



GCE AS MARKING SCHEME

SUMMER 2024

**AS
PHYSICS – UNIT 1
2420U10-1**

About this marking scheme

The purpose of this marking scheme is to provide teachers, learners, and other interested parties, with an understanding of the assessment criteria used to assess this specific assessment.

This marking scheme reflects the criteria by which this assessment was marked in a live series and was finalised following detailed discussion at an examiners' conference. A team of qualified examiners were trained specifically in the application of this marking scheme. The aim of the conference was to ensure that the marking scheme was interpreted and applied in the same way by all examiners. It may not be possible, or appropriate, to capture every variation that a candidate may present in their responses within this marking scheme. However, during the training conference, examiners were guided in using their professional judgement to credit alternative valid responses as instructed by the document, and through reviewing exemplar responses.

Without the benefit of participation in the examiners' conference, teachers, learners and other users, may have different views on certain matters of detail or interpretation. Therefore, it is strongly recommended that this marking scheme is used alongside other guidance, such as published exemplar materials or Guidance for Teaching. This marking scheme is final and will not be changed, unless in the event that a clear error is identified, as it reflects the criteria used to assess candidate responses during the live series.

GCE AS PHYSICS
UNIT 1 – MOTION, ENERGY AND MATTER
SUMMER 2024 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)		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 closed system 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) accept closed system	2			2		
	(b)	(i)	Correct application of C of M e.g. Expression for momentum before collision: 0.20×9 [= 1.8] (1) Expression for momentum after collision: $(0.20 \times -2) + 0.40v$ (1) Convincing algebra: $v = [+]$ 5.5 [m s⁻¹] (1) Error in 'signs' (e.g. for rebounding snowball gains no credit and no ecf for final answer) Alternative: Δp for snowball = -2.2 [Ns] i.e. $0.2(-2 - (+9))$ (1) Δp for hat = + 2.2 [Ns] (1) ecf Hence $v_{\text{hat}} = \frac{2.2}{0.4} = 5.5$ [m s⁻¹] (1)		3		3	3	
		(ii)	$\Delta p_{\text{hat}} = 5.5 \times 0.40 = 2.2$ [Ns] ecf on v from (b)(i) (1) $F = \frac{2.2}{0.14} = 15.7$ [N] (Accept 16 N) (1) Alternative: $a_{\text{hat}} = \frac{5.5}{0.14} = 39.3$ [m s⁻²] ecf on v from (b)(i) (1) $F = 0.4 \times 39.3 = 15.7$ [N] (1)		2		2	2	

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
	(c)		Explanation: Momentum change (decrease) of snowball is reduced / less (compared to (b)(i)) (1) Momentum change (increase) of hat is reduced / less or compared with 2.2 [N s] (1) Therefore velocity (increase) of hat is less (than in (b)(i)) and so Natalie is incorrect (1) If calculation and conclusion only, award maximum 2 marks (treat as neutral): e.g. $1.8 = 0.6v$ (1) $v = 3 \text{ [m s}^{-1}\text{]}$ and hence Natalie is incorrect (1)			3	3		
			Question 1 total	2	5	3	10	5	0

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
2	(a)		A and C and E identified as correct (2) 2 correct gains one mark -1 for each additional tick > 3 ticks	2			2		
	(b)	(i)	$x = (\cos 25^\circ \times 12) - 5.44$ seen or $x = 5.44$ or $6 \cos 25^\circ$ or use of $\sin 25$ and Pythagoras or argument based on C of G of extendable arm in middle therefore $x = 2.00 + 3.44$		1		1	1	
		(ii)	C.M. = $2.2 \times 10^4 \times 2.00$ (or 4.4×10^4 seen) (1) A.C.M. = $(W \times 8.88 \text{ ecf}) + (3.0 \times 10^3 \times 3.44)$ (1) Correct algebra and W shown = 3793 [N] (1) 3767 [N] if approximation of 5.5 used 3810 [N] if approximation of 5.4 used		3		3	3	
		(iii)	3800 ecf – 1700 = 2100 [N] (1) Conversion of mass-force i.e. $m = \frac{F}{g}$ (1) = 214 [kg] (1) Conclusion reasonable and consistent with their figures (1) Alternative: 2 people mass approx 200 kg (1) Conversion of mass-force i.e. $F = mg$ (1) Adding both forces – giving around 3700 [N] depending on mass (1) Conclusion reasonable and consistent with their figures ecf on comparison with (b)(ii) (1)			4	4	2	
			Question 2 total	2	4	4	10	6	0

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
3	(a)	(i)	Mean acceleration = 0.75[3] [m s ⁻²] (1) Absolute uncertainty = $\frac{(0.79 - 0.71)}{2} = \pm 0.04$ [m s ⁻²] (1)		2		2	2	2
		(ii)	5% (accept 5.3%) (ecf) no s.f. penalty		1		1	1	1
	(b)	(i)	$\frac{0.6}{60}$ or $\frac{0.1}{10}$ so % uncertainty = 1 [%]		1		1	1	1
		(ii)	Total mass = $\frac{60 \times 10^{-3} \times 9.81}{0.75[3]}$ ecf = 0.78 [kg] (1) Mass of glider = 0.78(ecf) – 0.06 = 0.72 [kg] (1) Total % uncertainty = 6.3% (accept 6%) (ecf from (a)(ii) and (b)(i)) (1) Absolute uncertainty in mass of glider = ± 0.045 or ± 0.05 or 0.04 if 6% used (ignore sig figs and ecf if total mass used - expect ± 0.047 (6%) or 0.049 (6.3%)) (1) Mass of glider = 0.72 ecf (even if 0.78 used) ± 0.04 or 0.05 [kg] seen (1) Sig figs need to be consistent and to a max of 2 sig figs for the uncertainty Accept: 0.722 - 0.725 ± 0.043 - 0.050 [kg] (NOT 0.72 ± 0.050 kg) 720 ± 40 [g] 720 ± 50 [g] 722 - 725 ± 43 - 50 [g]		5		5	5	5
	(c)		Reasonable suggestion e.g. release mechanism - no detail required or equivalent Move light gate to the right Increase mass <u>of glider</u> or decrease slotted mass. Don't accept increase mass only. Measure acceleration between two light gates Accept more repeat readings			1	1		1
			Question 3 total	0	9	1	10	9	10

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
4	(a)		3 protons and 4 neutrons (1) 3 leptons and 7 baryons (1) 10 'up' and 11 'down' quarks (1)	3			3		
	(b)	(i)	Quark-antiquark combination	1			1		
		(ii)	$(+\frac{2}{3} - \frac{2}{3})$ or $(+\frac{1}{3} - \frac{1}{3}) = 0$ seen or charge of particle and its antiparticle is 0		1		1		
		(iii)	udd → udd → $\bar{u}d$ uud 4 × 1 mark for each box	4			4		
		(iv)	Production: $\bar{u}u$ (or 0) + u = u (1) Decay: u = $\bar{u}$ + uu (1) Alternative: Production: -1+1 +1 = [+] 1 (1) Decay: 1 = -1+1+1 (1)		2		2		
	(c)		Required: [Very] short decay time (1) Any × (1): - Individual quark flavours (numbers) conserved - No neutrino and no gamma emissions - Only {quarks / hadrons} involved	2			2		
			Question 4 total	10	3	0	13	0	0

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
5	(a)		$\frac{[\text{Total}] \text{ displacement}}{\text{time}}$ Accept rate of change of displacement	1			1		
	(b)	(i)	Speed = $\frac{3.14 \times 1.25}{4}$ [= 0.98 m s ⁻¹]	1			1	1	
		(ii)	Velocity = $\frac{2.5}{4}$ [= 0.63 m s ⁻¹] (1) South (1) accept downwards arrow	1	1		2	1	
		(iii)	Acceleration = rate of change of velocity (or implied) (1) Velocity [constantly] changing (1) since direction is [constantly] changing so Seren is correct (1) Accept leuan is incorrect Award 2 marks max for circular motion stated (1) Centripetal acceleration or acceleration towards centre (1)			3	3		
	(c)		Calculation of time for decelerating e.g. by $x = \frac{(u+v)t}{2}$ so $t = 2.4$ [s] (1) N.B. can be awarded from the graph Appropriate v - t graph vertical axis (0 to 1 or 2) (1) Straight horizontal line on v - t graph from (0,1) to (2,1) and decreasing steadily (4.4,0) (1) ecf on 4.4 if calculated Appropriate displacement-time vertical axis (0 to about 4 m) (ecf) (1) or part of the scale, be tolerant Straight line from (0,0) to (2,2) (1) allow if exceeds 2.2 Smooth curve from (2,2) to (4.4, 3.2) and horizontal at (4.4, 3.2) (1) accept horizontal line continuing beyond 4.4	1	1 1 1 1 1		6	6	
			Question 5 total	4	6	3	13	8	0

Question			Marking details	Marks available																									
				AO1	AO2	AO3	Total	Maths	Prac																				
6	(a)		Indicative response: Before jumping, all of the energy is in the form of gravitational potential energy (GPE). As the jumper falls, the original GPE is transferred to KE. When the cord starts to stretch the KE continues to increase initially, as does the elastic potential energy (EPE). Both GPE and KE will decrease as the cord stretches further, until eventually the KE becomes (momentarily) zero at the lowest point of the jump. At this point the decrease in GPE is equal to the EPE in the cord. As the jumper starts to move upwards the EPE is transferred back to KE and GPE. The jumper does not reach the initial height above the ground, as some energy is transferred to air molecules (and / or reference to hysteresis). Additional comments: Some energy is transferred to air molecules. Explanation of why jumper does not reach original height after first bounce. N.B. Table below is to aid marking – candidates must write in extended prose to gain 6 marks. <table><tr><th>Position</th><th>E_g</th><th>E_k</th><th>E_{el}</th></tr><tr><td>At start (before jump)</td><td>Max or mgh where h is height above ground</td><td>0</td><td>0</td></tr><tr><td>Free fall, cord slack</td><td>Decreasing</td><td>Increasing</td><td>0</td></tr><tr><td>Cord stretching</td><td>Decreasing</td><td>Continues to increase initially before decreasing.</td><td>Increasing</td></tr><tr><td>At bottom of first bounce</td><td>Minimum - don't accept zero unless explained. Accept $-mg\Delta x$ where Δx is distance fallen</td><td>0</td><td>Maximum or $\Delta E_{el} = -mg\Delta x$</td></tr></table>	Position	E_g	E_k	E_{el}	At start (before jump)	Max or mgh where h is height above ground	0	0	Free fall, cord slack	Decreasing	Increasing	0	Cord stretching	Decreasing	Continues to increase initially before decreasing.	Increasing	At bottom of first bounce	Minimum - don't accept zero unless explained. Accept $-mg\Delta x$ where Δx is distance fallen	0	Maximum or $\Delta E_{el} = -mg\Delta x$	2	4		6		
Position	E_g	E_k	E_{el}																										
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Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
			5-6 marks Comprehensive analysis of all 3 energy forms. Reference to energy loss due to air resistance and / or hysteresis. <i>There is a sustained line of reasoning which is coherent, relevant, substantiated and logically structured.</i> 3-4 marks Comprehensive account of two energy forms or a limited account of all three. No reference to energy losses. <i>There is a line of reasoning which is partially coherent, largely relevant, supported by some evidence and with some structure.</i> 1-2 marks Limited account of one or two energy forms. No reference to energy losses. <i>There is a basic line of reasoning which is not coherent, largely irrelevant, supported by limited evidence and with very little structure.</i> 0 marks <i>No attempt made or no response worthy of credit.</i>						
6	(b)	(i)	Returns to original shape (unstretched length)	1			1		1
		(ii)	[Work done to] straighten (untangle / unravel) polymer chains / molecules Accept C-C bonds are rotated	1			1		1

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
		(iii)	Valid method for calculating the area (1) Correct value based on valid method (expect 6.0 ± 0.4 [J]) (1) Valid methods are: Counting squares expect 6 large squares, expect 24 of the $\frac{1}{4}$ squares and expect 600 tiny squares OR Trapezium (0,0), (0.3, 0), (0.3, 30), (0.2, 30) Note that this is equivalent to a triangle and a quadrilateral. Expect: $\frac{1}{2} \times (0.1 + 0.3) \times 30$ OR $\frac{1}{2} \times 0.2 \times 30 + 0.1 \times 30$ OR Trapezium (0,0), (0.3, 0), (0, 10), (0.2, 30) Note that this is equivalent to a triangle and a quadrilateral. Expect very similar numbers: $\frac{1}{2} \times (10 + 30) \times 0.3$ OR $\frac{1}{2} \times 20 \times 0.3 + 10 \times 0.3$ OR Triangle (0,0), (0.3, 0), (0.3, 40) Expect the numbers: $\frac{1}{2} \times 0.3 \times 40$ OR Triangle and trapezium method. Expect the numbers: $\frac{1}{2} \times 0.1 \times 20 + \frac{1}{2} \times (20 + 30) \times 0.2$ (= 1 J + 5 J) OR Anything else which is clearly correct award the marks e.g. triangle-trapezium-trapezium all with a base of 0.1 gives 6.1 [J] The final mark is for the correct answer 6.0 ± 0.4 [J]		2		2	2	2
		(iv)	Hysteresis (1) Difference between energy stored in the rubber band when it is stretched and [useful] energy recovered from it when it is unstretched. Or energy dissipated (or described) [lost] in one cycle of loading and unloading (1)	2			2		2
			Question 6 total	6	6	0	12	2	6

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
7	(a)		Study of {space / stars / galaxies} (1) don't accept planets For the 2 nd mark either: At {different / various} {wavelengths / frequencies / energies} of the em spectrum OR Of various regions of the em spectrum	2			2		
	(b)		W in base units $\rightarrow \text{kg m}^2 \text{s}^{-3}$ or $\text{J} \rightarrow \text{kg m}^2 \text{s}^{-2}$ or $\text{N} \rightarrow \text{kg m s}^{-2}$ (1) Units of $\sigma = \text{kg s}^{-3} \text{K}^{-4}$ (1)	1	1		2	2	
	(c)	(i)	Use of $T = \frac{W}{\lambda_{\text{max}}}$ (re-arrangement and substitution) i.e. $T = \frac{2.9 \times 10^{-3}}{674 \times 10^{-9}}$ (1) $T = 4303 \text{ K}$ (1) unit mark		2		2	2	
		(ii)	Red / orange	1			1		
	(d)		Correct substitution into $P = A\sigma T^4$ i.e. $P = 5.67 \times 10^{-8} \times 4\pi \times (1.39 \times 10^{10})^2 \times (4303)^4$ ecf on T Or $P = 4.72 \times 10^{28} \text{ [W]}$ seen (1) Recall $I = \frac{P}{4\pi D^2}$ (1) Alternative 1 - Substitution and rearrange i.e. $D = \sqrt{\frac{4.72 \times 10^{28} \text{ ecf}}{4\pi \times 3.09 \times 10^{-8}}}$ (1) $D = 3.49 \times 10^{17} \text{ [m]}$ (1) $D \text{ in light years} = \frac{3.49 \times 10^{17}}{9.46 \times 10^{15}} = 36.8[5 \text{ ly}]$ so claim correct ecf on D (1)			5	5	5	

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
			Alternative 2 – Substitution and rearrange i.e. $I = \frac{4.72 \times 10^{28} \text{ecf}}{4\pi \times (37 \times 9.46 \times 10^{15})^2} \text{ (1)}$ $= 3.07 \times 10^{-8} \text{ [W m}^{-2}\text{]} \text{ (1)}$ Compare with $3.09 \times 10^{-8} \text{ [W m}^{-2}\text{]}$ so claim correct or valid conclusion if ecf used Alternative 3 – Substitution and rearrange i.e. $P = 3.09 \times 10^{-8} \times 4\pi \times (37 \times 9.46 \times 10^{15})^2 \text{ (1)}$ $= 4.72 \times 10^{28} \text{ [W]}$ Compare intensities so claim correct or valid conclusion if ecf used (1) To summarise: Correct substitution into Stefan's law (1) Quoting or using $I = \frac{P}{4\pi d^2} \text{ (1)}$ Correct substitution and algebra (1) Correct almost final value (1) Comparison and valid comment (1)						
			Question 7 total	4	3	5	12	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	2	5	3	10	5	0
2	2	4	4	10	6	0
3	0	9	1	10	9	10
4	10	3	0	13	0	0
5	4	6	3	13	8	0
6	6	6	0	12	2	6
7	4	3	5	12	9	0
TOTAL	28	36	16	80	39	16