Practice paper – Set 2

A Level Physics A

H556/02 Exploring physics

MARK SCHEME

Duration: 2 hours 15 minutes

MAXIMUM MARK 100

FINAL

This document consists of 17 pages

MARKING INSTRUCTIONS

PREPARATION FOR MARKING

RM ASSESSOR

1. Make sure that you have accessed and completed the relevant training packages for on-screen marking: *RM 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 RM Assessor and mark the **required number** of practice responses ("scripts") and the **required number** of standardisation responses.

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 RM Assessor 50% and 100% (traditional 40% 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 or the RM Assessor messaging system, or by email.

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 RM Assessor **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 RM Assessor messaging system, or e-mail.

9. Assistant Examiners will send a brief report on the performance of candidates directly to the Principal Examiner (PE) by the end of the marking period. The Assistant Examiner's Report Form (AERF) can be found on the RM Cambridge Assessment Support Portal. Your report should contain notes on particular strength 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.

11. Annotations available in RM Assessor

Annotation	Meaning
BOD	Benefit of doubt given
CON	Contradiction
	Incorrect response
ECF	Error carried forward
L1	Level 1
L2	Level 2
L3	Level 3
TE	Transcription error
NBOD	Benefit of doubt not given
POT	Power of 10 error
^	Omission mark
SF	Error in number of significant figures
	Correct response
	Wrong physics or equation

12. Abbreviations, annotations and conventions used in the detailed Mark Scheme (to include abbreviations and subject-specific conventions).

Annotation	Meaning
/	alternative and acceptable answers for the same marking point
reject	Answers which are not worthy of credit
not	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

13. **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 Marker Guide RM Assessor Document on the Examiners and Assessors Communications page on the OCR website. If you are examining for the first time, please ensure that you have completed *OCR's Essential Guide to Marking Part 1*.

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.

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.

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.

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

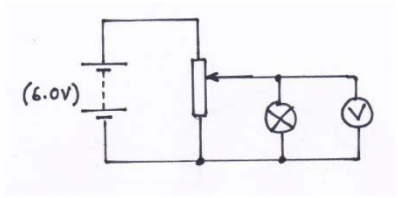
Note about significant figures:

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 Guidance.

SECTION A

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

SECTION B

Question			Answer	Marks	Guidance
16	(a)		$I = I_1 + I_2$ V is the same (for each resistor) $\frac{V}{R} = \frac{V}{R_1} + \frac{V}{R_2}$ leading to correct expression	M1 M1 A1	
	(b)	(i)	Correct circuit with a battery, potential divider, lamp and voltmeter.  Correct symbols used for all components.	B1 B1	**Allow**: A cell symbol for a battery
		(ii)	Description: The temperature of the filament increases. (AW) The resistance of the lamp increases from a non-zero value of resistance. Explanation: Resistance increases because electrons/charge carriers make frequent collisions with ions. (AW)	B1 M1 A1 B1	**Allow** 'when cold the resistance is small'
		(iii)	($P = VI$) current in **X** is 3 times the current in **Y** Or area of **X** is 4 times smaller than area of **Y** $I = Anev$ and ratio = $\frac{3}{0.25}$ ratio = 12	C1 C1 A1	**Allow** other correct methods.
			Total	**12**	

Question			Answer	Marks	Guidance
17	(a)		$V = \frac{R}{R + 0.25R} \times 6.0$ V = 4.8 (V)	C1 A1	**Allow** other correct methods.
	(b)		The total resistance of the voltmeter and resistor in parallel is less than *R.* (AW) A suitable alternative device stated, e.g. digital voltmeter, oscilloscope or data-logger (connected to a laptop).	B1 B1	
	(c)		The resistance of the thermistor increases. The current in the circuit decreases. The p.d. across the resistor decreases because of $V = IR$ or $V \propto R$. The p.d. becomes constant. (AW)	B1 B1 B1 B1	
			Total	**8**	

Question			Answer	Marks	Guidance
18	(a)		wavelength = 60 (cm) $v = 0.30/2.5 \times 10^{-3} = 120$ (m s^{-1}) $f = 120/0.60 = 200$ (Hz)	C1 C1 A1	**Ignore** POT Possible ECF from incorrect value of speed v
	*(b)		**Level 3 (5–6 marks)** Clear explanation and analysis *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)** Some explanation and some analysis. *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)** Limited explanation **or** limited analysis *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**	**Indicative scientific points may include:** **Explanation** • Sound reflected at closed end • Superposition / interference produces stationary wave within tube • Maximum identified as anti-nodes • Minima identified as nodes **Analysis** • $\lambda/2 = 0.26$ (m) or $\lambda = 0.52$ (m) • period = 1.5 (ms) • frequency = 1/0.0015 or frequency = 660 (Hz) • $v = 0.52 \times 660 = 340$ $\underline{\text{m s}^{-1}}$ (**Note**: $v = 350$ m s^{-1} if there is no rounding.)
			Total	**9**	

Question			Answer	Marks	Guidance
19	(a)		5.0 eV = 8.0×10^{-19} (J) and 2.0 eV = 3.2×10^{-19} (J) photon energy = $\frac{6.63\times10^{-34}\times3.0\times10^{8}}{300\times10^{-9}} = 6.6(3)\times10^{-19}$ (J) energy of photon > work function of **X** Or energy of photon < work function of **Y** Hence electrons emitted from **X** with speed / KE from zero to a maximum value and no electrons are emitted from **Y**	**B1** **B1** **B1** **B1**	**Allow** correct answers in terms of threshold frequency / wavelength for the metals and the frequency / wavelength of the photon **Allow** first two B1 marks for photon energy quoted as 6.6×10^{-19} J and 4.1 eV
	*(b)		**Level 3 (5–6 marks)** Clear explanation and discussion *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)** Some explanation and some discussion *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)** Limited explanation **or** limited discussion *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**	**Indicative scientific points may include:** **Explanation** • $hf = \phi + KE_{max}$ (any subject) • A graph of KE_{max} against f is a straight line graph with gradient = h (and intercept = $-\phi$) • Draw a straight best-fit line through points and determine the gradient using a 'large triangle' **Discussion of accuracy and precision** • % uncertainties are 4.8% for **A** and 9.1% for **B** • Data points widely spread out for **B**. (ORA) • For **B** the value of h is accurate because its closer to the real / actual value (but the results are not precise) • For **A** the value of h is precise because of the smaller % uncertainty (but the result is not accurate)
			Total	**10**	

Question			Answer	Marks	Guidance
20	(a)		The charge on each plate remains the same. $C = \varepsilon_0 A/d$, hence the capacitance is halved. $E = ½ Q^2/C$, $E \propto 1/C$ and hence energy stored doubles.	B1 B1 B1	**Allow** other correct methods.
	(b)	(i)1	A straight line of best-fit drawn passing through all error bars.	B1	
		(i)2	$V = V_0 e^{-t/CR}$, therefore $½ = e^{-T/CR}$ $\ln(0.5) = -T/CR$ $T = -\ln(0.5)CR$	M1 M1 A0	
		(i)3	gradient = (-) $\ln(0.5)C$ gradient determined using a 'large triangle' and equal to (-) 7.7×10^{-4} (s Ω^{-1}) C = gradient/$\ln(0.5)$ = (-) $7.7 \times 10^{-4}/\ln(0.5)$ $C = 1.1 \times 10^{-3}$ (F)	C1 C1 A1	 **Allow** gradient in the range 7.5 to 8.0×10^{-4} Possible ECF from value of gradient
		(ii)	Draw a worst-fit straight line through the error bars. Correct description of how to determine the % uncertainty in *C*.	M1 A1	 **Allow**: $\frac{\text{difference between worst and best - fit gradients}}{\text{value of best gradient from (i)3}} \times 100$
			Total	11	

Question			Answer	Marks	Guidance
21	(a)	(i)	The direction of the electric field due to the negative charge is to the left and right for the positive charge. The magnitude of the electric field strength due to the positive charge is smaller than that for the negative charge (because of greater distance). (Hence the resultant electric field strength is to the left.)	B1 B1	
		(ii)	energy = $\frac{Qq}{4\pi\varepsilon_0 r} = \frac{(1.60\times10^{-19})^2}{4\pi\varepsilon_0 \times 3.0\times10^{-10}}$ energy = 7.67(2) $\times 10^{-19}$ (J) energy = 4.8 (eV)	C1 C1 A1	
	(b)	(i)	($v^2 = u^2 + 2as$) $(2.4 \times 10^6)^2 = (7.2 \times 10^6)^2 + 2 \times a \times 1.2 \times 10^{-2}$ a = (-) 1.9 $\times 10^{15}$ (m s^{-2})	C1 A1	**Allow** other correct methods **Allow** 1 mark for 1.9 $\times 10^{13}$; distance left in cm **Note** answer to 3 s.f. is 1.92 × 10^{15} (m s^{-2}) **Ignore** sign
		(ii)	$E = F/Q$ and $F = ma$ $E = \frac{1.67\times10^{-27}\times1.92\times10^{15}}{1.60\times10^{-19}}$ E = 2.0 $\times 10^7$ (N C^{-1})	C1 C1 A1	 Possible ECF from **(b)(i)** **Allow** 2 marks for 1.1 $\times 10^4$; mass of electron used **Allow** 1 s.f. answer
			Total	9	

Question			Answer	Marks	Guidance
22	(a)		Flemings left hand rule / the force on the electron is in the plane of the paper, right angles to the velocity and 'downwards'. Circular path within field in a clockwise direction.	B1 B1	 **Note**: If drawn on Fig. 22.1, then judge 'circular' path by eye.
	(b)		Strong nuclear (force / interaction) Attractive at short distances and repulsive at short distances Mention of distances of 3 fm and 0.5 fm	B1 M1 A1	**Allow** 'strong' (force / interaction)
	(c)		$d \rightarrow u + {}^{0}_{-1}e + \bar{\nu}_{(e)}$	B1 B1	**Allow** ${}^{0}_{-1}\beta^{(-)}$ for the electron
	(d)	(i)	total nucleon number after fusion = 3 + 3 – 4 = 2 total proton number after fusion = 1 +1 -2 = 0 (Hence it must be 2 neutrons ${}^{1}_{0}n$ after the fusion reaction)	M1 M1 A0	**Allow** other correct methods
		(ii)	(BE of neutron(s) = 0 and BE of ${}^{4}_{2}He$ = 28.4 MeV) BE of ${}^{3}_{1}H$ nucleus = ½ × (28.4 – 11) = 8.7 (MeV) BE per nucleon = 8.7/3 = 2.9 (MeV) BE per nucleon = $2.9 \times 10^{6} \times 1.60 \times 10^{-19}$ BE per nucleon = 4.6×10^{-13} (J)	 C1 C1 A1	
			Total	**12**	

Question			Answer	Marks	Guidance
23	(a)		λ = ln2/6.0 = 0.116 (h^{-1}) ($A = A_0e^{-\lambda t}$) $t = \frac{\ln(630/820)}{0.116}$ t = 2.3 (h)	C1 C1 A1	**Allow** λ = ln2/(6.0 × 3600) = 3.21 × 10^{-5} (s^{-1}) **Allow** $\frac{\ln(630/820)}{3.2\times10^{-5}}$ (= 8200 s)
	(b)	(i)	Collimator: Only gamma rays / photons travel along the axes of lead tubes are detected. (AW) Scintillator: A gamma ray photon produces thousands / many photons of (visible) light. (AW) Photomultiplier: An electrical pulse is produced from each photon of visible light entering a photomultiplier tube. (AW)	B1 B1 B1	
		(ii)	The long and thin tubes would be suitable because gamma photons over smaller spread of angles / area of patient would be detected. (AW) This would produce a clearer / sharper / less blurred image (scan) of the patient. (AW)	B1 B1	
			Total	**8**	

Question			Answer	Marks	Guidance
24	(a)		The reflection of the ultrasound produces the pulses **Q** and **R** Pulses **Q** and **R** are due to reflections from the front and back of the clot	**B1** **B1**	
	(b)		speed = $2 \times 1.5 \times 10^{-2}/19 \times 10^{-6}$ (= 1579 m s^{-1}) $Z = \rho c = 1070 \times 1579$ $Z = 1.7 \times 10^{6}$ unit: kg m^{-2} s^{-1}	**C1** **C1** **A1** **B1**	**Allow** 2 marks for 8.4×10^{5}; factor of 2 omitted
			Total	**6**	