GCE AS MARKING SCHEME

SUMMER 2016

PHYSICS AS - Unit 1
2420U10/01

INTRODUCTION

This marking scheme was used by WJEC for the 2016 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)	$\rho = \frac{45.4}{5.6} = 8.1\,[\text{g cm}^{-3}]$ (1) Accept 8.11 but not 8.10 or 8.12) p_{volume} = 3.6% **and** p_{mass} = 1.1% **or** $p_{density} = \frac{0.2}{5.6} + \frac{0.5}{45.4}$ **or** $= \frac{0.2}{5.6} \times 100 + \frac{0.5}{45.4} \times 100$ (1) $p_{density}$ = 4.7[%] (**ecf:** p_{volume} and p_{mass})(Adding % uncertainties) (1) No sig fig penalty in % unc e.g. allow 4.67% **Alternative for 2nd and 3rd marks** $\text{Unc} = \frac{\text{max} - \text{min}}{2} = \frac{8.50 - 7.74}{2}$ (**1 mark** for either 8.50 or 7.74 or both) Correct method to calculate % unc e.g. $\frac{7.74}{8.11} \times 100 = 95.4\% \sim 4.6\%$ (1)	1	1 1		3	2	3
		(ii)	0.38 if 4.7% used or 0.41 if 5% used. Accept 0.4[0] Allow 1 or 2 sig figs **ecf** on sig figs from (i) Bod on incorrect % unc from (i)		1		1	1	1
	(b)	(i)	Iron and Brass and Nichrome (all required) (1) **ecf** from (a)(ii) All lie within calculated uncertainty(1) Accept in the range 7.7 to 8.5 Do not accept large uncertainty only or vague reference to uncertainty		1	1	2		2
		(ii)	Volume (1) Greater % uncertainty or linked to 3.6% (1) Don't accept reference to absolute uncertainties			2	2		2
			Question 1 total	**1**	**4**	**3**	**8**	**3**	**8**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
2	*(a)*		Baryons: Combination of 3 quarks (1) Accept combination of 3 antiquarks. Don't accept baryons made up of 3 quarks and antiquarks Mesons: Combination of 1 quark and 1 antiquark (1) Don't accept 2 quarks	2			2		
	(b)	(i)	$u\bar{u}$ or $d\bar{d}$ **or** $\frac{(u\bar{u}-d\bar{d})}{\sqrt{2}}$	1			1		
		(ii)	Baryon number LHS: 2, RHS: 1 Particle x must have baryon number: 1 (1) i.e. $1 + 1 = 1 + B_x + 0$ Charge number LHS: +2, RHS +1 Particle must have charge +1 (1) i.e. $1 + 1 = 1 + Q_x + 0$ Particle x is a proton (1) Accept Δ^+ **Alternative response to baryon analysis: (1st mark)** LHS: uud +uud and RHS: uud + x + $u\bar{u}$ (or equivalent) (1)	1 1	1		3		
		(iii)	Lepton number is zero on both sides e.g. 0 + 0 = 0 + 0 + 0 Accept there are no leptons Don't accept there is no change in lepton number	1			1		
	(c)		Electromagnetic (1) γ involvement or photon involvement (1) **and 1 reason from:** (1) • Lifetime too long for strong **or** too short for weak (or accept lifetime corresponds to em force) or reference to 8×10^{-17} s or intermediate lifetime. Don't accept quick time or short time • No neutrino involvement [so probably not weak force] • Total u quark number and total d quark number are conserved in the em interaction • Doesn't only consist of quarks [strong force] • No leptons so not weak force Award no marks if incorrect force identified	1 1	1		3		
			Question 2 total	**8**	**2**	**0**	**10**	**0**	**0**

Question			Marking details		Marks available				
				AO1	AO2	AO3	Total	Maths	Prac
3	*(a)*	(i)	Sirius A: λ_{max} = 290 × 10^{-9} [m] **and** Canopus: λ_{max} = 400 × 10^{-9} [m] [± 10 nm] for both (1) Attempt at **applying** $\lambda_{max}T$ = 0.0029 to both stars, even if powers of 10 incorrect (1) No need to change unit of λ to m Correct application, either by confirming Wien constant **or** star temperatures **or** λ_{max} (1) Accept correct calculations of λ_{max} even if no reference is made to the graph Application of Wien's law to one star only award 1 mark only			3	3	2	
		(ii)	Sirius A (1) Greater spectral intensity (at 'blue' end or at shorter wavelengths or towards 400 nm) (1) Don't accept peak wavelength of Sirius A is closest to the blue end of the spectrum than Canopus. Don't accept reference to temperature by itself e.g. Sirius has a higher temperature so therefore must be bluer. Accept ratio of $\frac{B}{R}$ for both stars, e.g. $\frac{6.1}{1.7}$ against $\frac{1.6}{0.8}$		1	1	2		

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
	(b)	(i)	Correct use of $P = A\sigma T^4$ for either Sirius A **or** Canopus **or** both i.e. Canopus: $P = 4 \times \pi \times (4.97 \times 10^{10})^2 \times 5.67 \times 10^{-8} \times (7\,250)^4$ Sirius A: $P = 4 \times \pi \times (1.19 \times 10^{9})^2 \times 5.67 \times 10^{-8} \times (10\,000)^4$ (1) Canopus: $P = 4.9 \times 10^{30}$ [W] (1) Sirius A: $P = 1.0 \times 10^{28}$ [W] (1) Accept powers of 10 error in answers omission of 4 deduct 1 mark $\frac{4.9\times10^{30}}{1.0\times10^{28}}$ (≈ 500) shown (1) **Alternative:** Attempt at $P = A\sigma T^4$ used in ratio (1) e.g. $\frac{L_C}{L_S} = \frac{49.7 \text{ x } 7\,250^4 (\ 1)}{1.192 \text{ x } 10\,000^4 (\ 1)} \approx 500$ (1)	1	1 1 1		4	4	
		(ii)	$I = \frac{1.0\times10^{28}}{4\pi (\ 8.15\times10^{16})^2}$ substitution (1) **ecf** $I = 1.19 \times 10^{-7}$ [W m^{-2}] (1) Accept 1.21×10^{-7} [W m^{-2}]	1	1		2	2	
		(iii)	Canopus is further away from earth or Sirius A is closer to earth (1) Intensity reaching earth α $\frac{1}{R^2}$ **or** P from star spread out over greater surface area (1) Accept intensity equation Don't accept intensity α $\frac{1}{\text{distance}}$ **or** because of the inverse square law		2		2		
			Question 3 total	**2**	**7**	**4**	**13**	**8**	**0**

Question				Marking details		Marks available				
					AO1	AO2	AO3	Total	Maths	Prac
4	*(a)*	(i)		Test wire and reference wire made from the same material or identical (1) Incorrect to refer to common support Temperature change will have the same effect on both wires (1) Don't accept reference to being at the same temperature			2	2		2
		(ii)		Extension / point beyond which the wire will not return to its original length / permanently deformed (1) Don't accept reference to Hooke's law or limit of proportionality Removing load (or equivalent) and observe whether or not wire returns to original length **or** when the load is removed the extension values are the same (1)	1		1	2		1
		(iii)	I	Improve accuracy by reducing [fractional] uncertainty **or** to provide a measurable extension / longer wire **or** produces greater extension / more accurate extension Don't accept reduce uncertainty only or a wider range of results			1	1		1
			II	Improve accuracy (or reduce uncertainty) in cross-sectional area / to obtain a mean value for diameter / check for uniformity			1	1		1
	(b)	(i)		$A = 8.04 \times 10^{-8}$ [m^2] / 0.08 mm^2 (1) (or by implication) Load extension combination e.g. 28 N, 4.8×10^{-3} m (1) (or by implication) e.g. 5 833.3 Substitution into $E = \frac{Fl}{Ae}$ e.g. $\frac{28 \times 2.4}{8.04 \times 10^{-8} \times 4.8 \times 10^{-3}}$ (1) (**ecf** on A and load extension combination) $E = 1.74 \times 10^{11}$ N m^{-2} or Pa or sensible alternative (1) **unit mark** Accept 2 or 3 sig figs	1	1 1 1		4	4	

Question				Marking details		Marks available				
					AO1	AO2	AO3	Total	Maths	Prac
		(ii)		Energy stored = ½ × 2.4 × 10^{-3} × 14 [substituting values from the graph] (1) Energy = 16.8 × 10^{-3} [J] (1) Accept 17 × 10^{-3} [J] **Alternative:** $E = ½ kx^2$ = ½ × 5 833.3 × (2.4 × 10^{-3})^2 (1) Energy = 16.8 × 10^{-3} [J] (1) Accept 17 × 10^{-3} [J] Deduct 1 mark for factor of 10 slip		2		2		
				Question 4 total	**2**	**5**	**5**	**12**	**4**	**5**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
5	*(a)*		**Energy Conversion** C0 - E_p to E_k C1 - and E_k to E_p C2 - Continued conversion, back and forth C3 - Decrease or increase linked to position e.g. A to B, E_k increases **Energy Loss** L0 - E_p or E_k degraded (or equivalent) L1 – Max height on right below A [or doesn't reach C] L2 - Final E_p and E_k = 0.... L3 - ....Linked to position i.e at B L4 - Energy lost as heat or internal energy L5 - Friction or air resistance linked to energy loss L6 - Molecular explanation of friction or air resistance **5-6 marks** 7 – 11 of C and L marks are present *There is a sustained line of reasoning which is coherent, relevant, substantiated and logically structured.* **3-4 marks** 4 – 6 of C and L marks are present *There is a line of reasoning which is partially coherent, largely relevant, supported by some evidence and with some structure.* **1-2 marks** 1 – 3 of C and L marks are present *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.*	2	4		6		

Question			Marking details		Marks available				
				AO1	AO2	AO3	Total	Maths	Prac
	(b)	(i)	Force in direction of travel required / 280 cos 35° needed Accept: force and distance not in the same direction Accept: horizontal component needs to be calculated or used Don't accept not all the 280 N is used in pulling the sled or pulled at an angle	1			1		
		(ii)	280 cos 35° **or** 229.4 N (1) Substitution: W = 229.4 (**ecf**) × 3 000 (1) [$W = 6.88 \times 10^5$ J] Substitution: $P = \frac{6.88 \times 10^5}{1200}$ **ecf** on W and t (1) P = 573.4 W **unit mark** or suitable unit alternative (1) **Alternative:** 280 cos 35° **or** 229.4 N (1) Calculation of $v = 2.5\,\text{m s}^{-1}$ (1) Substitution: $P = Fv$ i.e. P = 229.4 (**ecf**) × 2.5 (1) P = 573.4 W **unit mark** or suitable unit alternative (1)	1	1 1 1		4	4	
			Question 5 total	**4**	**7**	**0**	**11**	**4**	**0**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
6	*(a)*		**Vertical**: Decreasing (accept deceleration), then increasing (accept acceleration) / <u>changes</u> at 9.81 m s^{-2} (1) **Horizontal**: Constant (1) **Reason**: Gravity acts vertically **or** no forces act horizontally (1)	3			3		
	(b)	(i)	0.15 [m s^{-1}] i.e. $\frac{(1000)}{(110\times60)}$ or 0.54 km/h		1		1		
		(ii)	Correct substitution into $x = ut + \frac{1}{2}at^2$ Ignore sign convention e.g. 1 000 = ½ × a × (55 × 60)^2 (1) At least one mathematical step shown leading to a = 0.00018 [m s^{-2}] e.g. $a = \frac{2\,000}{1.09\times10^7}$ (1) **Alternative:** u_{vertical} calculated from $x = \frac{1}{2}(u + v)t$ i.e. u = 0.606 m s^{-1} (1) Substitution into: $a = (v-u)/t$ to show a = 0.00018 [m s^{-2}] (1)	1	1		2	2	
		(iii)	Correct substitution into $v = u + at$ **or** $v^2 = u^2 + 2ax$ e.g. 0 = u – 0.00018 (55 × 60) **or** 0 = u^2 – 2 × 0.00018 × 1 000 (1) **ecf** [accept use of 0.0002 m s^{-2}] e.g. u = 0.61 [m s^{-1}] (1) e.g. $\frac{0.61}{0.88}\times$ 100% seen (1) Accept 67% – 75% **Alternative for final mark:** 60% of 0.88 m s^{-1} = 0.53 m s^{-1} therefore: 0.61 > 0.53	1	1 1		3	3	

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
	(c)		For: • Job creation • Cost/year reasonable • Generate interest in science • New technologies developed e.g. renewable • Improve understanding of origin of life on earth Against: • Funding could have been used to address earth based issues. • Little impact on society • Costs outweigh discoveries • Risky mission it might have failed 3 statements given **must expand** on bullet points in question (3) No mark for agreeing or disagreeing			3	3		
			Question 6 total	**5**	**4**	**3**	**12**	**5**	**0**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
7	*(a)*		[It has] magnitude (accept size) and direction	1			1		
	(b)	(i)	Total momentum before collision = 30 000 + 15 000 [= 45 000 kg m s^{-1}] (1) Total momentum after collision = 27 000 + 18 000 [= 45 000 kg m s^{-1}] (1) Ignore units Deduct 1 mark for powers of 10 slip Award 1 mark only for - Momentum is not lost [in collision] or momentum before [collision] is the same as momentum after [collision] / momentum is conserved (1) Don't accept: they are the same **Alternative:** Loss in momentum of A =12 000 [kg m s^{-1}] (1) Gain in momentum of B = 12 000 [kg m s^{-1}] (1) Hence the gain in momentum of B = loss in momentum of A (1)	1	1 1		3	2	
		(ii)	Attempt at using $p_A + p_B = (m_A + m_B)v$ (1) Correct substitution e.g. 45 000 **ecf** = 25 000v (1) Award 2 marks if this seen. v = 1.8 [m s^{-1}] (1)	1	1 1		3	3	
	(c)	(i)	A body's <u>rate of</u> / change per second (reference to time) change of momentum (1) is proportional to [accept 'equal to'] the [resultant] force acting on it (1) [and is in the direction of this force] **Alternative:** Formula stated (1) with all terms defined (1)	2			2		
		(ii)	Time for collision = 0.2 s (1) accept (0.5 – 0.3) $F = \frac{-12\,000}{0.2}$ (1) F = -60 000 [N] (1) **ecf** on powers of 10 slip		1 1	1	3	3	

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
		(iii)	Newton's 3rd Law (1) Accept N3 Law Change of momentum is +12 000 kg m s^{-1} or the same **and** collision time is the same (1) Accept: [magnitude] of gradient same Don't accept graph is symmetrical	1	1		2		
			Question 7 total	**6**	**7**	**1**	**14**	**8**	**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	3	8	3	8
2	8	2	0	10	0	0
3	2	7	4	13	8	0
4	2	5	5	12	4	5
5	4	7	0	11	4	0
6	5	4	3	12	5	0
7	6	7	1	14	8	0
TOTAL	**28**	**36**	**16**	**80**	**32**	**13**