GCE AS MARKING SCHEME

SUMMER 2018

AS (NEW)
PHYSICS - UNIT 1
2420U10-1

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.

AS UNIT 1 – MOTION, ENERGY AND MATTER

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.

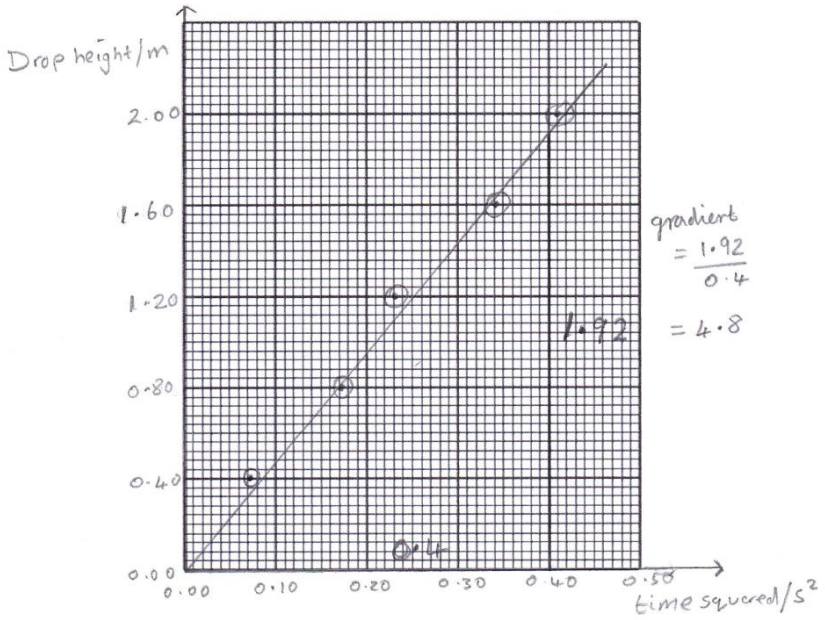
Marking abbreviations

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)*		Moment of force about a point = Force × perpendicular distance from [**not** around] the point (to the line of action of the force). Accept symbol for perpendicular	1			1		
	(b)	(i)	Clockwise moment [CM] = 52 × 0.15 **Or** CM = 7.8 (N m) seen		1		1	1	
		(ii)	F × 0.58 = 8 **or** answer to (b)(i) **or** F × 0.58 =52 × 0.15 (**ecf** from (b)(i)) (1) F = 13.8 N (or 13.4 if 7.8 N m used – accept 13.5) (1) [Accept 2 s.f.] Correct answer → 2 marks		2		2	2	
	(c)		In position 2 [perpendicular] distance of weight from hinge is smaller (1) …. so CM decreased (1) So ACM reduced (1) so force in bar decreased and so Tom incorrect **o**r Bethan correct (1) **Or** (converse argument): In position 1 [perpendicular] distance of weight from hinge is greater (1)… so CM increased (1) So ACM increased (1) So force in bar increased and so Tom incorrect or Bethan correct (1) Accept answers based on calculation Do not accept reference to Tom/Bethan being correct/incorrect without explanation Alternative explanation using vertical position of bar: In position 1 the bar is closer to the pivot (1) .. so to balance the clockwise moment (1).. the force in bar is increased so Tom incorrect / Bethan correct (1)			4	4		
			Question 1 total	**1**	**3**	**4**	**8**	**3**	**0**

<table>
<tr><th colspan="3" rowspan="2">Question</th><th rowspan="2">Marking details</th><th colspan="4">Marks available</th><th></th><th></th></tr>
<tr><th>AO1</th><th>AO2</th><th>AO3</th><th>Total</th><th>Maths</th><th>Prac</th></tr>
<tr><td>2</td><td>(a)</td><td>(i)</td><td>Magnitude of vertical force = 2.0×10^{-4} (N) (1) [Direction not required here]
Application of Pythagoras and correct overall magnitude determined i.e $R^2 = (2.0 \times 10^{-4})^2 + (5.0 \times 10^{-4})^2$
$R = 5.4 \times 10^{-4}$ (N)[accept 5.38 or 5.39] (1) No ecf
$\theta = 21.8°$ [tolerance of rounding errors] below horizontal [allow 112°, 22° South of E…] stated or clearly shown in diagram [accept 68.2° to the vertical stated or shown] ecf on R (1)</td><td></td><td>3</td><td></td><td>3</td><td>3</td><td></td></tr>
<tr><td></td><td></td><td>(ii)</td><td>Air resistance and force due to gravity [or weight] are equal [or air resistance = 6.0×10^{-4} N] hence no resultant force [accept forces balanced /cancel / no acceleration]</td><td>1</td><td></td><td></td><td>1</td><td></td><td></td></tr>
<tr><td></td><td>(b)</td><td>(i)</td><td>Subtract …0.05 [from readings (of time)] / ….the time delay / …it</td><td></td><td></td><td>1</td><td>1</td><td></td><td>1</td></tr>
<tr><td></td><td></td><td>(ii)</td><td>
<table>
<tr><td>Drop height h, (m)</td><td>0.40</td><td>0.80</td><td>1.20</td><td>1.60</td><td>2.00</td></tr>
<tr><td>Corrected time t, (s)</td><td>0.27</td><td>0.41</td><td>0.48</td><td>0.58</td><td>0.64</td></tr>
<tr><td>Corrected time squared t^2, (s^2)</td><td>0.07(3)</td><td>0.17</td><td>0.23</td><td>0.34</td><td>0.41</td></tr>
</table>
All values of t^2 calculated correctly (1) [award this mark, even if sig figs incorrect]
To 2 sig. fig. [Allow 1 sf on first answer] [see table] (1)</td><td></td><td>2</td><td></td><td>2</td><td>2</td><td>2</td></tr>
<tr><td></td><td></td><td>(iii)</td><td>$x = ut + \frac{1}{2}at^2$ identified (1)
Explanation that: [$x = h$], $u = 0$ and $a = g$ [or by implication] (1)
No algebra required</td><td>1</td><td>1</td><td></td><td>2</td><td></td><td></td></tr>
</table>

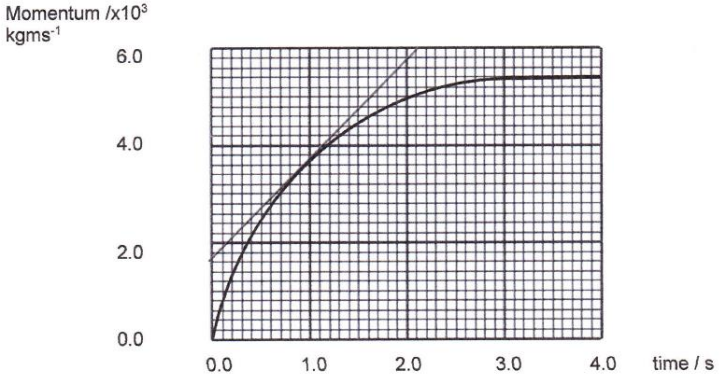
Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
		(iv)	Suitable scale and both axes labelled correctly with appropriate units: [drop] height [h]/ m and time squared [t^2]/ s^2 [or $(t / s)^2$] (1) Allow ecf from table All 5 points plotted correctly ± ½ small square division (2) If 4 points plotted correctly ± ½ small square division (1) If 3 or less points plotted correctly ± ½ small square division (0) Appropriate line of best fit [through origin] (1) **ecf**  		4		4	4	4
		(v)	Suitable triangle shown on graph [or two points on line implied in calculation] with $\Delta h \geq 1.0$ m [or two appropriate points shown on line] See above (1) Gradient calculated correctly [Accept 4.6 to 5.0] (1) g = 2 × gradient [Allow **ecf**] (1) 2nd and 3rd mark can be awarded even if first mark withheld. [Allow final mark for correct answers using data points rather than gradient]			3	3	2	3

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
	(c)		Straight line / $h \propto t^2$ / linear graph (1) Through [or close to] origin (1) g close to accepted value / 9.81 or low degree of scatter / points close to line of best fit [accept relevant comment based upon candidate's graph] (1)			3	3		3
			Question 2 total	**2**	**10**	**7**	**19**	**11**	**13**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
3	*(a)*		**Equipment:** Award **one mark** for…..(1) Appropriate diagram [or good description] to include: rubber band supported vertically, ruler [or equivalent], weights (or force-meter attached to band) **or** appropriate horizontal setup (1) **Method**. Award **1 mark** for 2 of the following: (1) • Add weights [or masses] / increase the force … in incremental steps • Secure base with G clamp [can be credited from diagram] • Place ruler at appropriate point close to / aligned with band / avoiding parallax or use optical pin (or equivalent) [can be credited from diagram] **Measuring extension** Award 1 mark for …….(1) **Either:** Measure original length, then new length and subtract to find extension. **Or:** Set ruler to zero at low weight/band taut but not extended and read extension directly [or equiv.]	3			3		3

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
	(b)	(i)	Strain = $\frac{6}{8}$ = [0.75] [ignore units]		1		1	1	1
		(ii)	Stress = $\frac{7.0}{0.050}$ (1) = 140 N cm^{-2} [Or 1.4 × 10^{6} N m^{-2}] Note: No unit requirement for stress value E = 140 ÷ 0.75 (1) (**ecf** on strain) E = 186.7 **N cm^{-2}** (1) **[UNIT].** **Or**: E = 1.87 × 10^{6} **N m^{-2} (or Pa)** **Alternatives for the first two marks:** Use of $E = \frac{Fl}{Ax}$ or $E = \frac{F}{A\varepsilon}$ (1) Then 1 mark for substitution (1) **Either** (in cm): $E = \frac{7 \times 8}{0.050 \times 6}$ or $E = \frac{7}{0.050 \times 0.75}$ **Or** (in m) $E = \frac{7 \times 8 \times 10^{-2}}{0.050 \times 10^{-4} \times 6 \times 10^{-2}}$ or $E = \frac{7}{0.050 \times 10^{-4} \times 0.75}$			3	3	3	3
	(c)		At (C) molecules unravel / straighten (accept untangle) under the action of a force. [Accept – C-C bond rotates] (1) At (D) molecules fully stretched/ strong forces between atoms within molecule / stretching (covalent) bonds (1) **Either:** Small force (or stress) produces large extension (or strain) hence shallow gradient initially/ or at C **Or:** Large force (or stress) produces small extension (or strain) hence steep gradient finally/ or at D (1)	3			3		3
			Question 3 total	**6**	**1**	**3**	**10**	**4**	**10**

<table>
<tr><th colspan="3" rowspan="2">Question</th><th rowspan="2">Marking details</th><th></th><th colspan="3">Marks available</th><th></th></tr>
<tr><th>AO1</th><th>AO2</th><th>AO3</th><th>Total</th><th>Maths</th><th>Prac</th></tr>
<tr><td>4</td><td>(a)</td><td>(i)</td><td>
<table>
<tr><th>Particle</th><th>Symbol</th><th>Quark Combination</th><th>Charge/e</th><th>Baryon Number</th></tr>
<tr><td>Proton</td><td>p</td><td>uud</td><td>+1</td><td>1</td></tr>
<tr><td>Delta particle</td><td>Δ^{++}</td><td>uuu</td><td>+2</td><td>1</td></tr>
<tr><td>Electron</td><td>e^-</td><td>No quarks present</td><td>-1</td><td>0</td></tr>
<tr><td>Pion</td><td>π^-</td><td>$\bar{u}d$ or $d\bar{u}$</td><td>-1</td><td>0</td></tr>
</table>
[3 × 1] marks for each correct row (ignoring row for proton)</td><td></td><td>3</td><td></td><td>3</td><td></td><td></td></tr>
<tr><td></td><td></td><td>(ii)</td><td>Electron</td><td>1</td><td></td><td></td><td>1</td><td></td><td></td></tr>
<tr><td></td><td>(b)</td><td></td><td>Charge:
LHS: -1 +1 (=0)
RHS: -1 +2 -1 (=0) [must be shown how 0 is determined on both sides] (1)
Lepton Number:
LHS: 1 + 0 (= 1)
RHS: 1 + 0 + 0 (=1) [must be shown how 1 is determined on both sides] (1)</td><td></td><td>2</td><td></td><td>2</td><td></td><td></td></tr>
<tr><td></td><td>(c)</td><td>(i)</td><td>Up Quark: Δ^{++} contains 3 up quarks (uuu) = proton contains 2 up quarks (uud) + pion contains 1 up quark ($u\bar{d}$) (1)
Down Quark: Δ^{++} contains 0 down quarks = proton contains 1down quark (uud) + pion contains 1 antidown quark ($u\bar{d}$). (1)
Alternative for first mark: equation in quark form $uuu \rightarrow uud + u\bar{d}$</td><td></td><td>2</td><td></td><td>2</td><td></td><td></td></tr>
<tr><td></td><td></td><td>(ii)</td><td>Any 2 × (1) from:
• Very short lifetime / decays quickly / ref to 6×10^{-24} s
• No change in u or d quark number (or flavour)
• Only quarks or hadrons involved
• No γ (or photon) or no neutrino involvement</td><td>2</td><td></td><td></td><td>2</td><td></td><td></td></tr>
<tr><td></td><td>(d)</td><td></td><td>No practical use for electron or proton or both when they were discovered (1)
Now many uses and one example given for either electron or proton (1)</td><td></td><td></td><td>2</td><td>2</td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td>Question 4 total</td><td>3</td><td>7</td><td>2</td><td>12</td><td>0</td><td>0</td></tr>
</table>

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
5	*(a)*		Newton's 2nd Law	1			1		
	(b)	(i)	 Suitable tangent at t = 1.0 [±0.1] s seen [$\Delta t \geq 1.0$ s] (1) Appropriate [with $\Delta t \geq 1.0$ s] values taken from tangent and manipulated correctly to show $F_{\text{resultant}} \approx 2\,000$ N (1) [**ecf** on tangent in range 1.7 – 2.3 kN]		2		2	2	
		(ii)	m = 2 000 (or own value from (i)) ÷ 0.4 (= 5 000 kg)		1		1	1	
		(iii)	P labelled on line at $t \geq 3.0$ s	1			1		

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
	(c)	(i)	The vector sum of the momenta of bodies in a system stays constant (even if forces act between the bodies), ... (1) .....provided there is no external / resultant force / in an isolated system (1) Accept: The total momentum before a collision is equal to the total momentum after a collision..... (1) .....provided there is no external / resultant forces act / in an isolated system (1)	2			2		
		(ii)	Momentum before collision = 5.4×10^3 (N s) (1) [from graph] Momentum after collision = (5 000 or ans to *(b)*(ii)+ 7 000) v (1) v = 0.45 (m s^{-1}) (1) [**ecf** on value from graph, including slips in power of 10]	1	1 1		3	3	
			Question 5 total	**5**	**5**	**0**	**10**	**6**	**0**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
6	*(a)*		**Indicative content:** 1. Wavelength at peak intensity and Wien's Law [can be used to] determine [surface] temperature of the star. 2 Power emitted per square meter or area can be calculated using Stefan's law [details not required] 3. Colour of star can be deduced from wavelength of max intensity / spectrum. 4. Line **absorption** spectrum shown. 5 Line spectrum arises from passage of [continuous] spectrum/light/radiation / photons through stellar atmosphere 6 absorbing atoms/elements can be identified from wavelength of lines **Other relevant points:** • Total area under graph represents total power radiated • Absorption spectrum indicates temperature and generation of star • Redshift gives radial / recessional/ velocity/ distance • Reference to inverse square law and distance	6			6		

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
			5-6 marks At least 5 relevant points given *There is a sustained line of reasoning which is coherent, relevant, substantiated and logically structured.* **3-4 marks** At least 3 relevant points given *There is a line of reasoning which is partially coherent, largely relevant, supported by some evidence and with some structure.* **1-2 marks** At least 1 relevant points given *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			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
	(b)	(i)	Recall of $I = P \div 4\pi R^2$ in any form (1) Substitution: P (or Luminosity) = $1.32 \times 10^{-8} \times 4\pi \times (1.58 \times 10^{17})^2$ (1) $P = 4.1(4) \times 10^{27}$ W seen (1)	1	1 1		3	3	
		(ii)	Substitution: $P = A\sigma T^4$ in any form e.g.: $4 \times 10^{27} = A \times 5.67 \times 10^{-8} \times (7\,700)^4$ (1) [Accept $4.1(4)10^{27}$ for P] $A = 2.0 \times 10^{19}$ m^2 (1) [2.1×10^{19} if 4.14×10^{27} used] Diameter = 2.5×10^9 m (1) [2.6×10^9 if 2.1×10^{19} used] Use of πR^2 rather than $4\pi R^2 \rightarrow 5 \times 10^9$ m (2 marks)	1 1	1		3	3	
			Question 6 total	**9**	**3**	**0**	**12**	**6**	**0**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
7	*(a)*	(i)	Work done = $65\,000 \times 32 = 2.08 \times 10^6$ J		1		1	1	
		(ii)	Energy at B = $2\,600 \times 9.81 \times 42$ (1) or 1.07×10^6 seen Substitution into % efficiency = $\frac{1.07 \times 10^6 \times 100\%}{2.08 \times 10^6}$ (1) (**no ecf**) % efficiency = 51.5% (1) [accept 51% – 55%, or 0.51 – 0.55]	1	1 1		3	3	
	(b)		Work against resistive forces = $2\,800 \times 36$ (1) or 101 kJ seen ΔE_p using 30 m drop = -765 kJ (1) Substitution into work-energy theorem: KE gain = 765 kJ – 101 kJ = 664 kJ (1) 664 000 = ½ × 2 600 × v^2 (1) [allow use of 765 kJ] v = 22.6 m s^{-1} (1) [765 kJ → 24.3 m s^{-1}] Additional marking guidance • Whole drop (42 m) with resistive forces → 27.3 m s^{-1} → 4 marks • 30 m drop without resistive forces → 24.3 m s^{-1} → 3 marks • Whole drop without resistive forces → 28.7 m s^{-1} → 2 marks • Mixing force and energy → 0 • Use of $v^2 = u^2 + 2ax$ →0 • Dissipate energy =	1	1 1 1 1		5	5	
			Question 7 total	**2**	**7**	**0**	**9**	**9**	**0**

AS UNIT 1: Motion, Energy and Matter

SUMMARY OF MARKS ALLOCATED TO ASSESSMENT OBJECTIVES

Question	AO1	AO2	AO3	TOTAL MARK	MATHS	PRAC
1	1	3	4	8	3	0
2	2	10	7	19	11	13
3	6	1	3	10	4	10
4	3	7	2	12	0	0
5	5	5	0	10	6	0
6	9	3	0	12	6	0
7	2	7	0	9	9	0
TOTAL	**28**	**36**	**16**	**80**	**39**	**23**