m s}^{-1}\right]$ (1) = 0.21 m s^{-1} **UNIT** (1) Too large owing to energy dissipation in first quarter cycle (1) **Accept** less detailed reason, such as 'because of damping' **Alternative for last 3 marks:** $v_{\max} = 0.018 \times \frac{2\pi}{0.60}$ $\left[\text{m s}^{-1}\right]$ (1) = 0.19 m s^{-1} **UNIT** (1) Too small because amplitude has fallen or equivalent (1) **Alternative for last 3 marks (mean found):** $v_{\max} = 0.019 \times \frac{2\pi}{0.60}$ $\left[\text{m s}^{-1}\right]$ (2) = 0.20 m s^{-1} **UNIT** (1) no comment required	1	1 1 1		4	2	
	(d)		Data from one maximum or minimum on the graph (other than at t = 0) substituted into the given equation or equivalent accept slips (1) $\lambda = 0.35$ $[\text{s}^{-1}]$ $[\pm 0.03\ \text{s}^{-1}]$ (1)		2		2	1	
			Question 4 total	**3**	**5**	**4**	**12**	**5**	**0**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
5	*(a)*		**Indicative comments:** **A: Why the gas exerts a pressure** A1 Molecules collide with walls (or by implication). A2 Collisions exert (outward) forces on walls. A3 Molecules undergo changes in momentum [or in velocity or undergo acceleration] when colliding with walls. A4 Newton's third law applied correctly [even if not named] A5 Collisions distributed randomly over wall area. **Accept** reference to $p = \frac{F}{A}$. A6 Collisions between molecules and walls [on average] elastic **B: Why the pressure increases with temperature** B1 Mean KE of molecules [or rms speed, or mean speed or mean [magnitude] of momentum] increases with temperature. B2 Hence increases pressure [or force] exerted on walls. B3 On average each collision contributes more to pressure [or exerts greater force or has a greater momentum change] if molecules moving faster. B4 There'll also be more collisions per second if molecules are moving faster. **5-6 marks** Comprehensive account of why the gas exerts a pressure along with why pressure increases with temperature typically: Typical example A1 + A2 + A3 + (A4 or A5 or A6) B1 + B2 + (B3 or B4) *There is a sustained line of reasoning which is coherent, relevant, substantiated and logically structured.* **3-4 marks** Either comprehensive account of why the gas exerts a pressure or why pressure increases with temperature or account given of why the gas exerts a pressure and why pressure increases with temperature typically: Typical example A1 + A2 + (A3 or A4 or A5) B1 (but no mention of 'mean' needed) + B2 *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 Limited account of why the gas exerts a pressure and/or why pressure increases with temperature typically: Typical example A1, A2 B1 (but no mention of 'mean' needed) Any other point from A3, A4, A5, A6, B2 *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.*						
	(b)	(i)	$\rho = \frac{0.091}{0.020}$ $\left[= 4.55 \text{ kg m}^{-3}\right]$ **or** $Nm = 0.091$ [kg] **or** by implication (1) $c_{\text{rms}} = \sqrt{\frac{3\times3.9\times10^5\times0.020}{0.091}}$ *or* ${c_{\text{rms}}}^2 = \frac{3\times3.9\times10^5\times0.020}{0.091}$ or by implic (1) [transposed and data inserted or vice versa] 510 m s^{-1} (1) Single arithmetical slips, including by a factor of 1 000, attract a 1 mark penalty. An error factor of N_{A}, (which may arise when $pV = \frac{1}{3}Nmc_{\text{rms}}^2$ is misapplied) loses 2 marks (error of principle).		3		3	3	
		(ii)	$n = \frac{91}{28} = [\,3.25 \text{ mol}]$ **or** by implication (1) $T = \frac{3.9\times10^5\times0.020}{3.25\times8.31}$ **or** by implication **ecf** on n for this mark only (1) = 290 K **UNIT** (1)		3		3	3	
			Question 5 total	**6**	**6**	**0**	**12**	**6**	**0**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
6	*(a)*	(i)	Circuit that will supply power to heating coil. Accept cell or battery symbol for power supply or unclear symbol for power supply if labelled. (1) Ammeter and voltmeter correctly connected. (1)	2			2		2
		(ii)	Heat loss [begins to show at higher temperatures] (1) Insulate (lag) the cylinder (1)			2	2		2
		(iii)	Reasonable max gradient line drawn through error bars and triangle or pair of points ≥ half grid width shown (1) Same for min gradient (1) Maximum gradient between 0.200 and 0.230 [°C s^{-1}] (1) Minimum gradient between 0.170 and 0.190 [°C s^{-1}] (1) No sig fig penalty		4		4	4	4
		(iv)	$VIt = mc\,(\theta - \theta_0)$ or $VI(\Delta)t = mc\,\Delta\theta$ (1) $\theta = \frac{VI}{mc}t + \theta_0$ or $\frac{\Delta\theta}{\Delta t} = \frac{VI}{mc}$ (1) [Hence gradient = $\frac{VI}{mc}$]		2		2	2	2
		(v)	Values of V, I, m and gradient(s) (max and min or mean) put into $c = \frac{VI}{m \times \text{gradient}}$ **or** by implication (1) Mean of extreme gradients taken **or** mean of extreme c values. (**ecf** on values whose mean is taken; this is a process mark) No sig fig penalty (1) Mean c value consistent with gradients and to **max of 3 sig figs** (**ecf**) and with correct **units** [e.g. 448 J kg^{-1} °C^{-1}or 450 J kg^{-1} °C^{-1}] (1) Extreme gradients put into % unc equation **or** half range of extreme c values calculated or by implication (1) Value of absolute unc evaluated correctly to 1 sig fig **ecf** (1) Accept 2 sig figs	1 1	1 1 1		5	5	5

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
	(b)	(i)	$\Delta U = \frac{3}{2} \times 0.031 \times 8.31 \times (424 - 295)$ [J] or by implication [ΔU = 49.85 J](1) $W = 95 \times 10^3 \times (1.15 - 0.80) \times 10^{-3}$ [J] or by implication [W = 33.3 J] (1) $Q = 83$ [J] **ecf** on ΔU or W (1)	1 1	1		3	3	3
		(ii)	Heat inflow depends on work done [as well as temperature rise] or equivalent (1) Work related to volume change e.g. [if no volume change no work done] (1)			2	2		2
			Question 6 total	**6**	**10**	**4**	**20**	**14**	**20**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
7	*(a)*		 or equivalent diagrams with A & N, dots (for nodes) and double-headed arrows (for antinodes) etc.	1 1			2		2
	(b)		f = 141 [Hz] (1) λ = 2.4 [m] (1)		2		2	2	2
	(c)		Correct reference to polarised light as having vibrations (or equivalent) in one direction (1) At θ = 0 and / or 180^o polaroids aligned (1) At θ = 90^o polaroids crossed (1) Intermediate angles partial blocking or partial transmission or equivalent (1)	4			4		4

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
	(d)	(i)	When $\theta = 0$, cos $\theta = 1$ or $(\cos\theta)^2 = 1$ so $I = I_0$ Accept substitution of I and θ for any other value of θ		1		1	1	1
		(ii)	$(\cos 140°)^2 = 0.587$ (1) predicted $I = 340 \times 0.587 = 200$ agreeing with graph point (1) [or $\frac{I}{I_0} = \frac{200}{340}$ =0.588 agreeing with $(\cos 140°)^2$]	1	1		2	2	2
	(e)		More grip for smooth rubber seems to contradict (1) 4^o difference but a resolution of 0.1^o (accept 1^o) **or** an uncertainty of <1% (1) Not random error **or** a less firm conclusion argued because more info needed about repeats (1)			3	3		3
	(f)		Valid demonstration of inverse cube, for e.g. $9.8 \times 8.0^3 = 5\,018$; $2.9 \times 12.0^3 = 5\,011$ (1) Comment: accept either "good agreement" or with reservations, such as more results needed (1)			2	2	1	2
	(g)	(i)	12.5 [m s^{-1}]		1		1		1
		(ii)	First 25 s: straight line from (0,0) to (25,12.5) **and** vertical scale (accept single label at 12.5) (1) 25 s – 30 s v continues to rise but at decreasing rate (curve) (1) 30 s – 50 s constant velocity with continuity of line at 30 s (1)		3		3	3	3
			Question 7 total	**7**	**8**	**5**	**20**	**9**	**20**

COMPONENT 1: NEWTONIAN PHYSICS

SUMMARY OF MARKS ALLOCATED TO ASSESSMENT OBJECTIVES

Question	AO1	AO2	AO3	TOTAL MARK	MATHS	PRAC
1	2	2	4	8	5	0
2	4	6	6	16	12	0
3	2	8	2	12	8	0
4	3	5	4	12	5	0
5	6	6	0	12	6	0
6	6	10	4	20	14	20
7	7	8	5	20	9	20
TOTAL	**30**	**45**	**25**	**100**	**59**	**40**