GCE AS MARKING SCHEME

SUMMER 2019

AS
PHYSICS - UNIT 1
2420U10-1

INTRODUCTION

This marking scheme was used by WJEC for the 2019 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.

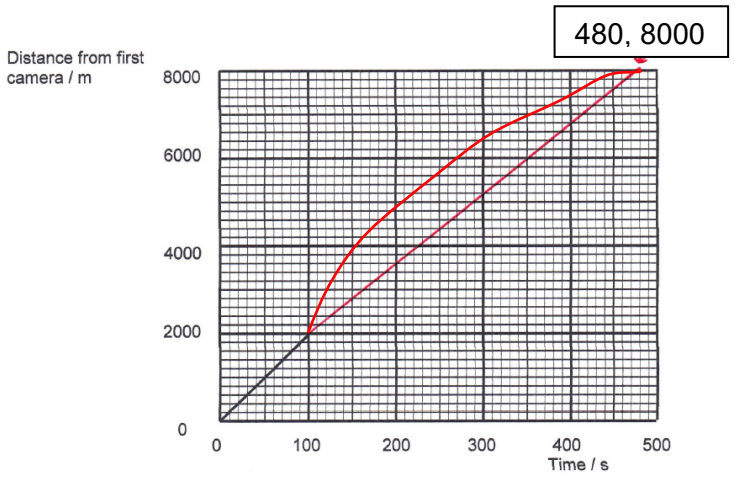
Marking abbreviations

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)*	(i)	Quarks **and** leptons **and** mesons – all required	1			1		
		(ii)	Quarks **and** mesons	1			1		
	(b)	(i)	Anti-[electron] neutrino Accept: [electron] anti-neutrino		1		1		
		(ii)	**Lepton number:** 0 = 0 + 1 -1 must be in this order **or** described: lepton number is 0 on LHS. Electron has lepton number of +1, anti-electron neutrino has a lepton number of -1. [1] Accept 4 = 4 + 1 -1 must be in this order. **Charge:** B has one more proton than Be, but appearance of e^- means that charge is conserved **or** +4 = +5 – 1 [+ 0] must be in this order **Or:** 0 $\rightarrow$1 -1 + 0 must be in this order or described **or** $n = p + e^- +$ anti-neutrino so $d = u + e^- +$ anti-neutrino so $-\frac{1}{3} = \frac{2}{3} - 1 + 0$ [1]		2		2		
	(c)	(i)	$^{10}_{4}Be$ has 6 neutrons **and** $^{10}_{5}B$ has 5 neutrons	1			1		
		(ii)	LHS: udd [1] RHS: uud [1] **N.B.** bod if udd $\rightarrow$ uud + e^- + anti-neutrino seen Award **1 mark** if above seen with quarks assigned to either the e^- and/or anti-neutrino Award **1 mark** for d$\rightarrow$u **or** d in n$\rightarrow$u in p or similar Award **1 mark** if equation written the wrong way around		2		2		
			Question 1 total	**3**	**5**	**0**	**8**	**0**	**0**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
2	*(a)*		Vector: Magnitude (size) and direction Scalar: Magnitude (size) only Minimum acceptable response: *a vector has direction* [1] Relevant example of each **e.g.** independent mark [1] **Vectors** / **Scalars** Displacement / Speed Velocity / Time Acceleration / Distance Force / Pressure Temperature	2			2		
	(b)	(i)	From graph speed = $\frac{2\,000}{100}$ or equiv [e.g. $\frac{1000}{50}$] (or $20\,\text{m s}^{-1}$) seen [1] Convincing conversion to km h^{-1} (i.e. $\times \frac{3\,600}{1000}$) or 72 [$\text{km h}^{-1}$] seen **or** convert $70\,\text{km h}^{-1}$ into $19.4\,\text{m s}^{-1}$ [1]	1	1		2	2	

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
		(ii)	Time to complete distance at mean speed of 60 km h^{-1} = $\frac{8}{60}$ [1] (= 0.1333) Conversion t = 480 s [1] Accept rounded values e.g. 17 m s^{-1} gives t = 471 s **Alternative for first 2 marks:** 60 km h^{-1} = $\frac{1000}{60}$ m s^{-1} (1) $t = \frac{8000}{\left(\frac{1000}{60}\right)}$ = 480 s (1) **Alternative for first 2 marks:** 1 km per minute (1) t = 8 minutes or 480 s (1) **3rd mark** - Continuous (though not necessarily straight) line drawn on graph from (100, 2 000) to (480**ecf**, 8 000) tolerance ± small square - two possible examples shown: [1] 	3		3	3	

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
	(c)		Correct substitution into $v^2 = u^2 + 2ax$ (i.e. $0 = u^2 - (2 \times 8 \times 85)$ [1] don't award mark if incorrect signs u = 36.9 [m s^{-1}] **ecf** on incorrect signs [1] No, greater than speed limit [1] must correlate with working **Alternative:** Correct substitution into $v^2 = u^2 + 2ax$ using 30 m s^{-1} to find x. (i.e. $0 = (30)^2 - (2 \times 8 \times x)$ [1] don't award mark if incorrect signs x = 56.3 [m] **ecf** on incorrect signs [1] No, greater than speed limit [1] must correlate with working **Alternative:** Using $v = u + at$ to determine t = 3.75 s (1) Using $x = \frac{1}{2}(u+v)t$ i.e. 3.75 $\times$ mean velocity (15) = 56.3 [m] (1) No, greater than speed limit [1] must correlate with working			3	3	2	
			Question 2 total	**3**	**4**	**3**	**10**	**7**	**0**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
3	*(a)*		The (vector) sum of the momenta of bodies in a system stays constant (even if forces act between the bodies) accept overall momentum remains constant [1] provided there is no external / resultant force [1] **Accept**: Total momentum of a system (or bodies) before a collision (or explosion) = total momentum after collision (explosion)... [1] ....provided no external / resultant forces act [1]	2			2		
	(b)	(i)	$600 \times 1.8 \times 10^3 = (500 \times v) + (100 \times 2 \times 10^3)$ [1] v = [+]1 760 [m s^{-1}] [1]		2		2	2	
		(ii)	Use of $\frac{1}{2}mv^2$ [1] Before separation $E_k = 9.72 \times 10^8$ [J] [1] After separation $E_k = 9.74 \times 10^8$ [J] **ecf** [1]	1	1 1		3	2	
		(iii)	Chemical energy **or** thermal energy **or** internal energy **or** work <u>from explosion</u> [transferred to E_k]	1			1		
	(c)		Substitution into $Ft = mv - mu$ for probe i.e. $F \times 0.002 = 100 (2 \times 10^3 - 1.8 \times 10^3)$ [1] **Alternative for 1st mark:** Use of $F = ma$ to calculate $a = \frac{(v-u)}{t}$ = 1×10^5 m s^{-2} **Alternative for 1st mark:** $F \times 0.002 = 500 (1.76 \times 10^3$ **ecf** $- 1.8 \times 10^3)$ [1] F = [-] 1×10^7 N **unit mark** [1]		2		2	2	
			Question 3 total	**4**	**6**	**0**	**10**	**6**	**0**

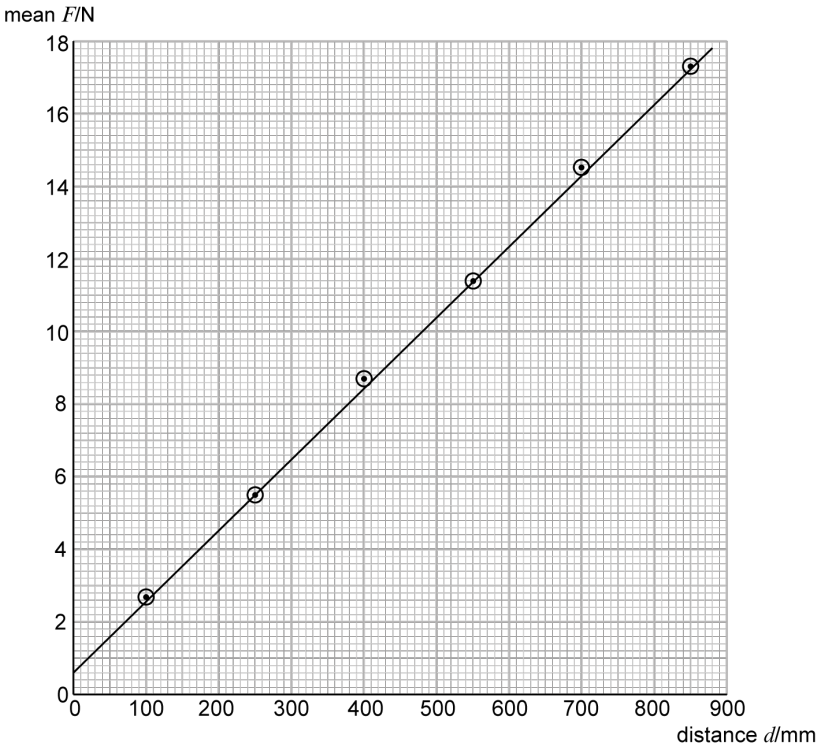
Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
4	*(a)*		$\frac{40}{T} = \cos 36°$ (1) T = 49.4 [N] seen [1] **Alternative:** Resistive force = $50\cos 36°$ [1] = 40.5 [N] seen [1] **Alternative:** $\theta = \cos^{-1}\left(\frac{40}{50}\right)$ [1] θ = 36.9° [1]	1	1		2	2	
	(b)	(i)	Horizontal component of tension increased **and consequence i.e.** reference to unbalanced forces (e.g. forward force > than resistive force) Accept greater horizontal resultant force [from dog]		1		1		
		(ii)	ΣF = 49.4 $\cos 20°$ - 40 [= 6.4 N] [1] $a = \frac{6.4}{35}$ **ecf** on ΣF [1] a = 0.18 [m s^{-2}] [1] N.B. If 50 N used then ΣF = 7 N and a = 0.2 [m s^{-2}]	1	1 1		3	3	

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
	(c)		Rate of doing work = $F_H \times v$ **or** $F_H \times \frac{d}{t}$ [1] accept answers based on work done i.e. work = $Fx\cos\theta$ or $W = F_H x$ 1×[1] for one of: • F_H has increased [v has increased – award mark if no reference made to v or $\frac{d}{t}$ here] ✓ • $\cos\theta$ increased ✓ • as v increases drag increases, so more work is done against drag (per unit distance and time) ✓ Therefore P increased / claim is incorrect [1] accept answer based on work rather than rate of doing work			3	3		
			Question 4 total	**2**	**4**	**3**	**9**	**5**	**0**

<table>
<tr><th colspan="3" rowspan="2">Question</th><th rowspan="2">Marking details</th><th colspan="6">Marks available</th></tr>
<tr><th>AO1</th><th>AO2</th><th>AO3</th><th>Total</th><th>Maths</th><th>Prac</th></tr>
<tr><td>5</td><td>(a)</td><td></td><td>For a system to be in equilibrium (1)
$\sum$ anticlockwise moments [about a point] = $\sum$ clockwise moments [about the same point] (1)
N.B. Award 1 mark for $\sum$ C.M = $\sum$ A.C.M. only
Alternative:
For a system to be in equilibrium (1) algebraic sum of moments / net moment / resultant moment [about a point] = 0 (1)</td><td>2</td><td></td><td></td><td>2</td><td></td><td></td></tr>
<tr><td></td><td>(b)</td><td></td><td>Centre of gravity or line of action of weight remained inside lower surface of block [or equiv, e.g. CoG remains to left of pivot]
Accept arrow clearly shown on diagram [1]
Produces anticlockwise <u>moment</u> (or torque) [about pivot] [1]</td><td></td><td>2</td><td></td><td>2</td><td></td><td>2</td></tr>
<tr><td></td><td>(c)</td><td>(i)</td><td>All mean F values determined correctly [1]

<table>
<tr><th>Mean F / N</th></tr>
<tr><td>2.7</td></tr>
<tr><td>5.5</td></tr>
<tr><td>8.7</td></tr>
<tr><td>11.4</td></tr>
<tr><td>14.6</td></tr>
<tr><td>17.4</td></tr>
</table>
Or accept:
<table>
<tr><th>Mean F / N</th></tr>
<tr><td>2.7[0]</td></tr>
<tr><td>5.45</td></tr>
<tr><td>8.65</td></tr>
<tr><td>11.4[0]</td></tr>
<tr><td>14.55</td></tr>
<tr><td>17.4[0]</td></tr>
</table></td><td></td><td>1</td><td></td><td>1</td><td>1</td><td>1</td></tr>
</table>

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
		(ii)	$FL = W_B d + 490W_R$ (1) Manipulation and use of L = 980 to show $F = \frac{W_B d}{L} + \frac{490W_R}{980}$ (1) **Alternative:** $FL = W_B d + W_R \frac{L}{2}$ (1) $\therefore \left[FL = W_B d + W_R \frac{L}{2} \right] \rightarrow F = \frac{W_B d}{L} + \frac{W_R}{2}$ (1)		2		2	2	2

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
		(iii)	Titles and units on the axis correct i.e. (Mean) force or F / N, distance or d / mm (1) Suitable scales chosen so that the data points occupy at least ½ of each axis and not involving awkward factors, e.g. 3 (1) allow **ecf** from table All points plotted correctly to within ± ½ small square division **ecf** from table (1) Line of best fit drawn correctly **not through origin** (1)  		4		4	4	4

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
		(iv)	I.	Gradient calculated correctly e.g. $\frac{12.4 - 0.6}{600}$ = 0.02 [1] W_B = gradient **ecf** × 980 e.g. = approx 19.6 [N] [1]			2	2	2	2
			II.	y-intercept determined correctly ± small square tolerance e.g. 0.7 [N] [1] W_R = 2 × y-intercept e.g.= 1.4 N **ecf** but don't apply for intercept of 0 [1]			2	2	2	2
	(d)			% Unc (d) calculated i.e. 1 × $\frac{100}{100}$ = 1 % [1] Uncertainty in (spread) $\Delta F = \frac{2.8 - 2.6}{2}$ = 0.1 [1] $p_F = \frac{0.1\text{ecf}}{2.7} \times 100\,\%$ = 3.7 % [1] Ignore s.f.	1	1 1		3	3	3
	(e)			Any 1 × (1) of [Spirit] level / appropriate method to ensure that the ruler is horizontal Use digital forcemeter / forcemeter with a higher resolution Clamp stand to hold newtonmeter Repeat readings <u>of force</u> [due to random errors]			1	1		1
				Question 5 total	**3**	**11**	**5**	**19**	**14**	**17**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
6	*(a)*		2 materials chosen and microscopic structure of each explained [2 × (1)] See below. 1 example given of each material [2 × (1)] See below. **Crystalline** - long range order / lattice like arrangement/regular arrangement structure e.g. metals **Amorphous** - short range order / irregular or random arrangement / no order e.g. glass, ceramics, brick **Polymeric** - long chain molecule arrangement [of hydrocarbons] e.g. rubber, polythene accept plastic	4			4		
	(b)		**Indicative content:** **Measurements**: • Extension of wire [with pointer/ruler] • Original length of wire [from clamp to pointer] • Diameter of wire using micrometer or (Vernier) callipers **Determination of Young modulus:** • Use $E = \frac{Fl}{Ae}$ or plot graph of load/extension or stress/strain and find gradient • A determined from $\pi\left(\frac{d}{2}\right)^2$ **Precautions**: • Repeat readings of e (adding/removing load) • Measure $\{d$ in various places on wire / mean $d\}$ • Keep temperature constant / use of Searle's apparatus • Ensure no kinks in wire • Soft wood so as not to damage wire • Ensure wire is securely clamped • Stay within elastic limit • Use of a longer wire / travelling miroscope • Avoid parallax	4		2	6		6

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
			5-6 marks Comprehensive account with reference to how the measurements must be made, how they should be used to determine Young modulus and precautions that should be taken to minimise uncertainties. *There is a sustained line of reasoning which is coherent, relevant, substantiated and logically structured.* **3-4 marks** Comprehensive account with reference to 2 out of 3 of the following or a limited attempt at all 3 areas - how the measurements must be made, how they should be used to determine Young modulus and precautions that should be taken to minimise uncertainties. *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 with reference to 1 out of 3 of the following or a limited attempt at 2 areas - how the measurements must be made, how they should be used to determine Young modulus and precautions that should be taken to minimise uncertainties. *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 6 total	**8**	**0**	**2**	**10**	**0**	**6**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
7	*(a)*		Continuous spectrum due to radiation of all wavelengths emitted from surface of star [1] [superimposed] line absorption spectrum (due to passage of radiation) through atmosphere (of star) [1]	2			2		
	(b)	(i)	Use of $I = \frac{P}{4\pi R^2}$ [1] Substitution: $\frac{I_S}{I_V} = \frac{9.7\times10^{27}\times[4\pi]\left(2.4\times10^{17}\right)^2}{1.5\times10^{28}\times[4\pi]\left(8.1\times10^{16}\right)^2}$ [1] **Alternative for 2nd mark:** Calculation of either intensity: I_{Sirius} = 1.18 × 10^{-7} [W m^{-2}] or I_{Vega} = 2.07 × 10^{-8} [W m^{-2}] Ratio = 5.7 [1]	1	1 1		3	2	
		(ii)	Shape of curve below that of Sirius at all points [1] Peak at (1,λ_{max}) **ecf** [1]		2		2		
		(iii)	Substitution into $P=4\pi R^2\sigma T^4$ i.e. 9.7 × 10^{27} = 1.8 × 10^{19} × 5.67 × 10^{-8} × T^4 [1] T = 9.9 × 10^3 K (9 874 K) [1] Substitution into $\lambda_{max} = \frac{W}{T} = \frac{2.90\times10^{-3}\,[\mathrm{m\,K}]}{9.9\times10^{3}\,[\mathrm{K}]}$ **ecf** [1] λ_{max} = 2.9 × 10^{-7} [m] [1]	1 1	1 1		4	4	

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
	(c)		Reference to multiwavelength astronomy / using different parts of the em spectrum [1] Early photographs used visible light so limited / extra wavelengths **provide extra information** [1] Extra detail provided e.g. link between wavelength and temperature such as quasars at gamma / X-rays [1] This detail could be evidence for the 2nd mark.			3	3		
			Question 7 total	**5**	**6**	**3**	**14**	**6**	**0**

AS UNIT 1: MOTION, ENERGY AND MATTER

SUMMARY OF MARKS ALLOCATED TO ASSESSMENT OBJECTIVES

Question	AO1	AO2	AO3	TOTAL MARK	MATHS	PRAC
1	3	5	0	8	0	0
2	3	4	3	10	7	0
3	4	6	0	10	6	0
4	2	4	3	9	5	0
5	3	11	5	19	14	17
6	8	0	2	10	0	6
7	5	6	3	14	6	0
TOTAL	**28**	**36**	**16**	**80**	**38**	**23**