GCE AS MARKING SCHEME

SUMMER 2022

AS
PHYSICS – UNIT 1
2420U10-1

INTRODUCTION

This marking scheme was used by WJEC for the 2022 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 2022 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)		No net force (1) No net moment (1) Accept forces must add up to 0 / all forces must be balanced / all moments must be balanced / ACM = CM Don't accept forces must be equal or moments must be equal	2			2		
	(b)		$(2 \times 8) - 11.8$ (1) Weight of beam = 4.2 [N] (1) Or: Correct moment equation (1) Correct answer (1)		2		2		
	(c)		**Method 1**: Taking moments about B $F_A \times 1.8$ (1) $(7.2 \times 1.4) + (4.2 \times 0.9) + (11.8 \times 0.15)$ (1) F_A = 8.7 N (1) F_B = (4.2 + 11.8 + 7.2) (1) – 8.7 (**ecf**) **OR** FB $\times 1.8 = (7.2 \times 0.4) + (4.2 \times 0.9) + (11.8 \times 1.65)$ (1) F_B = 14.5 N (1) **ecf** **Method 2:** As method 1, but taking moments about A N.B. If all correct except F_A and F_B the wrong way round award 4 marks **Method 3:** Taking moments about centre (W): Correct clockwise expression e.g $0.9F_A + 8.85$ (1) Correct anticlockwise expression e.g. $0.9F_B + 3.6$ (1) Correct sum of forces expression: e.g. $F_A + F_B = 23.2$ (1) Correct algebra to show F_B = 14.5 N (1), F_A = 8.7 N (1)		5		5	5	
			Question 1 total	**2**	**7**	**0**	**9**	**5**	**0**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
2	(a)	(i)	Substitution: $W = ½ \times 1 \times 0.4$ **or** $W = ½ \times 2.5 \times 0.4^2$ (1) $W = 0.2$ [J] (1)	1	1		2	2	
		(ii)	**Either:** $W = ½Fx$ (1) F doubles **and** x doubles **or** W increased $\times$ 4 **or** increased to 0.8 J (1) **Or:** $W = ½ kx^2$ (1) k constant (by implication) and x is squared **or** W increased $\times$ 4 **or** increased to 0.8 J (1) **Or:** Correct use of numerical values from graph e.g. Area under graph stated or implied (1) W increased $\times$ 4 **or** increased to 0.8 J or equivalent (1)	1	1		2	1	

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
	(b)	(i)	Cons of energy correctly applied (or implied) i.e. 0.20 (**ecf**) = E_k + E_p (at top of loop) (1) Substitution e.g. 0.20 = ½ × (30 × 10^{-3}) × v^2 + (30 × 10^{-3}) × 9.81 × 0.50 (1) Award two marks if this seen and first mark not already awarded. v = 1.8[8 m s^{-1}] accept 1.9 m s^{-1} (1) Award 1 mark for 3.7 m s^{-1} (omitting GPE) **Award 3 marks for the following:** $\frac{1}{2}mv^2 = 0.2$ leading to 3.65 [m s^{-1}] (1) can be implied by correct answer Correct application of $v^2 = u^2 + 2as$ i.e. $v^2 = 3.65^2 - 2 \times 9.81 \times 0.5$ (1) Correct answer = 1.87 [m s^{-1}] (1)		3		3	3	
		(ii)	5% × 0.2 = 0.01 **ecf** (1) d correct method: ($\pi \times 0.25$) + 0.5 = 1.28[5 m] (1) $F = \frac{0.01}{1.285}$ = 0.0078 [N] **ecf** on **calculated** value of d and **calculated** value of E (1) Accept answers based on 0.9 m or 0.5 m i.e. d = 1.68[5 m] so F = 0.006 [N] so all 3 marks could be awarded	1	1 1		3	3	
			Question 2 total	**3**	**7**	**0**	**10**	**9**	**0**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
3	(a)	(i)	If a body A exerts a force on a body B, then B exerts an equal and opposite force on A (1) Accept: For every action there is an <u>equal and opposite</u> reaction	1			1		
		(ii)	1. <u>Gravitational</u> force of drone on Earth (1) (All required) 2. Force of rotors on air (1) (All required) Accept rotors pushing on air		2		2		
	(b)	(i)	The rate of change of momentum of an object is proportional to the resultant force acting on it, (and takes place in the direction of that force) [or equivalent] **Acceptable minimum answers**: Force is proportional (or equal) to the rate of change of momentum / force = <u>change</u> in momentum ÷ time **Or** in symbols e.g. $F = \frac{\Delta p}{\Delta t}$ and Δp defined	1			1		
		(ii)	Substitution into $4\pi r^2 \rho v^2$ i.e. $4 \times \pi \times (5 \times 10^{-2})^2 \times 1.3 \times (22)^2$ (1) F (= weight) = 19.7[7 N] or 19.8 [N] seen (1) Assume answer represents weight of drone, even if not stated. Answer gains both marks	1	1		2	2	

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
		(iii)	F (for 24 m s^{-1}) = 23.5 [N] **ecf** (1) ΣF = 23.5 **ecf** – 20 (or candidate answer to (b)(ii)) = 3.5 [N] (or 3.7 N) (1) Mass determined = 2.0 k[g] (1) $a = \frac{\Sigma F}{m} = \frac{3.5}{2.0\ \text{ecf}}$ = 1.75 m s^{-2} or 1.85 m s^{-2} (1) **unit mark** Accept correct answer based on candidate figures **OR:** Force = 23.5 [N] (obtaining force) (1) Mass = 2.015 k[g] (obtaining mass) (1) $a = \frac{\Sigma F}{m} = \frac{23.5}{2.015}$ = 11.67 and subtracting acceleration due to gravity (1) Answer = 1.85 m s^{-2} (1) **unit mark**	1	1 1 1		4	4	
	(c)	(i)	Rate of change of displacement Accept velocity = $\frac{\text{displacement}}{\text{time}}$ Don't accept distance in a given direction ÷ time **or** displacement in a given period of time	1			1		

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
		(ii)	Speed (of drone) = $\frac{170}{32}$ = 5.3 [m s^{-1}] (1) Displacement = 78.1 [m] (1) Velocity = $\frac{78.1(ecf)}{32}$ = 2.4 [m s^{-1}] (1) Ted correct (Bill incorrect) - only award mark for correct reasoning and consistent with calculated speed and velocity (1) Accept answers based on distance / displacement only i.e. Distance = 170 [m] (1) Displacement = 78.1 [m] (1) Time same for both stated (or equivalent) (1) Ted correct / Bill incorrect - only award mark if correct reasoning and consistent with calculated distance and displacement (1)			4	4	3	
	(d)		**Benefits (1 from):** • Surveying (general) or filming e.g archaeological sites, volcanoes, disaster areas etc • Monitoring (general) e.g wildlife • Potential for delivery of goods / Amazon • Aerial photography • Able to fly where other aircraft can't **Risks (1 from):** • Delivery of illegal goods e.g prison • Invasion of privacy • Air to air collisions • Disruption to society • Falling out of control • Risk of injury to humans and wildlife [due to the blades]			2	2		
			Question 3 total	**5**	**6**	**6**	**17**	**9**	**0**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
4	(a)	(i)	$A = \pi \times (0.09 \times 10^{-3})^2$ $A = 2.5 \times 10^{-8}$ [m^2] (1) % uncertainty = $= \frac{2 \times 0.01 \times 100}{0.18}$ seen or $= \frac{0.01 \times 100}{0.09}$ (1) accept Accept first principles method leading to 10.8 % or 11.4 % or both Or 11.1 % seen	1	1		2	2	2
		(ii)	$\frac{1 \times 100}{1940}$ (1) ignore sig figs (Or 0.05 % seen)	1			1	1	1
	(b)	(i)	Substitution: $E = \frac{9.81 \times 1.940}{2.5 \times 10^{-8} \times 6 \times 10^{-3}}$ (1) (**ecf** on A) E = 1.2688 $\times$ 10^{11} [Pa] (1) (**ecf** on slips in powers of 10) E = 127 **or** 130 GPa **or** 125 GPa if 2.544 $\times$ 10^{-8} m^2 is used	1	1		2	2	2
		(ii)	% Unc in extension = $\frac{0.5 \times 100}{6}$ = 8.3 [%] (1) Total % unc = 8.3 % (**ecf if incorrect or omitted**) + 5 % + 11 % = 24.3 % (1) Absolute unc = 130**(ecf)** x $\frac{24.3}{100}$ = 3.083 $\times$ 10^{10} (1) = 31 G[Pa] (1) N.B if 8 % used and 127 answer = 30 GPa If 8.3 % and 127 used answer = 31 GPa	1	1 1 1		4	3	4

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
	(c)		Jack: The metal is made from copper (1) Karen: The metal could be zinc, bronze or copper (1) **ecf** must be consistent with answer to (b)			2	2		2
	(d)		Procedure – Jack may have: (award 2 marks max) • Taken repeat readings <u>of diameter</u> (1) • Measure mass more accurately (1) • Added weights in incremental steps / obtained <u>varying extensions</u> [with varying masses] / use a larger mass (1) • Use travelling microscope / vernier scale for extension (1) Don't accept different lengths Analysis – Jack may have: (award 1 mark max) • Draw a graph of force v extension or stress v strain [to find a mean value or gradient] (1)			3	3		3
			Question 4 total	**4**	**5**	**5**	**14**	**8**	**14**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
5	(a)		• Hadrons are made up of quarks • Quarks / hadrons feel the strong force. • Hadrons can be split into two groups, baryons and mesons [Accept three groups and reference to anti-baryons] • Baryons contain three quarks. Protons and neutrons are baryons. • Protons contain 2 up quarks and 1 down quark. • Neutrons contain 1 up quark and 2 down quarks. • Up quarks carry a charge of $+\frac{2}{3}$, down quarks carry a charge of $-\frac{1}{3}$. • For protons: $+\frac{2}{3}+\frac{2}{3}-\frac{1}{3}=+1$ For neutrons: $+\frac{2}{3}-\frac{1}{3}-\frac{1}{3}=0$. • Mesons contain a quark and an antiquark or detail e.g π^+ is $u\bar{d}$ $(+\frac{2}{3}+\frac{1}{3})$ etc • There are 3 generations of hadrons / quarks. • Hadrons have a lepton number of 0, baryons have a baryon number of 1, anti-baryons -1 and mesons 0. **5-6 marks** A comprehensive analysis of baryons and mesons. *There is a sustained line of reasoning which is coherent, relevant, substantiated and logically structured.* **3-4 marks** A comprehensive account of either baryons or mesons or a limited account of both. *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 A limited account of either baryons or mesons. *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)		Charge: +1 -1 = 0 +1 -1 (1) Baryon: 1 + 0 = 1 + 0 + 0 (1) Accept: $uud + \bar{u}d = udd + u\bar{d} + \bar{u}d$ Lepton: 0 + 0 = 0 + 0 + 0 (1) N.B. Charge and lepton number must be present and either baryon or quark number		3		3		
			Question 5 total	**6**	**3**	**0**	**9**	**0**	**0**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
6	(a)		Acceleration (gradient) or equivalent $= \frac{(v-u)}{t}$ (1) Displacement (area) = $ut + ½\ t(v-u)$ or $\frac{(u+v)}{2}t$ (1) Substitution and clear algebra seen e.g. $x = ut + ½\ t\ (at)$ seen (1) No reference to graph award a maximum of 2 marks	3			3	3	
	(b)	(i)	11 sin50° [= 8.4 [3] m s^{-1}]		1		1	1	
		(ii)	Attempt at substituting into $H = ut + ½at^2$ even if incorrect signs (1) $H = 8.4 \times 1.95 - ½ \times 9.81 \times (1.95)^2$ seen (1) Award 2 marks if only this seen H = - 2.27 [m] (1) accept 2.21 [m] Accept use of v = 8 m s^{-1} leading to H = 3.05 [m]. **Alternative solution:** Time to reach max height = $\frac{(0-8.4)}{-9.81}$ (or 0.86 s) (1) Time from H to floor = 1.95 – (2 × 0.86) (or 0.232 s) (1) $H = (8.4 \times 0.23) + ½ \times 9.81 \times (0.23)^2$ (or 2.21 m) (1) Consider carefully consequence of 'rounding'	1 1	1		3	3	
		(iii)	Horizontal component of velocity = 11cos50° [= 7.1 m s^{-1}] or by Pythagoras (1) Substitution into $v_H = \frac{R}{t}$ R = 7.1 (**ecf)** × 1.95 = 13.8 [m] (1)		2			2	

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
	(c)		The time for which the shot is in the air will increase (Steve correct here - no explanation needed) (1) However, increasing the angle will decrease the horizontal component of velocity (1) Reasonable conclusion based on one or both factors e.g. both of these factors will tend to cancel each other out, so not a good idea to follow Steve's advice or it is a bad idea because the angle needs to be decreased (1)			3	3		
			Question 6 total	**5**	**4**	**3**	**12**	**9**	**0**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
7	(a)		A black body [is a body or surface which] absorbs all the [electromagnetic] radiation that falls upon it / no body is a better emitter of radiation [at any wavelength] than a black body at the same temperature	1			1		
	(b)	(i)	Valid strategy e.g. IR^2 = constant (1) Data from graph used to validate relationship e.g. $(2 \times 10^{11})^2 \times 0.8 = 3.2 \times 10^{22}$ $(4 \times 10^{11})^2 \times 0.2 = 3.2 \times 10^{22}$ (1) Award both marks for correct use of data only			2	2	2	
		(ii)	Correct substitution of corresponding pairs of values into $I = \frac{P}{4\pi R^2}$ regardless of units used (1) Correct re-arrangement and correct unit conversions to show clearly that $P \approx 4 \times 10^{26}$ W e.g. $P = 1.4 \times 10^3 \times 4\pi$ x $(1.5 \times 10^{11})^2$ (1)	1	1		2	2	
	(c)		λ_{peak} found from graph (= 500±10 $\times$ 10^{-9}) [m] (1) Wien's law to find T_{sun} i.e. $\frac{2.9\text{x}10^{-3}}{500\text{x}10^{-9}}$ [= 5 800 K] (1) (**ecf** on λ_{peak}) Substitution into $P = 4\pi R^2_{sun}\sigma T^4$ (**ecf** on T) e.g. $4 \times 10^{26} = 4 \times \pi \times R^2_{sun} \times 5.67 \times 10^{-8} \times (5\,800)^4$ (1) $R_{sun} = 7.0 \times 10^8$ m (1) **unit mark**	1	1 1 1		4	4	
			Question 7 total	**3**	**4**	**2**	**9**	**8**	**0**

GCE AS UNIT 1 - MOTION, ENERGY AND MATTER

SUMMARY OF MARKS ALLOCATED TO ASSESSMENT OBJECTIVES

Question	AO1	AO2	AO3	TOTAL MARK	MATHS	PRAC
1	2	7	0	9	5	0
2	3	7	0	10	9	0
3	5	6	6	17	9	0
4	4	5	5	14	8	14
5	6	3	0	9	0	0
6	5	4	3	12	9	0
7	3	4	2	9	8	0
TOTAL	**28**	**36**	**16**	**80**	**48**	**14**