A Level Physics B (Advancing Physics)
H557/02 Scientific literacy in physics

PRACTICE 2 MARK SCHEME

Duration: 2 hours 15 minutes

MAXIMUM MARK 100

FINAL

This document consists of 16 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 **5a** and **10.**

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.

Question			Answer	Marks	Guidance
1	(a)	i	$V = 6.0\ V(1 - e^{-60\ s/(150\times10^{3}\ \Omega\times200\times10^{-6}\ F)})$ ✓ = 6.0 V - (1- 0.135) = 5.19 V ✓	2	No s.f. penalty. Must show clear working and own answer
		ii	p.d. across resistor = 6.0 – 5.19 ✓ = 0.8V ✓	2	e.c.f
		iii	$E = ½ \times 200 \times 10^{-6}\ F \times (5.2\ V)^2$ ✓ = 0.0027 J ✓	2	
	b	i	p.d. across capacitor after 5 *RC* $V = 6.0(1\text{-}e^{-5})$ ✓ = 5.96 V✓ This is more than 99% of the supply voltage so the p.d. across capacitor is roughly at maximum. As charge is proportional to voltage, the capacitor is nearly fully charged at this point. ✓	3	Can argue from $Q = Q_0(1\text{-}e^{-t/RC})$: First mark for calculating maximum charge (= 0.0012 C) ✓ After 5*RC*, $Q = 0.0012(1\text{-}e^{-5})$ ✓ = 0.00119, more than 99% of maximum charge ✓
		ii	Discharge = 5 *RC* $= R = 40 \times 10^{-3}/(5 \times 2 \times 10^{-4})$ ✓ = 40 Ω ✓	2	Allow use of 6*RC*
			Total	11	

Question			Answer	Marks	Guidance
2	(a)	i	If there were more colours in the orange light, more colours would be observed in the diffracted image. AW✓	1	Allow the red and green combine to create the orange light
		ii	Both red light and green light are in phase at central maximum AW ✓	1	Accept other correct suggestions, e.g. each 1st order maximum has only one of the two wavelengths, or the intensity at this point is lower as it is convoluted with the single-slit diffraction envelope
	(b)	i	wavelength = hc/E = 6.6×10^{-34} J s $\times 3 \times 10^{8}$ m $s^{-1}/(1.6 \times 10^{-19}$ J $\times 1.9)$ = 6.5×10^{-7} m✓ sin $\theta = 6.5 \times 10^{-7}$ m $\times 300 \times 10^{3}$ $m^{-1} = 0.195$✓ $\theta = 11^{o}$ ✓	3	no s.f. penalty Accept bald correct answer for 3 marks
		ii	By ratio, angle to 1st order for green = 9^{o} ✓ wavelength = sin 9^{o}/ 300×10^{3} m^{-1} = 5.2×10^{-7} m✓	2	Accept answers in range 5.1 – 5.3 x 10^{-7} m Accept bald correct answer for 2 marks
	(c)		$n = d \sin\theta/\lambda$, sin $\theta \leq 1$ ✓ therefore, number of orders possible = d/λ ✓ λ_{green} is smaller than λ_{red} so d/λ gives larger ratio AW✓	3	Allow argument by calculation. Each step must be clear Allow attempted calc. of θ for n = 5 and 6 for each wavelength for full marks if correct conclusion drawn
			Total	**10**	

Question			Answer	Marks	Guidance
3	(a)	i	Young modulus is the gradient of the linear portion of graph ✓ Gradient = $(1.0 \times 10^9$ Pa - 0) /(0.005 - 0.000) ✓ = 2×10^{11} Pa (200 GPa) ✓	3	Other ranges acceptable Accept values between 1.9×10^{11} and 2.2×10^{11} Pa
		ii	Alloy stiffer shown by steeper gradient ✓ Alloy stronger shown by higher stress at breaking✓ Pure metal more ductile with wider plastic region ✓	3	
	(b)		Any four from: • Pure metal has regular planes which can slip over one another • by mobile dislocations • producing plastic flow • Alloy has atoms of different metals within the microstructure • These 'pin' dislocations AW • reducing plastic behaviour/increasing strength	4	Accept 'foreign atoms'
			Total .	10	

Question			Answer	Marks	Guidance
Section B					
4	**(a)**		$\Delta mv = 2\,mv$ ✓ $\Delta t = \frac{2L}{v}$ ✓ $F = \frac{\Delta mv}{\Delta t} = \frac{2mv}{(2L/v)} = \frac{mv^2}{L}$ ✓	**3**	
	(b)		Statement showing that 1/3 of the velocity components of the *N* molecules will be perpendicular to a given face. ✓ Force on face $F = \frac{1}{3}\frac{Nm\overline{c^2}}{L}$ ✓ $P = F/A = \frac{1}{3}\frac{Nm\overline{c^2}}{L \times L^2} = \frac{1}{3}\frac{Nm\overline{c^2}}{V}$ ✓	**3**	
	(c)		One from: • Particles have range of energies because of the range of speeds • Particles collide with one another • Energy exchanged in collisions ✓ To gain energy much greater than 'average' requires many consecutive collisions in which the molecule gains energy AW ✓ This is unlikely hence few molecules will gain sufficient energy to have much greater velocities ✓	**3**	
	(d)		$\frac{1}{3}Nm\,\overline{c^2} = NkT \Rightarrow m\,\overline{c^2} = 3kT$ ✓ kinetic energy = $\frac{1}{2}m\,\overline{c^2} = \frac{3}{2}kT$ ✓	**2**	
	(e)		r.m.s speed = 1.2 × 400 m s^{-1} = 480 m s^{-1} ✓ E_k = ½ × 4.7 × 10^{-26} kg × (480 m s^{-1})^2 = 5.4 × 10^{-21} J✓ T = 2 × 5.4 × 10^{-21} J/(3 × 1.38 × 10^{-23} J K^{-1}) ✓= 260 K ✓	**4**	Allow alternative correct methods
			total	**15**	

Question			Answer	Marks	Guidance
5	(a)		**Level 3 (5–6 marks)** Marshals argument in a clear manner, proceeding from correctly calculating acceleration of ball to an explanation that this is lower than expected acceleration = $g\sin\theta$. Considers possible reason for discrepancy in expected and recorded times its consequent effect. *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)** Correctly calculates acceleration of the ball and makes considered statements about discrepancies in expected and recorded times. *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)** Either correctly calculates acceleration of the ball OR makes valid suggestion as to why the recorded time was more than the expected time but does not provide any supporting reasoning. *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	**6**	**Indicative scientific points may include:** • Acceleration of ball stated as $2s/t^2$ (or numerically) • Acceleration calculated as 1.98 m s^{-2} • Statement that student might expect $a = g\sin\theta$ • $a = g\sin\theta$ =9.81 x sin 20 = 3.35 m s^{-2} • Expected acceleration using 0.85s calculated at 3.35 m s^{-2} • Suggested acceleration leading to a journey time of $(2.4/3.35)^{0.5}$ • Suggested journey time calculated at 0.846 s ~ 0.85 s • Some p.e. transferred to rotational k.e. or work done against friction • Clear reasoning to explain lower acceleration for example: energy transfer from ball will give lower k.e and thus lower velocity at the bottom of the ramp so the journey time will be longer than expected. (AW)

Question			Answer	Marks	Guidance
5	(b)		Any five points from: • Change in p.e. the same in both cases • Therefore, final k.e. the same • Therefore, final velocity the same • Initial acceleration greater for the second slope • greater average velocity • therefore, time to reach the end of the slope will be less. • Assuming that the effects of energy loss/friction are the same for both tracks	**5**	
	(c)	**i**	T = 5.61 s/3 = 1.87 s & L = 0.85 m $T = 2\pi\sqrt{(L/g)} \Rightarrow g = 4\pi^2 L/T^2$ ✓ = 9.596 m s^{-2} = 9.6 m s^{-2} ✓	**2**	First mark is for correct T and L and rearrangement of equation Second mark is for evaluation and rounding to 2 s.f.
		ii	suggestion ✓ explanation ✓	**2**	e.g. time more oscillations ✓ because %age error in timing is reduced by division✓ e.g. repeat measurement (for L = 85 cm) several times and average ✓ because if reduces random error ✓ e.g. repeat for different values of L and plot graph of T^2 against L to find gradient (and hence g) ✓ because graphing counteracts random error✓
			total	**15**	

Question			Answer	Marks	Guidance
6	(a)		acceleration = $\frac{(2\pi r/T)^2}{r}$ ✓ = 5.8 x 10^{-3} m s $^{-2}$ ✓	2	Correct bald answer gains both marks
	(b)	i	$\frac{v^2}{r} = \frac{GM}{r^2}$ $v^2 r = GM$ ✓ $\frac{4\pi^2 r^3}{T^2} = GM$✓ $\frac{r^3}{T^2} = \frac{GM}{4\pi^2}$✓ statement that *G,M,* π^2 are all constants so $\frac{r^3}{T^2}$ is a constant✓	4	Any clear, complete, derivation gains first three marks
	(b)	ii	$\frac{(1.5\times10^{11})^3}{1^2} = \frac{(2.28\times10^{11})^3}{T^2}$✓ Calculated result: orbital period of Mars = 1.87 years✓	2	Correct bald answer gains both marks
	(c)	i	$\Delta V_g = -GMm\left(\frac{1}{r_1} - \frac{1}{r_2}\right)$✓ = -6.7 × 10^{-11} × 6.4 × 10^{23} × 2 x $10^{30}\left(\frac{1}{2.5\times10^{11}} - \frac{1}{2.1\times10^{11}}\right)$✓ = 6.5(3) × 10^{31} J✓	3	Correct bald answer gains three marks Other methods acceptable. One mark for calculating p.e. at greatest distance (aphelion)= - 2.3 × 10^{32} J One mark for calculating p.e. at smallest distance (perihelion) = - 2.98 × 10^{32} J
		ii	k.e. of Mars at aphelion = 2.3 × 10^{32} J ✓ k.e. at perihelion = 2.3 × 10^{32} + 6.5 x 10^{31} = 2.95 × 10^{32} J✓ velocity at perihelion = 3.1 × 10^4 m s^{-1}✓	3	Ecf from c (i) if answer to c(i) rounds to 7 x 10^{31} If 7 × 10^{31} used, v = 3.1 × 10^4 m s^{-1} (3.06 × 10^4 m s^{-1})
			total	14	

Section C					
Question			**Answer**	**Marks**	**Guidance**
7	**(a)**		Decay constant = 4.1×10^{-9} s^{-1} ✓ Number of nuclei present = 1×10^{22}✓ Activity $1 \times 10^{22} \times 4.1 \times 10^{-9} = 4.1 \times 10^{-13}$ (Bq) ✓	**3**	Alternative methods possible, must show working and own answer.
	(b)		Total energy of gamma rays =1.17+1.33 MeV✓ power = $2.50 \times 10^{6} \times 1.6 \times 10^{-19} \times 4.1 \times 10^{13} = 16$ (W) ✓	**2**	
			total	**5**	
8	**a**		maximum work function = $6.6 \times 10^{-34} \times 3 \times 10^{8} / 4.2 \times 10^{-7}$✓ $= 4.7 \times 10^{-19}$ (J)✓	**2**	correct bald answer gains both marks
	b	**i**	$v = (100 \times 1.6 \times 10^{-19} \times 2/9.1 \times 10^{-31})^{1/2}$ ✓ $= 5.9 \times 10^{6}$ m s^{-1} ✓	**2**	correct bald answer gains both marks
		ii	Gamma factor = $(5.1 \times 10^{5} + 1 \times 10^{2})/5.1 \times 10^{5}$ ✓ = 1.0002 which is almost unity, so relativistic effects can be ignored. ✓	**2**	'gamma factor will be roughly one so relativistic effects can be ignored' gains one mark
			total	**6**	
9	**a**		$I / I_0 = 0.5 = e^{-0.25\mu}$ ✓ ln 0.5 = -2.5 μ $\mu = 0.28$ cm^{-1}✓	**2**	Must show working and own answer
	b		Reduction in count rate due to inverse square law: Count rate = $900 \times 10^{2}/40^{2}$ ✓ = 56(.25) ✓ Reduction due to absorber: Count rate = $56.25\ e^{-0.28x0.5}$✓ = 49 Bq✓	**4**	
	c		Fraction of gamma rays absorbed per cm in material ✓ If the intensity of gamma rays is high enough the fraction absorbed will represent many photons and provide a therapeutic dose ✓	**2**	AW throughout.
			total	**8**	

<table>
<tr><th colspan="6">Section C continued</th></tr>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>10</td><td></td><td></td><td>Level 3 (5–6 marks)
Marshals argument in a clear manner. All technical vocabulary is used with accuracy and clarity. The candidate's response shows an understanding of the properties of gamma radiation and the answer is informed by quantitative reasoning based on the data given.
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)
The response may cover the three aspects listed in the guidance but may lack clarity or depth. A calculation, if present, may not be clearly linked to the main argument.
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)
The calculation may be incorrect or missing, the answer is based on assumptions rather than analysis of the article or question. The specific properties of gamma radiation may ot be considered (i.e. why the patient can irradiate others)
The information is basic and communicated in an unstructured way.
0 marks No response or no response worthy of credit
No response or no response worthy of credit.</td><td>6</td><td>Indicative scientific points may include:
Safety: Minimise time of exposure from patient, minimise close contact.
Access to accelerator:
short half-lives mean that the useful time of the radiochemical is limited.
proximity to accelerator (which produces the radioisotope) reduces transit time, giving more time to prepare chemical.
Patient remaining in location:
Radiochemical will still be emitting gamma rays at a rate above background
Gamma rays can pass through patient and irradiate other people.
Candidate includes a calculation of activity of fluorine-18 in patient.
Values from possible calculations:
<table>
<tr><th>time elapsed/hr</th><th>Activity of fluorine-18</th></tr>
<tr><td>1</td><td>2060</td></tr>
<tr><td>2</td><td>1400</td></tr>
<tr><td>3</td><td>950</td></tr>
</table>
</td></tr>
<tr><td></td><td></td><td></td><td>total</td><td>6</td><td></td></tr>
</table>