GCE AS MARKING SCHEME

SUMMER 2023

AS
PHYSICS – UNIT 1
2420U10-1

INTRODUCTION

This marking scheme was used by WJEC for the 2023 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 AS PHYSICS

UNIT 1 – MOTION, ENERGY AND MATTER

SUMMER 2023 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)		Force per unit extension **or** $\frac{\text{force}}{\text{extension}}$ **or** $\frac{F}{x}$ (or e, Δl - not l unless stated as extension) Don't accept $F = kx$ without terms explained	1			1		
	(b)		Extension = 0.07 [m] (1) Spring force = $20 \times 0.07 = 1.4$ [N] (**ecf** for e) (1) Principle of Moments correct: $1.4 \times 0.9 = (1.2 \times 0.5) + (3x)$ (1) x = 0.22 [m] **ecf** for use of 0.45 (1) If x = 0.24 [m] award 3 marks only		4		4	3	
	(c)		Extension doubled for given force (can be implied) (1), so spring constant halved, [Laura correct] (1) **Alternative:** Extension = 14 [cm], force = 1.4 [N] (1) $k = \frac{1.4}{0.14} = 10$ [N m^{-1} so Laura is correct] (1)			2	2		
			Question 1 total	**1**	**4**	**2**	**7**	**3**	**0**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
2	(a)	(i)	Vol = $\frac{4}{3}\pi \times (0.938)^3$ (1) substitution either in mm or cm or m Vol = 3.457 or 3.46 or 3.5 [cm^3] (1) % unc in $V = 3 \times 0.02 \times \frac{100}{18.76} = 0.32$ [%] seen **or** % unc in r = 0.1 % so if you cube r then 3 × uncertainty so 0.32 [%] (1)	1	1 1		3	3	3
		(ii)	% unc in mass = $0.5 \times \frac{100}{26.3}$ **or** shown = 1.9 [%] (1) Density = $\frac{26.3}{3.46\ \textbf{ecf}} = 7.61$ [g cm^{-3}] (1) Total % unc = 2.2 [%] **ecf** on % unc in mass (1) Density shown as 7.6 ± 0.2 [g cm^{-3}] **ecf** Accept 7.61 ± 0.17 (1) No more than 2 sig figs for the uncertainty.		4		4	4	4
	(b)		**For the 1st mark:** – % unc in vol = 2.9 [%] or greater **and** [%] unc in mass same as for Tomos / unchanged – % uncertainty in density = 4.8 [%] calculated – [absolute] uncertainty for Tomos = 0.01 [cm^3] **and** [%] unc in mass is the same – calculate [absolute] uncertainty for Jerry = 0.37 or 0.4 [g cm^{-3}] **2nd mark:** So [absolute] unc in density greater for Jerry **or** [absolute] unc in density lower for Tomos			2	2	1	2

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
	(c)		Tomos – Only stainless steel [within uncertainty range] **ecf** (1) Jerry – [Uncertainty range includes] stainless steel [and tin] and iron (1) **ecf** on any visible calculation **Answers must be consistent with candidate values**			2	2		2
			Question 2 total	**1**	**6**	**4**	**11**	**8**	**11**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
3	(a)	(i)	Horizontal – constant speed (with or without reference to force) (1) Vertical – [constant] acceleration due to force of gravity [acting downwards] (1)	2			2		
		(ii)	Similarity- projectile will [still] hit the apple (1) Difference - the apple falls further before being hit **or** greater time [before being hit] (1) Award 2 marks for - The apple will be hit further down		2		2		
	(b)	(i)	$v_H = 3.0$ [m s^{-1}]	1			1	1	
		(ii)	$v_v = 2.1$ [m s^{-1}] (from 3tan35°) (**ecf** on v_H) other methods possible (1) Attempt at use of $v^2 = u^2 + 2ax$ including allowing for incorrect use of signs (1) Correct substitution e.g. $0 = (2.1)^2 – 19.62h$ (1) (**ecf** on u_v) $h = 0.22$ [m] (1) **Alternative:** $v_v = 2.1$ [m s^{-1}] (from 3tan35°) (**ecf** on v_H) other methods possible (1) Attempt at use of $x = ut + ½ at^2$ including allowing for incorrect use of signs (1) Correct substitution: $h = 2.1 \times 0.2 – 4.9 \times 0.2^2$ (**ecf** on u_v) (1) $h = 0.224$ [m] (1)	1 1	1 1		4	4	

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
			Alternative: v_v = 2.1 [m s^{-1}] (from 3tan35°) (**ecf** on v_H) other methods possible (1) Attempt at use of $h = \frac{(u+v)}{2}t$ including allowing for incorrect use of signs (1) Correct substitution: $h = \frac{(2.1 \times 0.2)}{2}$ (**ecf** on u_v) (1) h = 0.21 [m] (1) **Alternative:** v_v = 1.962 [m s^{-1}] using $v = u + at$ (1) Attempt at use of $h = \frac{(u+v)}{2}t$ (1) Correct substitution: $h = \frac{(1.962 \times 0.2)}{2}$ (**ecf** on u_v) (1) h = 0.196 [m] (1) **Alternative:** Attempt at use of $x = ut + ½\,at^2$ including allowing for incorrect use of signs (1) u = 0 (or ut = 0) (1) Correct substitution: $h = 0 + ½ \times 9.81 \times 0.2^2$ (1) h = 0.196 [m] (1)						

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
		(iii)	Concept: $E_{total} = E_k + E_p$ (1) Subs: E_{total} = ½ × 0.1 × (3)^2 + 0.1 × 9.81 × 0.22 (1) **ecf** on v_H but not incorrect v used, and h. E_{total} = 0.67 [J] (1) **Alternative** Total E at h = initial KE (1) can be implied = ½ × 0.1 × 3.66^2 (1) = 0.67 [J] (1)	1	1 1		3	3	
	(c)		Energy at C = 0.5 × 0.1 × (3.3)^2 (1) = 0.54 [J] (1) Valid method for showing loss is approximately 20% e.g. 0.67 **ecf** × 0.8 = 0.54 [J] so claim correct (1) **Alternative:** Ratio of KE attempted (1) Answer = 0.81 or 81% (1) Hence 19% drop so claim correct (1) **Alternative:** 0.8 × 0.67 = 0.536 [J] (1) $v = \sqrt{\frac{2 \times 0.536}{0.1}}$ (1) v = 3.27 [m s^{-1}] close to 3.3 so claim correct (1)			3	3	3	
			Question 3 total	**6**	**6**	**3**	**15**	**11**	**0**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
4			**Indicative response:** **Candidates may label their graphs.** Initially, the ductile material **obeys Hooke's Law** and undergoes **elastic stretching** both of which are shown by the **linear** portion. The limit of the linear portion is called the **limit of proportionality**. The **gradient of the linear portion is the Young Modulus** of the material. Just beyond the limit of proportionality is the **elastic limit**. Beyond this point the material does not return to its original shape. The **yield point** is the point at which the material undergoes a large increase in strain for little or no increase in stress. The maximum stress is called the **breaking stress or ultimate tensile stress.** The material continues in the plastic stage until **the breaking point**. The curve bends downwards beyond the maximum stress. [In this region the sample exhibits **necking,** which is a narrowing of the region where it will eventually break.] **5-6 marks** Both elastic and plastic regions are covered comprehensively. *There is a sustained line of reasoning which is coherent, relevant, substantiated and logically structured.* **3-4 marks** Either the elastic and the plastic regions are covered partially or one of the regions covered comprehensively. *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 Little coverage of either plastic or elastic region. *There is a basic line of reasoning which is not coherent, largely irrelevant, supported by limited evidence and with little structure.* **0 marks** No attempt made or no response worthy of credit.						
			Question 4 total	**6**	**0**	**0**	**6**	**0**	**0**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
5	(a)		Net / resultant / [vector] sum of / total force (1) Correct example showing net of two or more forces numerically, algebraically or by convincing diagram (1)	1	1		2		
	(b)	(i)	Weight of block = 14 715 [N] (1) $a = \frac{(16\,000 - 14\,715)}{1500}$ (1) substitution and re-arrangement a = 0.86 [m s^{-2}] (1) **Alternative:** $a = \frac{16\,000}{1500}$ = 10.67 [m s^{-2}] (1) a = 10.67 – 9.81 (1) a = 0.86 [m s^{-2}] (1)	1	1 1		3	3	
		(ii)	Depends on acceleration (1) may exceed 16 000 N, so no (1)			2	2		
	(c)		Stress = $2 \times 10^{11} \times 3.2 \times 10^{-5} = 6.4 \times 10^{6}$ [N m^{-2}] (1) Tension = $6.4 \times 10^{6} \times 2 \times 10^{-3}$ = 12 800 [N] (1) **Award 2 marks** for determining T directly using strain $\times E \times A$ Decelerating – value not required but may be seen (1) **ecf from T** Because T < 14 715 [N] (can be implied) (1) **Alternative for 3rd and 4th marks** ΣF = 12 800 – 14 700 = -1 900 [N] (1) Negative value indicates a negative acceleration so the load must be decelerating (1)		4		4	2	

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
			Alternative: Stress with weight only = $\frac{14\,715}{2 \times 10^{-3}}$ = 7.36 M[Pa] (1) Strain for this force = $\frac{7.36 \times 10^{6}}{2 \times 10^{11}}$ = 3.7×10^{-5} (1) Comparing with 3.2×10^{-5} (in question and might be implied) (1) Hence decelerating (1)						
			Question 5 total	**2**	**7**	**2**	**11**	**5**	**0**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
6	(a)		Attempt at a tangent at t = 1 s (1) Correct values taken from graph (1) F = 0.035 [N] [tolerance ± 0.01] (1)	1 1	1		3	3	
	(b)		Graph horizontal / momentum does not change / constant before impact (1) Indicates no resultant / external / net forces (1) Conservation of momentum applies (1) [Gain in momentum of B is equal to the loss in A]	1	1 1		3		
	(c)	(i)	At zero between 0 s and 2.8 s - accept no line by implication (1) Straight line increase of 0.08 N s between 2.8 s and 3.0 s (1) **ecf** Horizontal at 0.08 N s from 3.0 s to 4.0 s (1) **ecf**		3		3	3	
		(ii)	p_B = 0.08 **ecf** (1) $v = \frac{0.08}{0.16}$ = 0.5 [m s^{-1}] (1)		2		2	2	
			Question 6 total	**3**	**8**	**0**	**11**	**8**	**0**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
7	(a)		• Proton or delta plus – accept symbols • Leptons • Antiquarks • Weak	4			4		
	(b)		Charge **shown** to be 0 (i.e. $-\frac{2}{3}+\frac{1}{3}+\frac{1}{3}$) seen (1) Antineutron / antidelta zero (1) accept symbols Don't accept antineutrino	2			2		
	(c)	(i)	Baryon: 1 + 1 = 1 + (-1) + 1 + 0 Not conserved (1) Lepton: 0 + 0 = 0 + 0 + 0 + 1 Not conserved (1) Charge: 1 + 0 = 1 + (-1) + 1 + 0 Conserved (1)		3		3		
		(ii)	Baryon number of pion = 0, so <u>baryon number still not conserved</u>, [removing neutrino will balance lepton number]			1	1		
			Question 7 total	**6**	**3**	**1**	**10**	**0**	**0**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
8	(a)		A series of dark lines superimposed on a continuous spectrum (1) [Due to passage of radiation through] atmosphere **/** photosphere **/** chromosphere [of star] (1) Accept gases around the star Don't accept stratosphere	2			2		
	(b)		Recall of $I = \frac{L}{4\pi d^2}$ can be implied (1) Correct pair of values from graph (1) Substitution and re-arrange to find L (or P) = 4×10^{26} W or 4×10^{23} kW **unit mark** (1)	1	1 1		3	2	
	(c)		T calculated from $P = \sigma AT^4$ Substitution and re-arrange **ecf** on P (1) T = 5808 [K] (1) Peak λ identified (490-510 nm) and used in Wien's equation (1) T = 5800 [K] (5686-5918 K) – consistent (1) **Alternative:** Determine T from spectrum graph as above [2 marks] Substitute T into $P = \sigma AT^4$ and re-arrange (1) To confirm either P, A or σ (1)			4	4	4	
			Question 8 total	**3**	**2**	**4**	**9**	**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	1	4	2	7	3	0
2	1	6	4	11	8	11
3	6	6	3	15	11	0
4	6	0	0	6	0	0
5	2	7	2	11	5	0
6	3	8	0	11	8	0
7	6	3	1	10	0	0
8	3	2	4	9	6	0
TOTAL	**28**	**36**	**16**	**80**	**41**	**11**