GCE

Physics B

H157/02: Physics in depth

AS Level

Mark Scheme for June 2025

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This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

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 available in RM Assessor

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. **Crossed Out Responses**
   Where a candidate has crossed out a response and provided a clear alternative then the crossed out response is not marked. Where no alternative response has been provided, examiners may give candidates the benefit of the doubt and mark the crossed out response where legible.

   Rubric Error Responses – Optional Questions
   Where candidates have a choice of question across a whole paper or a whole section and have provided more answers than required, then all responses are marked and the highest mark allowable within the rubric is given. Enter a mark for each question answered into RM assessor, which will select the highest mark from those awarded. *(The underlying assumption is that the candidate has penalised themselves by attempting more questions than necessary in the time allowed.)*

Multiple Choice Question Responses
When a multiple choice question has only a single, correct response and a candidate provides two responses (even if one of these responses is correct), then no mark should be awarded (as it is not possible to determine which was the first response selected by the candidate).
When a question requires candidates to select more than one option/multiple options, then local marking arrangements need to ensure consistency of approach.

Contradictory Responses
When a candidate provides contradictory responses, then no mark should be awarded, even if one of the answers is correct.

Short Answer Questions (requiring only a list by way of a response, usually worth only **one mark per response**)
Where candidates are required to provide a set number of short answer responses then only the set number of responses should be marked. The response space should be marked from left to right on each line and then line by line until the required number of responses have been considered. The remaining responses should not then be marked. Examiners will have to apply judgement as to whether a 'second response' on a line is a development of the 'first response', rather than a separate, discrete response. *(The underlying assumption is that the candidate is attempting to hedge their bets and therefore getting undue benefit rather than engaging with the question and giving the most relevant/correct responses.)*

Short Answer Questions (requiring a more developed response, worth **two or more marks**)
If the candidates are required to provide a description of, say, three items or factors and four items or factors are provided, then mark on a similar basis – that is downwards (as it is unlikely in this situation that a candidate will provide more than one response in each section of the response space.)

Longer Answer Questions (requiring a developed response)
Where candidates have provided two (or more) responses to a medium or high tariff question which only required a single (developed) response and not crossed out the first response, then only the first response should be marked. Examiners will need to apply professional judgement as to whether the second (or a subsequent) response is a 'new start' or simply a poorly expressed continuation of the first response.

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 is not 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 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:
    a. **To determine the level** – start at the highest level and work down until you reach the level that matches the answer
    b. **To determine the mark within the level**, consider the following:

Descriptor	**Award mark**
On the borderline of this level and the one below	At bottom of level
Just enough achievement on balance for this level	Above bottom and either below middle or at middle of level (depending on number of marks available)
Meets the criteria but with some slight inconsistency	Above middle and either below top of level or at middle of level (depending on number of marks available)
Consistently meets the criteria for this level	At top of level

11. **Annotations**

Annotation		**Meaning**
	Correct response	Used to indicate the point at which a mark has been awarded (**one tick per mark awarded**).
	Incorrect response	Used to indicate an incorrect answer or a point where a mark is lost.
AE	Arithmetic error	Do not allow the mark where the error occurs. Then follow through the working/calculation giving full subsequent ECF if there are no further errors.
BOD	Benefit of doubt given	Used to indicate a mark awarded where the candidate provides an answer that is not totally satisfactory, but the examiner feels that sufficient work has been done.
BP	Blank page	Use BP on additional page(s) to show that there is no additional work provided by the candidates.
CON	Contradiction	No mark can be awarded if the candidate contradicts himself or herself in the same response.
ECF	Error carried forward	Used in numerical answers only, unless specified otherwise in the mark scheme. Answers to later sections of numerical questions may be awarded up to full credit provided they are consistent with earlier incorrect answers. Within a question, ECF can be given for AE, TE and POT errors but not for XP.
L1	Level 1	L1 is used to show 2 marks awarded and L1^ is used to show 1 mark awarded.
L2	Level 2	L2 is used to show 4 marks awarded and L2^ is used to show 3 marks awarded.
L3	Level 3	L3 is used to show 6 marks awarded and L3^ is used to show 5 marks awarded.
POT	Power of 10 error	This is usually linked to conversion of SI prefixes. Do not allow the mark where the error occurs. Then follow through the working/calculation giving ECF for subsequent marks if there are no further errors.
SEEN	Seen	To indicate working/text has been seen by the examiner.
SF	Error in number of significant figures	Where more SFs are given than is justified by the question, do not penalise. Fewer significant figures than necessary will be considered within the mark scheme. **Penalised only once in the paper.**

Annotation		Meaning
TE	Transcription error	This error is when there is incorrect transcription of the correct data from the question, graphical read-off, formulae booklet or a previous answer. Do not allow the relevant mark and then follow through the working giving ECF for subsequent marks.
XP	Wrong physics or equation	Used in numerical answers only, unless otherwise specified in the mark scheme. Use of an incorrect equation is wrong physics even if it happens to lead to the correct answer.
^	Omission	Used to indicate where more is needed for a mark to be awarded (what is written is not wrong but not enough).

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

Annotation	Meaning
I	alternative and acceptable answers for the same marking point
✓	Separates marking points
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

12. **Subject Specific Marking Instructions**

SECTION A

Question			Answer	Mark	Guidance
1	(a)		Comparison of $V = \varepsilon - Ir$ with y = mx + c ✓	1	Allow equation written as $V = -rI + \varepsilon$
			ε = intercept on vertical axis (=1.5 V) ✓	1	Allow use of equation with current = 0
			r = -gradient ✓	1	Insist on negative sign
			gradient calculation seen, with answer rounding to 1.2 ✓	1	Two separate points on the line of best fit clearly used – do not penalise points being close together in this case.
1	(b)	(i)	Use of I = Q/t (ne/t) ✓	1	
			N = 0.40 / (1.6 x 10^{-19}) = 2.5 x 10^{18} ✓	1	Working and answer with no unit
1	(b)	(ii)	When I = 0.40 A, V = 1.02 V (from graph) ✓	1	No tolerance
			Energy transferred (per electron) = 1.6 x 10^{-19} x 1.02 ✓	1	Allow calculation using misread from graph
			= 1.6(3) x 10^{-19} (J) ✓	1	Answer to at least 2sf
			Total	**9**	

Question			Answer	Mark	Guidance
2	(a)		The student adjusts the slope of the runway ✓ until the trolley (on its own) moves down it at <u>constant speed</u> when given a small push. ✓	1 1	Allow any description which would alter the slope
2	(b)		a (= $2s/t^2$) = 2 x 1 / 2.2^2 = 0.413 (ms^{-2}) ✓	1	Expect to see 3sf answer
2	(c)	(i)	At least three values of mass x acceleration correctly calculated (to 2 or more sf) ✓ Comparison of calculated values <u>and</u> clear statement about them all being very similar <u>and</u> so validating Newton's 2nd law OR about there being some variation and so not (quite) validating Newton's 2nd law ✓	1 1	May be written next to table 0.75 x 0.53 = 0.3975 0.85 x 0.45 = 0.3825 0.95 x 0.41 = 0.3895 1.050 x 0.38 = 0.3990 1.150 x 0.33 = 0.3795
2	(c)	(ii)	A graph of *a* against 1/*m* OR 1/*a* against *m* (or reversed axes) ✓ The graph should be a straight line through the origin ✓	1 1	Allow a sketched graph with labelled axes This must be from a suitable graph
			Total	7	

Question			Answer	Mark	Guidance
3	(a)		Any two from: • Check for zero error on micrometer ✓ • Several readings taken (at regular intervals) along the wire ✓ • Readings at 90° to each other/different orientation to the wire ✓	2	Must be clear that it is at different points on the wire
3	(b)		$A = \pi r^2 = 3.142 \times (1.9 \times 10^{-4})^2$ ✓ $(= 1.13 \times 10^{-7}\ (m^2))$ $E = FL/Ax = 2.000 \times 9.81 \times 1.5 / (1.13 \times 10^{-7} \times 2.2 \times 10^{-3})$ ✓ $= 1.2 \times 10^{11}$ (Pa) ✓	1 1 1	Calculation of area shown No use of 9.81 is XP Accept 1.18×10^{11} (Pa) Penalise POT errors once only Allow 2.9×10^{10} for 2 marks, if calculated from incorrect *A*
3	(c)		Graph must have a straight-line section followed by a levelling off before stopping ✓	1	By eye Allow straight line followed by decreasing gradient Do not penalise any incorrect detail after the levelling off.
			Total	6	

Question			Answer	Mark	Guidance
4			At least three correct calculations of g✓ Statement that all results suggest g greater than accepted value ✓ Two from: • Systematic error present as the values of g are greater than accepted value (beyond the uncertainty in the data) • Random uncertainty present as there is some scatter • Position of the ruler/measurement of drop height/response time of trap door/electromagnet as possible causes of systematic error Alternative method for first two marks: time calculated using g, time = 0.503 s comparison with experiment times, such that shorter measured time indicates a larger value of g	**1** **1** **2** **(1)** **(1)**	Calculated accelerations are: T = 0.493 s, g = 10.2 m s $^{-2}$ T = 0.490 s, g = 10.3 m s $^{-2}$ T = 0.491 s, g = 10.3m s $^{-2}$ T = 0.490 s, g = 10.3 m s $^{-2}$ T = 0.495 s, g = 10.1 m s $^{-2}$
			Total	**4**	

SECTION B

Question			Answer	Mark	Guidance
5	(a)		Mean from dot plot = 4.14 Ω	1	Mean must be given to at least 2 dp
			Range of resistances = 0.6 Ω so uncertainty is (half range) = 0.3 Ω	1	
			Conclusion: the label should be 4.1 ± 0.3 Ω	1	*R* must be to 1dp only
			as this shows the true variation of values in the box	1	
					Alternative method: For the single resistor R = 1.10/0.26 = 4.2(3) Ω ✓ ΔR = ±(0.01/1.10 + 0.01/0.26) x 4.2(3) = ± 0.2(0) ✓ **OR** R_{min} = 1.09/0.27 = 4.04 **and** R_{max} = 4.44 Leading to ΔR = ± 0.2(0) From the dot plot the mean value of R = 4.1(4) ± (4.4 – 3.8)/2 = 4.1(4) ± 0.3 OR 4.1(4) Ω ± 7.(3) % ✓ Conclusion: the label should be 4.1 ± 0.3 Ω as this shows the true variation of values in the box.✓

Question			Answer	Mark	Guidance
5	(b)	(i)	$4.2 = (1.4 \times 10^{-6})) \times L / (5.9 \times 10^{-8})$ or $L = 4.2 \times (5.9 \times 10^{-8}) / (1.4 \times 10^{-6})$ ✓	1	
			= 0.177 (m) = 17.7 cm ✓	1	Need to see the metres answer (unit not needed) to at least 3dp and conversion to cm (allow 18cm)
5	(b)	(ii)	mass of wire = $8400 \times (5.9 \times 10^{-8}) \times 0.177 = 8.77 \times 10^{-5}$ kg ✓	1	8.92×10^{-5} kg if 0.18 m used.
			$I = 1.5/4.2 = 0.36$ A leading to $E = 1.5 \times 0.36 \times 1 = 0.536$ J ✓	1	or use of V^2/R
			$0.536 = 8.77 \times 10^{-5} \times 450 \times \Delta\theta$ ✓	1	
			$\Delta\theta = 13.6$ °C ✓	1	Allow 14°C
5	(b)	(iii)	If wire is thicker it will have a lower resistance / must be longer to achieve the same resistance ✓	1	
			Any three points from: **Advantage** Increased diameter (mass) gives a lower value of $\Delta\theta$ ✓ Resistor less likely to burn / can store thermal energy ✓ **Disadvantage** Smaller surface area:volume ratio leads to heat being dissipated to the surroundings more slowly ✓ Needs to be physically larger, so will take up more room in a circuit ✓	3	

Question			Answer	Mark	Guidance
6	(a)		**(Level 3) (5 – 6 marks)** Explanation of calculation of resistance: Use of potential divider (or other method) to determine the resistance, using the emf of 6.0 V. For 3.0V, resistance = 1000Ω and for 4.0V, resistance = 2000Ω. Explanation of calculation of light level: Readings from graph at given voltages used to determine distance x. For 3.0V, x = 12.2cm and L = 54 lux, for 4.0V, x = 16.7(or 16.8) cm and L = 28 (or 29) lux Plotting of graph of these two points. Relationship: either check for inverse relationship, or determine R and L for an additional point and plot Clear description of method linked with clear and Successful calculations of at least two corresponding pairs of light intensity and resistance. Graph shows smooth curve downwards from left to right with decreasing negative gradient passing through or close to any two points from: (20, 3000), (30, 1900), (40, 1400), (50, 1100), (60, 900), (70, 750), (80, 650) *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 description of method and successful attempt to calculate at least one value of light level and/or resistance; smooth curve downwards from left to right with decreasing negative gradient. Expect (at least) one point to be calculated and correctly plotted. *There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.*	6	**Indicative scientific points may include:** • **Explanation** Calculate resistance from p.d. across LDR using potential divider equation or proportionality. • Calculate light level using equation given. • Plot pairs of points on the graph **Calculations** Possible additional points which could be plotted e.g. If x = 0.15 m, $L = 0.80/0.15^2$ = 36 lux The graph in **Fig. 6.2** gives V = 3.65 (or 3.70) So R_{LDR} = 3.65 x 1000/(6.00 – 3.65) = 1550 Ω x / m | L / lux | V_{LDR} / V | R / Ω 0.100 | 80.0 | 2.35 | 645 0.110 | 66.1 | 2.66 | 796 0.120 | 55.6 | 2.94 | 964 0.130 | 47.3 | 3.21 | 1149 0.140 | 40.8 | 3.45 | 1353 0.150 | 35.6 | 3.67 | 1574 0.160 | 31.3 | 3.87 | 1814 0.170 | 27.7 | 4.05 | 2073 0.180 | 24.7 | 4.21 | 2351 0.190 | 22.2 | 4.36 | 2648 0.200 | 20.0 | 4.49 | 2965

Question			Answer	Mark	Guidance
			(Level 1) (1 – 2 marks) Attempt at describing method and attempt at calculating both resistance and light level. *There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant* **(0 marks)** Insufficient or irrelevant science. Answer not worthy of credit.		
6	**(b)**		So no current is diverted through the voltmeter Which means that the current through the component does not change So that the voltage across the component is the same whether it is present or not OR So that the resistance of the parallel combination does not change As $R = (R_V + R_{LDR})/R_{LDR}R_V$ where R_V is infinite/very high So that the voltage across the component is the same whether it is present or not	**1** **1** **1** **(1)** **(1)** **(1)**	Allow equivalent argument if resistance is not very high Allow so that energy is not dissipated in the voltmeter Allow “so the voltmeter records the correct reading” Allow equivalent argument if resistance is not very high Accept equation in words and more general 1/R(total) = 1/R(1) + 1/R(2)
6	**(c)**		Sensitivity is adjusted by changing the resistance of the variable resistor Which alters the light intensity at which the alarm switches on (or off)	**1** **1**	

Question			Answer	Mark	Guidance
			Considerations: whether it is to be used during the day and/or night / how bright/powerful the torch is / how far away the torch is / whether it could be activated if a door opened / or other valid responses	**1**	Allow: two different factors if two marks weren't obtained from first two marking points.
			Total	**12**	

SECTION C

Question			Answer	Mark	Additional Guidance
7	**(a)**	**(i)**	Use of $F = \frac{\Delta mv}{\Delta t}$ ✓ 7.00 = *v* x 0.020 ✓ v = (7.00/0.020) = 350 (ms^{-1}) ✓	**1** **1** **1**	Allow $F = v\Delta m/\Delta t$
7	**(a)**	**(ii)**	Resultant force *F* = 7.00 – 0.500 x 9.81 = 2.095 N ✓ *a* = *F/m* = 2.095/0.500 (= 4.19 ms^{-1}) ✓	**1** **1**	
7	**(a)**	**(iii)**	Mass/weight of rocket decreases (as fuel burns) ✓ Resultant force increases (as the weight of the rocket decreases) ✓	**1** **1**	
7	**(b)**	**(i)**	4.35 ✓ 4.44 4.55	**1**	
7	**(b)**	**(ii)**	10.44 ✓ 12.62✓	**1** **1**	Allow numbers that round to 10.4 Accept 12.6 and 12.7 (from use of 10.4)

Question			Answer	Mark	Additional Guidance
7	(b)	(iii)	Any two from: The final velocity increases (if the time interval is smaller) ✓ The acceleration is increased more often / continuously ✓ The accuracy of the model increases ✓	2	
7	(c)*		**(Level 3) (5 – 6 marks)** Changes in momentum and efficiencies compared and supported by calculations; other factors applied to specific contexts also compared, all leading to a clear conclusion. *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)** Changes in momentum compared and supported by calculations, leading to a conclusion. *There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.* **(Level 1) (1 – 2 marks)** General factors compared, with no specific conclusion. *There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant* **(0 marks)** Insufficient or irrelevant science. Answer not worthy of credit.	6	**Indicative scientific points may include:** **Changes in momentum** • Use of $\Delta p = F\Delta t$ • For rocket Δp = 400 x 300 = 120000 $kgms^{-1}$ • For ion thrustor Δp = 0.050 x 200 x 24 x 3600 = 864000 $kgms^{-1}$ **Efficiencies** • The chemical rocket produces 120000/50 = 2400 $kgms^{-1}$ per kg fuel • The ion thrustor produces 864000/50 = 17280 $kgms^{-1}$ per kg propellant • It would take the ion thrustor 2,400,000 s / 667 hours / 27 days to reach the maximum momentum caused by the chemical rocket **Motion** • The chemical rocket would cause acceleration over a distance of (1.8 x 10^7)/mass metres

Question			Answer	Mark	Additional Guidance
					• The ion thruster would cause acceleration over a distance of (1.49 x 10^{14})/mass metres • The ion thruster would result in a final velocity about 7 times greater than the chemical rocket **General factors** While the spacecraft is in the solar system • the chemical rocket produces 8000 x the thrust of the ion thruster • the higher thrust would allow the spacecraft to escape the gravitational pull of planets • the higher thrust is also more useful for take-off • the small thrust of the ion thrustor would allow subtle manoeuvres • Interstellar space travel involves huge distances so the journey duration is critical • Journey time compared to human lifespan is a factor to consider • As there is no air resistance, once the thrust has been used, it will continue to travel at a constant velocity **Use the L1, L2, L3 annotations in RM Assessor; do not use ticks.**
			Total	**18**	

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