Cambridge Assessment International Education

# Cambridge IGCSE™

**PHYSICS** **0625/43**

Paper 4 Extended Theory **October/November 2021**

MARK SCHEME

Maximum Mark: 80

**Published**

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge International will not enter into discussions about these mark schemes.

Cambridge International is publishing the mark schemes for the October/November 2021 series for most Cambridge IGCSE™, Cambridge International A and AS Level components and some Cambridge O Level components.

This document consists of **16** printed pages.

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## Generic Marking Principles

These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptors for a question. Each question paper and mark scheme will also comply with these marking principles.

GENERIC MARKING PRINCIPLE 1:

Marks must be awarded in line with:

- the specific content of the mark scheme or the generic level descriptors for the question
- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

GENERIC MARKING PRINCIPLE 2:

Marks awarded are always **whole marks** (not half marks, or other fractions).

GENERIC MARKING PRINCIPLE 3:

Marks must be awarded **positively**:

- marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate
- marks are awarded when candidates clearly demonstrate what they know and can do
- marks are not deducted for errors
- marks are not deducted for omissions
- answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.

GENERIC MARKING PRINCIPLE 4:

Rules must be applied consistently, e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

| |
|---|
| GENERIC MARKING PRINCIPLE 5:<br><br>Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen). |
| GENERIC MARKING PRINCIPLE 6:<br><br>Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind. |

**Science-Specific Marking Principles**

| | |
|---|---|
| 1 | Examiners should consider the context and scientific use of any keywords when awarding marks. Although keywords may be present, marks should not be awarded if the keywords are used incorrectly. |
| 2 | The examiner should not choose between contradictory statements given in the same question part, and credit should not be awarded for any correct statement that is contradicted within the same question part. Wrong science that is irrelevant to the question should be ignored. |
| 3 | Although spellings do not have to be correct, spellings of syllabus terms must allow for clear and unambiguous separation from other syllabus terms with which they may be confused (e.g. ethane / ethene, glucagon / glycogen, refraction / reflection). |
| 4 | The error carried forward (ecf) principle should be applied, where appropriate. If an incorrect answer is subsequently used in a scientifically correct way, the candidate should be awarded these subsequent marking points. Further guidance will be included in the mark scheme where necessary and any exceptions to this general principle will be noted. |
| 5 | ‘List rule’ guidance<br><br>For questions that require ***n*** responses (e.g. State **two** reasons …):<br><br>• The response should be read as continuous prose, even when numbered answer spaces are provided.<br>• Any response marked *ignore* in the mark scheme should not count towards ***n***.<br>• Incorrect responses should not be awarded credit but will still count towards ***n***.<br>• Read the entire response to check for any responses that contradict those that would otherwise be credited. Credit should **not** be awarded for any responses that are contradicted within the rest of the response. Where two responses contradict one another, this should be treated as a single incorrect response.<br>• Non-contradictory responses after the first ***n*** responses may be ignored even if they include incorrect science. |

6 Calculation specific guidance

Correct answers to calculations should be given full credit even if there is no working or incorrect working, **unless** the question states 'show your working'.

For questions in which the number of significant figures required is not stated, credit should be awarded for correct answers when rounded by the examiner to the number of significant figures given in the mark scheme. This may not apply to measured values.

For answers given in standard form (e.g. $a \times 10^n$) in which the convention of restricting the value of the coefficient ($a$) to a value between 1 and 10 is not followed, credit may still be awarded if the answer can be converted to the answer given in the mark scheme.

Unless a separate mark is given for a unit, a missing or incorrect unit will normally mean that the final calculation mark is not awarded. Exceptions to this general principle will be noted in the mark scheme.

7 Guidance for chemical equations

Multiples / fractions of coefficients used in chemical equations are acceptable unless stated otherwise in the mark scheme.

State symbols given in an equation should be ignored unless asked for in the question or stated otherwise in the mark scheme.

**Examples of how to apply the list rule**
State **three** reasons…. [3]

**A**

| | | |
|---|---|---|
| 1. Correct | ✓ | **2** |
| 2. Correct | ✓ | |
| 3. Wrong | × | |

**B (4 responses)**

| | | |
|---|---|---|
| 1. Correct, Correct | ✓, ✓ | **3** |
| 2. Correct | ✓ | |
| 3. Wrong | ignore | |

**C (4 responses)**

| | | |
|---|---|---|
| 1. Correct | ✓ | **2** |
| 2. Correct, Wrong | ✓, × | |
| 3. Correct | ignore | |

**D (4 responses)**

| | | |
|---|---|---|
| 1. Correct | ✓ | **2** |
| 2. Correct, CON (of 2.) | ×, (discount 2) | |
| 3. Correct | ✓ | |

**E (4 responses)**

| | | |
|---|---|---|
| 1. Correct | ✓ | **3** |
| 2. Correct | ✓ | |
| 3. Correct, Wrong | ✓ | |

**F (4 responses)**

| | | |
|---|---|---|
| 1. Correct | ✓ | **2** |
| 2. Correct | ✓ | |
| 3. Correct<br>CON (of 3.) | ×<br>(discount 3) | |

**G (5 responses)**

| | | |
|---|---|---|
| 1. Correct | ✓ | **3** |
| 2. Correct | ✓ | |
| 3. Correct<br>Correct<br>CON (of 4.) | ✓<br>ignore<br>ignore | |

**H (4 responses)**

| | | |
|---|---|---|
| 1. Correct | ✓ | **2** |
| 2. Correct | × | |
| 3. CON (of 2.)<br>Correct | (discount 2)<br>✓ | |

**I (4 responses)**

| | | |
|---|---|---|
| 1. Correct | ✓ | **2** |
| 2. Correct | × | |
| 3. Correct<br>CON (of 2.) | ✓<br>(discount 2) | |

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**RM Assessor 3 annotations:**

| annotation | suggested use |
|---|---|
| tick | mark awarded (note the ticks are added up next to the tick annotation, check the total you enter agrees) |
| cross | no mark awarded |
| SEEN | indicates page seen |
| BOD | benefit of doubt given |
| NBOD | no benefit of doubt given |
| on page comment | gives a text box to write comment –much easier to use than in the previous version of RM assessor |
| ECF | error carried forward |
| ^ | omission mark |
| ? | unclear |
| U<br>UU | unit penalty applied<br>unit penalty not applied because already applied earlier in same question |

| annotation | suggested use |
|---|---|
| wavy line (horizontal or vertical) | used to highlight a particular point |
| CON | contradiction |
| | |
| NAQ | not answered question |
| PD | poor diagram |
| SF<br><br>SFSF | error in number of significant figures<br>significant figure error not penalized. |
| POT<br><br>POT POT | power-of-ten error<br><br>POT penalty not applied as already applied |
| TV | too vague |
| I | ignore |
| | |
| SC | special case |

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NOTES ABOUT MARK SCHEME SYMBOLS & OTHER MATTERS

| | |
|---|---|
| B marks | are 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 answer. |
| M marks | are method marks upon which accuracy marks (A marks) later depend. For an M mark to be scored, the point to which it refers **must** be seen in a candidate's answer. If a candidate fails to score a particular M mark, then none of the dependent A marks can be scored. |
| C marks | are compensatory marks in general applicable to numerical questions. These can be scored even if the point to which they refer are not written down by the candidate, **provided 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 substitution or working which shows he knew the equation, then the C mark is scored. A C mark is not awarded if a candidate makes two points which contradict each other. Points which are wrong but irrelevant are ignored. |
| A marks | In general, A marks are commonly awarded for final answers to numerical questions. If a final numerical answer, eligible for A marks, is correct, with the correct unit and an acceptable number of significant figures, all the marks for that question are awarded. |
| Brackets ( ) | Brackets around words or units in the mark scheme are intended to indicate wording used to clarify the mark scheme, but the marks do not depend on seeing the words or units in brackets, e.g. 10 (J) means that the mark is scored for 10, regardless of the unit given. However, if a word in brackets is replaced with another word that is clearly wrong then the mark should not be awarded. |
| Underlining | Underlining indicates that this **must** be seen in the answer offered, or something very similar. |
| OR / or | This indicates alternative answers, any one of which is satisfactory for scoring the marks. |
| eeoo. | This means "each error or omission". |
| owtte. | This means “or words to that effect”. |
| Ignore | This indicates that something which is not correct or irrelevant i.e. it is not a contradiction (CON) is to be disregarded and does not incur a penalty. |
| Spelling | Be generous about spelling and use of English. If an answer can be understood to mean what we want, give credit. However, do not allow ambiguities, e.g. spelling which suggests confusion between reflection / refraction / diffraction or thermistor / transistor / transformer. |

| | |
|---|---|
| Not/NOT | This indicates that an incorrect answer is not to be disregarded, but cancels another otherwise correct alternative offered by the candidate, i.e. right plus wrong penalty applies. |
| ecf | meaning "error carried forward" is mainly applicable to numerical questions, but may in particular circumstances be applied in non-numerical questions. This indicates that if a candidate has made an earlier mistake and has carried an incorrect value forward to subsequent stages of working, marks indicated by ecf may be awarded, provided the subsequent working is correct, bearing in mind the earlier mistake. This prevents a candidate from being penalised more than once for a particular mistake, but **only** applies to marks annotated ecf in the mark scheme. **Always annotate ecf if applied.** |
| cao | correct answer only. |
| Significant Figures | Answers are normally acceptable to any number of significant figures ≥ 2.<br>Any exceptions to this general rule will be specified in the mark scheme. Annotate with SF from the toolbar. A second (or further) sig. fig. error in a single question is not penalised; annotate with SF SF. It is normally acceptable to quote just 1 s.f. for answers, which are exact to 1 s.f. |
| Units | Deduct one mark for each incorrect or missing unit from an answer that would otherwise gain all the marks available for that answer: **maximum 1 per question**. No deduction is incurred if the unit is missing from the final answer but is shown correctly in the working. Annotate with U.<br>For more than one unit error in a question, annotate UU to indicate an error which has not been penalised.<br>Unless listed here or stated in the mark scheme for the question, do not accept derived units e.g. kg m $s^{-2}$ for N is NOT acceptable.<br>The following are acceptable alternatives: Nm for J, $Js^{-1}$ or $Nms^{-1}$ for W, $Nm^{-2}$ for Pa, Ns and kg m $s^{-1}$ are both acceptable for both momentum and impulse.<br>Beware : J NOT acceptable for moments.<br>Condone wrong use of upper and lower case symbols, e.g. pA for Pa. |
| Arithmetic errors | If the **only** error in arriving at a final answer is clearly an arithmetic one, then the mark awarded will be one mark lower than the maximum mark.<br>Regard a power-of-ten error as an arithmetic error unless otherwise specified in the mark scheme. Annotate with POT. Do not penalise the same POT error more than once. Annotate POT POT. However if the power-of-ten error is due to the wrong omission or inclusion of *g* (= 10 N / kg) this rule does not apply.<br>The use of a wrong SI prefix in the final answer is counted as a power-of-ten error rather than a unit error. |
| Transcription errors | If the only error in arriving at a final answer is because previously calculated data has clearly been misread, but used correctly, then for that part question the mark will be one less than the maximum mark. |
| Fractions | Allow these only where specified in the mark scheme; they are a form of sig. fig. error; annotate with SF. Consequently, when a sig. fig. error and a fraction is used in the same question, the second answer may still be awarded full marks. |

Crossed out — Work which has been crossed out **and not replaced but can easily be read**, should be marked as if it had not been crossed out. Look to see if it has been replaced on a blank page or another part of the same page.

Use of **NR** — (# or / key on the keyboard). Use this if the answer space for a question is completely blank or contains no readable words, figures or symbols.

## Annotation

To increase marking transparency, reduce the number of enquiries about results and assist team leaders, the following is mandatory:

- For **all** questions with two or more marks, examiners should tick to indicate where each credit is awarded.
- For questions with one mark, examiners do not need to annotate the script to indicate that credit is awarded.
- Any text annotation or annotation in a comment box should never contain -1 or allow a possible misinterpretation that negative marking was applied.

Normally place the ticks close to where the mark is scored.

| Question | Answer | Marks |
|---|---|---|
| 1(a) | $0.0069\ m/s^2$ | **A2** |
| | (acceleration =) gradient of graph or $\Delta v / \Delta t$ in any form OR $\frac{15-7.5}{(60-42)60}$ | C1 |
| 1(b) | 48 000 m or 48 km | **A3** |
| | area under graph | C1 |
| | $\frac{1}{2}(18\times7.5\times60)+(7.5\times18\times60)+(15\times40\times60)$ | C1 |
| 1(c)(i) | (force =) $2.0\times10^5$ N | **A2** |
| | (F =) ma OR $2.3\times10^7\times0.0087$ in any form | C1 |
| 1(c)(ii) | there is a backward / drag force OR water resistance | **B1** |

| Question | Answer | Marks |
|---|---|---|
| 2(a) | (rate of transfer of gravitational potential energy =) 0.17 W | **A4** |
| | (gravitational PE lost =) mgh in any form OR $12\times10\times1.7$ | C1 |
| | (gravitational PE lost =) 204 (J) | C1 |
| | (gravitational PE lost / s =) 204 / 1200 | C1 |
| 2(b) | 59% OR 0.59 | **A2** |
| | efficiency = useful power output / power input ($\times$ 100%) in any form OR 0.10 / 0.17 $\times$ 100% | C1 |
| 2(c) | any sensible advantage, e.g. no use of (fossil) fuel, no cost to run, can be used in remote areas, no $CO_2$ / air pollution, no greenhouse gases, does not contribute to global warming | **B1** |

| Question | Answer | Marks |
|---|---|---|
| 3(a)(i) | | **B2** |
| | pressure in a liquid increases with depth OR pressure decreases (as bubble rises) | B1 |
| | pressure (of gas) is inversely proportional to volume OR internal pressure greater than external pressure (momentarily) OR (air) molecules do not have to hit surface of bubble as frequently (to stop the bubble collapsing) OR the bubble is not as strongly compressed | B1 |
| 3(a)(ii) | $0.50\ cm^3$ | **A4** |
| | PV = constant, in any form | C1 |
| | P (due to water) = ρgh, in any form | C1 |
| | $[1.0 \times 10^5 + (1000 \times 10 \times 3.0)] \times 0.40 = [1.0 \times 10^5 + (1000 \times 10 \times 0.5)] \times V_2$ | C1 |
| 3(b) | | **B2** |
| | paper is not compressed as much / less force on piston B | B1 |
| | air can be compressed OR some of the energy is used to compress the air (instead of the paper) | B1 |

| Question | Answer | Marks |
|---|---|---|
| 4 | | **B4** |
| | (temperature of air increases) so molecules move faster / their KE increases | B1 |
| | molecules collide with walls of container and change momentum | B1 |
| | greater change of momentum when temperature is higher OR collisions more frequent OR harder collisions OR force = rate of change of momentum | B1 |
| | (higher force and hence) higher pressure | B1 |

| Question | Answer | Marks |
|---|---|---|
| 5(a)(i) | 1.2 kg | **A2** |
| | $(m =)\frac{7600 \times 0.41}{2600}$ volume constant so mass directly proportional to density | C1 |
| 5(a)(ii) | 0.37 J / °C | **A2** |
| | (thermal capacity =) mass × specific heat capacity | C1 |
| 5(a)(iii) | 48 J | **A2** |
| | (E =) mc∆T OR 1.2 × 0.50 × (100 – 20) in any form | C1 |
| 5(b) | electrons mentioned | **B1** |
| | (metals have) electrons free to move / delocalised (which transfer thermal energy) | **B1** |

| Question | Answer | Marks |
|---|---|---|
| 6(a) | | **B5** |
| | method of producing sound, e.g. clap for echo method or gun for direct measurement, sig gen or loudspeaker, hammer on block | B1 |
| | apparatus used, e.g. stopwatch, long tape, trundle wheel, wall if using echo method, metre rule, microphones and timer or microphones and oscilloscope | B1 |
| | detail of measurement of (long) distance, e.g. measure distance between person and the wall, measure distance between loudspeaker and microphone or measure distance between two microphones | B1 |
| | detail of measurement of time OR appropriate time measured, e.g. at one end start stopwatch when smoke seen from gun and stop it when sound heard, start stopwatch when gun heard / clap heard and stop when echo heard, measure time taken between clap and hearing echo, timer starts when first microphone receives signal and stops when second receives signal OR measurement of wavelength, e.g. move one microphone away until two waves on oscilloscope have moved one wavelength apart | B1 |
| | speed = measured distance / time for direct method<br>OR speed = 2 $\times$ distance from student clapping to wall / time for echo method<br>OR distance between microphones = wavelength AND $v = f \times \lambda$ | B1 |
| 6(b) | | **B2** |
| | wavelength of light is (much) smaller than width of doorway or wavelength of sound | B1 |
| | wavelength of sound is similar to width of doorway OR $\lambda \simeq$ width of gap for diffraction to occur OR larger wavelength results in greater diffraction ORA | B1 |

| Question | Answer | Marks |
|---|---|---|
| 7(a)(i) | | **B2** |
| | ray approaching left hand face of prism closer to normal than emerging ray | B1 |
| | ray entering right hand face of prism showing refraction towards normal for ray already drawn | B1 |
| 7(a)(ii) | light of single frequency | **B1** |
| 7(b)(i) | $3(.0) \times 10^8$ m / s | **B1** |
| 7(b)(ii) | $5.8 \times 10^{14}$ Hz | **A2** |
| | ($f$ =) $v / \lambda$ in any form OR $3.0 \times 10^8 / 5.2 \times 10^{-7}$ | C1 |
| 7(b)(iii) | $2.0 \times 10^8$ m / s | **A2** |
| | refractive index = speed of light in air / speed of light in glass in any form | C1 |

| Question | Answer | Marks |
|---|---|---|
| 8(a) | | **B2** |
| | **five** straight, parallel vertical lines, equally spaced by eye, between plates | B1 |
| | arrow head pointing upwards on at least one line and none wrong | B1 |
| 8(b)(i) | 11 A | **A2** |
| | ($I$ =) $P / V$ in any form OR 2400 = $I$220 | C1 |
| 8(b)(ii) | 9900 C OR 9800 C | **A2** |
| | (Q =) $It$ in any form OR (Q =) $11 \times 15 \times 60$ | C1 |
| 8(b)(iii) | 13 A | **B1** |

| Question | Answer | Marks |
|---|---|---|
| 9(a)(i) | | **B2** |
| | four components joined in series | B1 |
| | all circuit symbols correct for resistor, thermistor, a filament lamp and a power supply | B1 |
| 9(a)(ii) | voltmeter connected in parallel to the resistor | **B1** |
| 9(a)(iii) | (p.d. across terminals of power supply) = 18 V | **A4** |
| | (current through resistor when p.d. across it is 6.0 V =) 0.4 A | C1 |
| | current same through all components in series circuit<br>OR horizontal line through 0.4 A on graph through all three curves<br>OR p.d. across filament lamp = 3.0 V<br>OR p.d. across thermistor = 9.0 V | C1 |
| | p.d. across filament lamp = 3.0 V AND p.d, across thermistor = 9.0 V | C1 |
| 9(b) | any sensible use requiring temperature control or depending on temperature, e.g. fire alarms, to keep computers cool (by operating fan), in incubators, electronic thermometer, electronic thermostat in kettle / car engine | **B1** |

| Question | Answer | Marks |
|---|---|---|
| 10(a)(i) | 6.0 V | **A2** |
| | ($V_S$ =) $N_S V_P$ / $N_P$ in any form or ($V_S$ =) (25 × 120) / 500 | C1 |
| 10(a)(ii) | 2.5 A OR 2500 mA | **A2** |
| | ($I_S$ =) $I_P$ $V_P$ / $V_S$ in any form OR (0.125 × 120) / 6.0 | C1 |
| 10(b)(i) | arrow right to left along loose part of wire or any other correct position | **B1** |
| 10(b)(ii) | | **B2** |
| | wire moves up | B1 |
| | (reversing direction of the current) reverses the direction of force | B1 |
| 10(c) | coil does not continue to rotate in the same direction | **B1** |

| Question | Answer | Marks |
|---|---|---|
| 11(a)(i) | background radiation OR any reasonable specific source of background radiation e.g. cosmic rays, the sun, space, building materials, earth, rocks, radon gas, student etc. | **B1** |
| 11(a)(ii) | (radioactive decay is a) <u>random</u> (process) | **B1** |
| 11(b) | | **B3** |
| | U: proton no 92 and nucleon number 238 | B1 |
| | Th: proton number 90 and nucleon number 234 | B1 |
| | $\alpha$: proton number 2 and nucleon number 4 | B1 |
| 11(c) | 11 | **A2** |
| | three half lives or evidence of multiplying half-life by 3 | C1 |