OCR
Oxford Cambridge and RSA

day June 20XX–Morning/Afternoon

A Level Physics B (Advancing Physics)

H557/01 Fundamentals of physics

SAMPLE MARK SCHEME

Duration: 2 hours 15 minutes

MAXIMUM MARK 110

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 e-mail.

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 **37(c) and 38(b)**.

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.

SECTION A

Question	Answer	Marks	Guidance
1	C	1	
2	D	1	
3	D	1	
4	D	1	
5	C	1	
6	D	1	
7	C	1	
8	A	1	
9	B	1	
10	A	1	
11	C	1	
12	B	1	
13	C	1	
14	D	1	
15	D	1	
16	C	1	
17	C	1	
18	D	1	
19	C	1	
20	B	1	
21	C	1	
22	C	1	
23	B	1	
24	C	1	
25	B	1	
26	A	1	
27	B	1	
28	C	1	
29	B	1	
30	C	1	
	Total	30	

SECTION B

Unless stated otherwise, correct numerical answer gains full credit

Question			Answer	Marks	Guidance
31	(a)		2.9 = 6.0 x (R_c/(R_c + 3200) ✓ R_c = 2994 Ω ✓	2	Accept RA: V = 6 x (3000/6200) ✓ = 2.90 V✓ Correct answer gains 2 marks.
	(b)		1/2994 = 1/3200 + 1/ R_v ✓ R_v = 46500 (Ω) ✓	2	Bald answer acceptable. Look for working from 3000 Ω and working using conductance.
			Total	4	
32			Any three from: less ductile Plastic flow reduced Alloying atoms pin (AW) dislocations **or** dislocations less mobile Reducing distance planes of atoms slip over one another **or** less slip	3	
			Total	3	

Question			Answer	Marks	Guidance
33	(a)		6.33×10^{-9} = d x sin(0.19) ✓ d = 3.4×10^{-6} ✓ working though to lines per mm (298) ✓	3	Bald answer not acceptable
	(b)		$n\lambda$ = d sinθ. Recognition that sinθ = 1 ✓ n = 3.4×10^{-6}/ 6.33×10^{-7} = 5.4 = 5 orders ✓	2	
			Total	5	
34			γ = 6.84 ✓ = $1/\sqrt{(1 - v^2/c^2)}$ Working through to v^2/c^2 = 0.979 ✓ Working through to v = 2.97×10^8 (m s^{-1})✓	3	
			Total	3	
35	(a)		Red shift of (distant) galaxies✓	1	Accept Hubble's law
	(b)		λ = *hc/E rearrangement* ✓ By calculation or simple ratio , increase in λ = 1000 times✓	2	
			Total	3	
36	(a)		$1.8 \times 10^5 \times 60 \times 60 \times 3.4 \times 10^{-15}/4 \times 10^{-3}$ ✓ = 0.000 55 (Gy)✓	2	
	(b)		Benefit: will destroy cancerous cells more effectively if it is in the organ; will prevent cancer returning in the following days; will have less affect on surrounding tissues. Risk: radioactive emission will continue for some time and could damage other tissues; surgery may damage the patient; the actual 'seed' could be poisonous.	2	One mark in each category not just 'will kill the cancer'
			Total	4	

Section C

Question			Answer	Marks	Guidance
37	(a)		energy supplied = 252000 J ✓ energy supplied/ mol = 45 360 J✓ energy per molecule = 7.53×10^{-20} J✓	3	credit reverse argument. Clear working required. number of molecules evaluated as 3.3×10^{24}
	(b)		Not all energy transferred from heater to water ✓ Alternative destination of energy transfer **or** vapour recondensing into kettle ✓	2	
	(c)*		**Level 3 (5–6 marks)** Marshals argument in a clear manner linking the idea of particle collisions and gaining energy with the model with the definition/explanation of the mathematical formalism of the BF. Shows clear working of BF ratio leading to answer in range *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)** Covers at least two aspects of the argument. Physics correct but perhaps not sufficiently detailed / doesn't cover enough indicative points. Mathematical aspect poorly worked or inaccurate. *There is a line of reasoning presented with some structure. The information presented is in the most-part relevant and supported by some evidence.*	6	**Indicative scientific points may include:** **Particle collisions:** • Particles exchange energy on collisions • Some particles will gain energy in a number of consecutive collisions • This can lead to particles with sufficient energy to evaporate **Boltzmann factor** • Gives the ratios of particles in energy states differing by ε • Linking this ratio to the probability of a particle moving from one energy state to the next(classical) particles cannot superpose **Comparison of rates:** • Rate of evaporation proportional to BF • Explanation of the above point (greater probability mean that more will leave the liquid per second)

Question			Answer	Marks	Guidance
			Level 1 (1–2 marks) Makes two expected points but the answer is superficial and incomplete. *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.		• Clear mathematical working – either direct or via natural logs. For example: $\ln(f_{303}/f_{293}) = 293/303$ • Answer in range 1.5 – 2.7 (variation large because BF so sensitive to intermediate roundings if candidate calculate individual E/kT values)
			Total	**11**	

Question			Answer	Marks	Guidance
38	(a)	(i)	Good best fit line, with ruler✓ Two pairs of points taken from line, x values separated by at least 150 s. ✓ Calculation of gradient eg. 1/100 = 0.01 s^{-1}✓	3	A candidate could calculate the half life by subtracting 0.693 from a y value and finding the difference in x, or by converting ln values to count rate. This is acceptable. Read offs correct to half a small square.
		(ii)	Half-life = 0.693/0.01✓ = 69 (s)✓	2	Range of values from candidates decay constant
	(b)*		**Level 3 (5–6 marks)** Marshals argument in a clear manner and includes clear explanation of three strands: • randomness • the exponential curve as a model • the effect of the number of nuclei present *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)** Shows clear understanding of at least two of the three strands above to the argument **or** covers all three at a superficial manner and does not include enough indicative points for level 3. *There is a line of reasoning presented with some structure. The information presented is in the most-part relevant and supported by some evidence.*	6	**Indicative scientific points may include:** **Randomness** • cannot know when an individual nucleus will decay • explanation of the meaning of the decay constant (e.g. probability of decay of individual nucleus in unit time) • λ as the probability related to dN/dt • discussion of an analogue (e.g. coins or dice) **The exponential curve as a model** • reference in correct context to $N = N_0e^{-\lambda t}$ **or** • linking to $dN/dt = -\lambda t$ **The effect of the number of nuclei present** • for fixed λ the number of nuclei decaying in a given time can be predicted given sufficiently large sample • as count rate falls, the number of nuclei that may decay also falls • as the number of nuclei falls the variation from the predicted outcome will increase

Question			Answer	Marks	Guidance
			Level 1 (1–2 marks) Makes at least two independent points that are relevant to the argument but does not link them together and shows only superficial engagement with the argument. *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.		• with increase variation comes increasing scatter
			Total	**11**	

Question			Answer	Marks	Guidance
39	(a)	(i)	ke = $p^2/2m$✓ $p^2 = h^2/\lambda^2$ ✓ $\lambda = 4r$ ✓ therefore $E = h^2/32mr^2$	3	Some steps can be in different order but the derivation must be clear. Allow starting point of $\lambda = h/mv$ *and* ke = $½mv^2$ to reach same conclusion.
		(ii)	ke = $((h^2/(32x9.1x10^{31}x1x10^{-20}))$✓ 1.5×10^{-18} (J)✓	2	
		(iii)	potential energy = $-8.9 \times 10^9 \times (1.6 \times 10^{-19})^2/1 \times 10^{-10}$ ✓ $= -2.3 \times 10^{-18}$ ✓ Total energy = -0.8×10^{-18} J ✓ This is negative, hence electron bound to proton. ✓	4	Must include negative sign for second marking point.
	(b)		Calculation of k.e = 1.5×10^{-10} J ✓ Calculation of p.e. = -2.3×10^{-14} J✓ Total energy = 1.5×10^{-10}J ✓ This is a positive value hence electron will escape AW✓	4	Calculations are expected to be made by simple ratio of results from (a) and change in ratio. Recalculations are acceptable. Negative sign required. 'Total energy now positive' without support gains one mark.
			Total	13	

Question			Answer	Marks	Guidance
40	(a)		current = 500 x 10^6/(25 x 10^3 x 16) ✓ = 1250 (A) ✓	2	
	(b)	(i)	neutrons released can cause other fission events✓ if at least one neutron released per event triggers a second event the reaction is self sustaining✓ If mass too small too many neutrons will escape without triggering secondary fissions AW✓	3	
		(ii)	mass difference = 0.186 u✓ mass difference/kg = 3.16 x 10^{-28} kg✓ energy released = 2.85 x 10^{-11} J✓	3	
	(c)		energy output per year = 4.48 x 10^{16} J ✓ energy per fission = 200×10^6 ×1.6×10^{-19} J = 3.2×10^{-11} J number of fissions = 4.48 x 10^{16} J/3.2×10^{-11} J = 1.4 x 10^{27}✓ Mass of thorium used = 1.4 x 10^{27} × 4 × 10^{-25} kg = 600 kg ✓ Reason for resuming research into thorium reactors: any one from: shortage of uranium makes thorium more economic/ end of nuclear arms race makes plutonium less needed/ so much energy is needed that all potential sources must be used ✓	4	accept 560 kg. Award final mark only for answers recorded to no more than 2sf.
			Total	12	

Question			Answer	Marks	Guidance
41	(a)		(straight) line passing through every second point ✓ Reasoning: half the frequency, twice the time interval between sample AW ✓ Effect: detail in the waveform lost e.g. high frequency components lost ✓	3	Ignore shape of line between points
	(b)		Number of bits used = $\log_2$ (number of levels) ✓ = 15.6 (therefore 16) ✓ More likely to use 65536 (or rounded value) ✓	3	65536 = 2^{16}, accept 64k
	(c)		Need to have sampling frequency of at least 2 x frequency of highest note✓ Higher frequency components of music give overall sound ✓	2	musical knowledge NOT required.
	(d)		Any three from: • Smaller information transfer rate required • Accurate reproduction of voices not needed for understanding telephone conversations • Conversations uses a more limited frequency range than music • Only 256 voltage levels • Only frequencies up to about 4000 Hz can be accurately reproduced • Music requires higher sampling rate to show different instruments • Music requires 16 bit sampling to give smoother changes in dynamics	3	
			Total	**11**	