Oxford Cambridge and RSA

…day June 20XX–Morning/Afternoon

A Level Physics A

H556/02 Exploring physics

SAMPLE MARK SCHEME

Duration: 2 hour 15 minutes

MAXIMUM MARK 100

This document consists of 20 pages

MARKING INSTRUCTIONS

PREPARATION FOR MARKING

SCORIS

1. Make sure that you have accessed and completed the relevant training packages for on-screen marking: *scoris assessor Online Training*; *OCR Essential Guide to Marking*.

2. Make sure that you have read and understood the mark scheme and the question paper for this unit. These are posted on the RM Cambridge Assessment Support Portal http://www.rm.com/support/ca

3. Log-in to scoris and mark the **required number** of practice responses ("scripts") and the **required number** of standardisation responses.

   YOU MUST MARK 10 PRACTICE AND 10 STANDARDISATION RESPONSES BEFORE YOU CAN BE APPROVED TO MARK LIVE SCRIPTS.

MARKING

1. Mark strictly to the mark scheme.

2. Marks awarded must relate directly to the marking criteria.

3. The schedule of dates is very important. It is essential that you meet the scoris 50% and 100% (traditional 50% Batch 1 and 100% Batch 2) deadlines. If you experience problems, you must contact your Team Leader (Supervisor) without delay.

4. If you are in any doubt about applying the mark scheme, consult your Team Leader by telephone, email or via the scoris messaging system.

5. Work crossed out:

   a. where a candidate crosses out an answer and provides an alternative response, the crossed out response is not marked and gains no marks

   b. if a candidate crosses out an answer to a whole question and makes no second attempt, and if the inclusion of the answer does not cause a rubric infringement, the assessor should attempt to mark the crossed out answer and award marks appropriately.

6. Always check the pages (and additional objects if present) at the end of the response in case any answers have been continued there. If the candidate has continued an answer there then add a tick to confirm that the work has been seen.

7. There is a NR (No Response) option. Award NR (No Response)

   - if there is nothing written at all in the answer space

   - OR if there is a comment which does not in any way relate to the question (e.g. 'can't do', 'don't know')

   - OR if there is a mark (e.g. a dash, a question mark) which isn't an attempt at the question.

   Note: Award 0 marks – for an attempt that earns no credit (including copying out the question).

8. The scoris **comments box** is used by your Team Leader to explain the marking of the practice responses. Please refer to these comments when checking your practice responses. **Do not use the comments box for any other reason.**

   If you have any questions or comments for your Team Leader, use the phone, the scoris messaging system, or email.

9. Assistant Examiners will send a brief report on the performance of candidates to their Team Leader (Supervisor) via email by the end of the marking period. The report should contain notes on particular strengths displayed as well as common errors or weaknesses. Constructive criticism of the question paper/mark scheme is also appreciated.

10. For answers marked by levels of response:

- Read through the whole answer from start to finish.
- Decide the level that **best fits** the answer – match the quality of the answer to the closest level descriptor.
- To select a mark within the level, consider the following:

  Higher mark: A good match to main point, including communication statement (in italics), award the higher mark in the level
  Lower mark: Some aspects of level matches but key omissions in main point or communication statement (in italics), award lower mark in the level.

  Level of response questions on this paper are **17(c)** and **23(a)**.

11. **Annotations**

Annotation	Meaning
DO NOT ALLOW	Answers which are not worthy of credit
IGNORE	Statements which are irrelevant
ALLOW	Answers that can be accepted
( )	Words which are not essential to gain credit
__	Underlined words must be present in answer to score a mark
ECF	Error carried forward
AW	Alternative wording
ORA	Or reverse argument

12. **Subject-specific Marking Instructions**

INTRODUCTION

Your first task as an Examiner is to become thoroughly familiar with the material on which the examination depends. This material includes:

- the specification, especially the assessment objectives
- the question paper
- the mark scheme.

You should ensure that you have copies of these materials.

You should ensure also that you are familiar with the administrative procedures related to the marking process. These are set out in the OCR booklet **Instructions for Examiners**. If you are examining for the first time, please read carefully **Appendix 5 Introduction to Script Marking: Notes for New Examiners**.

Please ask for help or guidance whenever you need it. Your first point of contact is your Team Leader.

CATEGORISATION OF MARKS

The marking schemes categorise marks on the MACB scheme.

B marks: These are awarded as independent marks, which do not depend on other marks. For a **B**-mark to be scored, the point to which it refers must be seen specifically in the candidate's answers.

M marks: These are method marks upon which **A**-marks (accuracy marks) later depend. For an **M**-mark to be scored, the point to which it refers must be seen in the candidate's answers. If a candidate fails to score a particular **M**-mark, then none of the dependent **A**-marks can be scored.

C marks: These are compensatory method marks which can be scored even if the points to which they refer are not written down by the candidate, providing subsequent working gives evidence that they must have known it. For example, if an equation carries a **C**-mark and the candidate does not write down the actual equation but does correct working which shows the candidate knew the equation, then the **C**-mark is given.

A marks: These are accuracy or answer marks, which either depend on an **M**-mark, or allow a **C**-mark to be scored.

Note about significant figures:

If the data given in a question is to 2 sf, then allow to 2 or more significant figures.
If an answer is given to fewer than 2 sf, then penalise once only in the entire paper.
Any exception to this rule will be mentioned in the Additional Guidance.

SECTION A

Question	Answer	Marks	Guidance
1	D	1	
2	D	1	
3	A	1	
4	A	1	
5	B	1	
6	A	1	
7	D	1	
8	B	1	
9	C	1	
10	D	1	
11	B	1	
12	C	1	
13	A	1	
14	D	1	
15	A	1	
	Total	**15**	

SECTION B

Question			Answer	Marks	Guidance
16	(a)		5.56 (V) and data point plotted correctly to ± ½ small square.	B1	
	(b)		Best fit straight line drawn through the last 4 data points. Gradient of the line determined. ρ = gradient × A, hence resistivity = $(1.1 \pm 0.1) \times 10^{-6}$ (Ω m)	B1 B1 B1	**Allow** a maximum of 2 marks if the line of best fit is drawn through all 5 data points.
	(c)		The actual resistance values will be smaller. The gradient of the graph will be lower. Hence resistivity of the metal will be smaller than the value in **(b)**.	B1 B1 B1	
			Total	**7**	

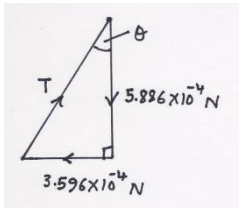
Question			Answer	Marks	Guidance
17	(a)		p.d. across resistor = 1.50 – 0.62 = 0.88 (V) current = 0.88/120 = 7.33... $\times 10^{-3}$ (A) power = VI = 1.50 $\times$ 7.33 $\times 10^{-3}$ = 1.1 $\times 10^{-2}$ (W)	**C1** **C1** **A1**	
	(b)		The voltmeter has large or infinite resistance. Hence the p.d across the lamp or current in the lamp is small or zero (and the lamp is not lit). Refining design: remove voltmeter from the circuit or place the voltmeter across the lamp.	**B1** **B1** **B1**	
	(c)*		**Level 3 (5–6 marks)** Explanation is complete with E1, 2 and 3 For calculation expect C3 At least two limitations mentioned. *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Level 2 (3–4 marks)** Expect two points from E1, 2 and 3 Expect either C1 or C2 for the calculations Expect at least one limitation Limitation identified but calculations are inappropriate. *There is a line of reasoning presented with some structure. The information presented is in the most-part relevant and supported by some evidence.* **Level 1 (1–2 marks)**	**B1** **×6**	**Explanation (E)** 1. Total resistance decreases as temperature increases (allow reverse argument) 2. Current in circuit increases as temperature increases or p.d. is in the ratio of the resistance values 3. Therefore, the p.d. across resistor increases or p.d. across thermistor decreases. **Calculations (C)** 1. $I = V/R$ used to show current increases as temperature increases 2. Potential divider equation (or $I = V/R$ and $R = R_1 + R_2$) used to calculate the voltmeter reading at either 200°C or 300°C • V_{300} = 6.0 $\times$ 25/(25+500) = 0.29 V • V_{200} = 6.0 $\times$ 60/(60+500) = 0.64 V) 3. Potential divider equation used to calculate the voltmeter reading at **both** 200°C and 300°C

Question			Answer	Marks	Guidance
			Expect at least one point from explanation Expect C1 and an attempt at C2 Limitations given are inappropriate. *The information is basic and communicated in an unstructured way. The information is supported by limited evidence and the relationship to the evidence may not be clear.* **0 marks** No response or no response worthy of credit.		**Limitation (L)** 1. The change in resistance is small when resistance of thermistor changes from 200 °C to 300 °C 2. Change in voltmeter reading is too small over this range 3. Non-linear change of resistance with temperature.
			Total	**12**	

Question			Answer	Marks	Guidance
18	(a)		Waves are reflected at the pulley end. This produces nodes and antinodes on the string.	B1 B1	
	(b)		$\lambda/2 = 0.54/3 = 0.18$ m $\lambda = 0.18 \times 2 = 0.36$ (m) $v = 60 \times 0.36$; speed = 21.6 m s^{-1} ≈ 22 (m s^{-1})	C1 C1 A1	
	(c)		$v \propto f$ and since $v \propto \sqrt{T}$, therefore $f \propto \sqrt{T}$ frequency will increase by a factor of $\sqrt{1.14} = 1.068$, therefore increase = 6.8 %	C1 A1	
			Total	**7**	

Question			Answer	Marks	Guidance
19	(a)		The emission of electrons from the surface of a metal when electromagnetic waves (of frequency greater than the threshold frequency) are incident on the metal.	B1	
	(b)		The wave model cannot explain why there is a threshold frequency for metals. The new model / photon model proposed one-to-one interaction between photons and electrons and this successfully explained why threshold frequency exists. Any further one from: Energy of photon (hf) must be greater than or equal to work function of metal. The kinetic energy of emitted electrons was independent of the incident intensity. Correct reference to hf = Φ + KEmax	B1 B1 B1	
	(c)	(i)	$E = \frac{6.63\times10^{-34}\times3.0\times10^{8}}{380\times10^{-9}}$ or $\phi = 1.1\times1.6\times10^{-19}$ $\frac{6.63\times10^{-34}\times3.0\times10^{8}}{380\times10^{-9}} = 1.1\times1.6\times10^{-19} + \frac{1}{2}\times9.11\times10^{-31}v^{2}$ speed = 8.7×10^{5} (m s^{-1})	C1 C1 A1	This is substituting values into $\frac{hc}{\lambda} = \phi + \frac{1}{2}mv^{2}$
		(ii)	The energy of a photon depends only on wavelength or frequency, so intensity does not change the maximum speed of the photoelectrons.	B1	
			Total	**8**	

Question			Answer	Marks	Guidance
20	(a)		Electrons in the circuit move in a clockwise direction **and e**lectrons are deposited on plate **B.** (An equal number of) electrons are removed from plate **A** giving it a positive charge (of equal magnitude).	**B1** **B1**	**Allow**: Conventional current is in anticlockwise direction.
	(b)		series capacitors: $C = (100^{-1} + 220^{-1})^{-1} = 68.75$ (μF) total capacitance = 500 + 68.75 = 568.75 (μF) $E = ½ \times 12^2 \times 568.75 \times 10^{-6}$ $E = 4.1 \times 10^{-2}$ (J)	**C1** **C1** **C1** **A1**	
	(c)		Connect a voltmeter or data-logger or oscilloscope across the resistor (or capacitor) or an ammeter in series with the resistor. A stopwatch is started when the switch is opened and stopped when the p.d. or the current to decreases to 37% of its initial value. The time constant is the time taken for the p.d. or the current to decreases to 37% of its initial value.	**B1** **B1** **B1**	
			Total	**9**	

Question			Answer	Marks	Guidance
21	(a)		**Similarity** The field strength or force $\propto$ 1/separation^2 or both produce a radial field. **Differences** Gravitational field is linked to mass and electric field is linked to charge. Gravitational field is always attractive whereas electric field can be either attractive or repulsive.	**B1** **B1** **B1**	
	(b)	**(i)**	The charges repel each other (because they have like charges). Each charge is in equilibrium under the action of the three forces: downward weight, a horizontal electrical force and an upwardly inclined force due to the tension in the string.	**B1** **B1**	
		(ii)	$F = \dfrac{(4.0\times10^{-9})^2}{4\pi\varepsilon_0 \times 0.02^2} = 3.596....\times10^{-4}$ (N) weight $W = 6.0 \times 10^{-5} \times 9.81 = 5.886 \times 10^{-4}$ (N) tan $\theta = \dfrac{3.596\times10^{-4}}{5.886\times10^{-4}}$ angle $\theta = 31°$	**C1** **C1** **C1** **A1**	Correct use of $F = \dfrac{Qq}{4\pi\varepsilon_0 r^2}$ 
	(c)	**(i)**	Parallel and equidistant field lines. Field direction is correct (from left to right).	**B1** **B1**	**Note**: Field lines must be right angle to the plates.

Question			Answer	Marks	Guidance
		(ii)	work done = $1500 \times 1.6 \times 10^{-19} \times 1.2 \times 10^{-2} = 2.88 \times 10^{-18}$ (J)	C1	
			$\frac{1}{2} \times 9.11 \times 10^{-31} \times v^2 = \frac{1}{2} \times 9.11 \times 10^{-31} \times (5.0 \times 10^6)^2 - 2.88 \times 10^{-18}$	C1	Correct use of: final KE = initial KE – work done.
			speed = 4.3×10^6 (m s^{-1})	A1	
			Total	**14**	

Question			Answer	Marks	Guidance
22	(a)		The force is towards the centre of the circle. The force is perpendicular to the motion or no component of force in direction of motion; hence no work is done on the particle.	B1 B1	
	(b)		centripetal force provided by BQv; hence $\frac{mv^2}{r} = BQv$ $B = \frac{mv}{Qr} = \frac{9.11\times10^{-31}\times5.0\times10^{7}}{1.6\times10^{-19}\times0.018}$ $B = 1.6 \times 10^{-2}$ (T)	C1 C1 A1	
	(c)		energy of <u>two</u> photons = $2 \times mc^2$ or $2\times\frac{hc}{\lambda} = 2\times mc^2$ $\lambda = \frac{h}{mc} = \frac{6.63\times10^{-34}}{9.11\times10^{-31}\times3.0\times10^{8}}$ wavelength = 2.4×10^{-12} (m)	C1 C1 A1	Correct use of $\frac{hc}{\lambda} = mc^2$
			Total	**8**	

Question			Answer	Marks	Guidance
23	(a)*		**Level 3 (5–6 marks)** For equipment expect both E1 and E2 Descriptions has all the points At least two safety precautions mentioned Both Q1 and Q2 mentioned for the quality of results. *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Level 2 (3–4 marks)** Expect at least E1 for equipment For description expect D1 and D2 and an attempt at either D3 or D4 At least one safety point mentioned Expect either Q1 or Q2 for quality of results. *There is a line of reasoning presented with some structure. The information presented is in the most-part relevant and supported by some evidence.* **Level 1 (1–2 marks)** Expect at least E1 for equipment For description expect D1 and D2 At least one safety point mentioned Statements for quality are not relevant. *The information is basic and communicated in an unstructured way. The information is supported by limited evidence and the relationship to the evidence may not be clear.* **0 marks** No response or no response worthy of credit.	**B1** **×6**	**Equipment (E)** 1. GM tube, counter or rate-meter and lead plates used 2. Micrometer or vernier calliper (to measure thickness of plates). **Description (D)** 1. Measure counts for a specific time and hence the count-rate for each thickness of lead 2. Vary the thickness of lead and record the count-rates 3. Plot a graph of count-rate against thickness and determine the half thickness of lead 4. Fig. 23.1 is used to determine the photon energy. **Safety (S)** 1. Do not point source at person 2. Keep safe distance between you and source 3. Use tongs to handle source. **Quality of results (Q)** 1. The counts are recorded over a long period of time 2. Background radiation taken into account.

Question			Answer	Marks	Guidance
	(b)		$\lambda = \frac{\ln 2}{6600} = 1.050 \times 10^{-4}\ (s^{-1})$	C1	Correct use of $A = \lambda N$
			$N = \frac{400 \times 10^{6}}{1.050 \times 10^{-4}} = 3.809 \times 10^{12}$	C1	
			mass of FDG = $\frac{3.809 \times 10^{12}}{6.02 \times 10^{23}} \times 0.018 \div 0.099$	C1	
			mass of FDG = 1.15×10^{-12} (kg) or 1.2×10^{-12} (kg)	A1	
	(c)		Doctors have to make difficult decisions about who can and cannot have a PET scan.	B1	
			Some patients will miss out on PET scans because of their location / not all patients will have access to the scans.	B1	
			Total	**12**	

Question			Answer	Marks	Guidance
24	(a)		The material expands or contracts when a p.d. is applied across its opposite faces.	B1	**Allow**: When a p.d. is applied across its opposite faces the material expands or contracts.
	(b)		The fraction *f* of the incident intensity of ultrasound reflected at the boundary is given $f = \frac{(Z_1 - Z_2)^2}{(Z_1 + Z_2)^2}$ There is reflection when $Z \neq 2.5 \times 10^6$ (kg m^{-2} s^{-1}) At $Z = 2.5 \times 10^6$ (kg m^{-2} s^{-1}) there is impedance (acoustic) matching and hence no reflection of ultrasound.	B1 B1 B1	
	(c)		The transducer is placed at an angle to the arm or artery **and** ultrasound is reflected by the moving blood cells. The wavelength or the frequency of the reflected ultrasound is altered. Since $\Delta f = \frac{2vf\cos\theta}{c}$, the change in frequency $\propto$ speed of the blood. The technique is non-invasive/no incision needed/minimises risk of infection.	B1 B1 B1 B1	
			Total	**8**	