



Cambridge IGCSE™

CO-ORDINATED SCIENCES

0654/43

Paper 4 Theory (Extended)

May/June 2023

MARK SCHEME

Maximum Mark: 120

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 May/June 2023 series for most Cambridge IGCSE, Cambridge International A and AS Level and Cambridge Pre-U components, and some Cambridge O Level components.

This document consists of **14** printed pages.

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:

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:

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 | <p><u>'List rule' guidance</u></p> <p>For questions that require <i>n</i> responses (e.g. State two reasons ...):</p> <ul style="list-style-type: none"> • The response should be read as continuous prose, even when numbered answer spaces are provided. • Any response marked <i>ignore</i> in the mark scheme should not count towards <i>n</i>. • Incorrect responses should not be awarded credit but will still count towards <i>n</i>. • 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. • Non-contradictory responses after the first <i>n</i> 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.

Acronyms and shorthand in the mark scheme

| Acronym / shorthand | Explanation |
|---------------------|--|
| Brackets () | Words not explicitly needed in an answer, however if a contradictory word / phrase / unit to that in the brackets is seen the mark is not awarded. |
| <u>Underlining</u> | The underlined word (or a synonym) must be present for the mark to be scored. If the word is a technical scientific term, the word must be there. |
| / or OR | Alternative answers any one of which gains the credit for that mark. |
| owtte | Or words to that effect. |
| ORA | Or reverse argument. |
| AW | Alternative wording |
| AVP | Alternative valid point |

| Question | Answer | Marks | | | | | | | | |
|-----------------------|--|---------|--------------------------|-------------|--------|-------|-----------------------|-----------------------|----------------------|---|
| 1(a)(i) | A ; B ; | 2 | | | | | | | | |
| 1(a)(ii) | F ; | 1 | | | | | | | | |
| 1(a)(iii) | bacteria ; | 1 | | | | | | | | |
| 1(a)(iv) | any two from: incisor ; canine ; pre-molar ; molar ; | 2 | | | | | | | | |
| 1(b) | <table><tr><td>protein</td><td>kwashiorkor / marasmus ;</td></tr><tr><td>vitamin C ;</td><td>scurvy</td></tr><tr><td>fibre</td><td>causes constipation ;</td></tr><tr><td>vitamin D / calcium ;</td><td>rickets / weak bones</td></tr></table> | protein | kwashiorkor / marasmus ; | vitamin C ; | scurvy | fibre | causes constipation ; | vitamin D / calcium ; | rickets / weak bones | 4 |
| protein | kwashiorkor / marasmus ; | | | | | | | | | |
| vitamin C ; | scurvy | | | | | | | | | |
| fibre | causes constipation ; | | | | | | | | | |
| vitamin D / calcium ; | rickets / weak bones | | | | | | | | | |
| 1(c) | any two from: stress ; smoking ; genetic predisposition ; age ; gender ; AVP ; | 2 | | | | | | | | |

| Question | Answer | Marks |
|----------|--|-------|
| 2(a) | $\text{CaCO}_3 + 2\text{HCl} \rightarrow \text{CaCl}_2 + \text{H}_2\text{O} + \text{CO}_2$ correct formulae ; correct balancing ; | 2 |
| 2(b) | test – limewater ; result – turns milky / cloudy ; | 2 |
| 2(c)(i) | 59 (°C) ; | 1 |
| 2(c)(ii) | as the temperature increases the rate of reaction increases / owtte ; | 1 |
| 2(d) | particles are more crowded / more particles per cm^3 / owtte ; more frequent collisions / more collisions per second / owtte ; | 2 |
| 2(e) | <u>activation</u> energy for reaction A is lower than for reaction B ; idea that more / higher proportion of reactant particles can react on collision in reaction A ; | 2 |

| Question | Answer | Marks |
|----------|---|-------|
| 3(a) | (m =) $\rho V / 920 \times 2 \times 10^5$; (m =) 1.84×10^8 (kg) ; | 2 |
| 3(b)(i) | <i>any three from:</i> changes in mass calculated: polystyrene: 2.04 g, copper: 4.12 g, glass: 3.35 g ; copper melts the most / polystyrene melts the least ; copper is a good conductor / polystyrene is an, insulator / poor conductor ; maximum (rate of) energy transfer in copper / minimum energy transfer in polystyrene ; copper is a metal / expanded polystyrene contains trapped air ; | 3 |
| 3(b)(ii) | (forces between molecules) decrease ; (distance between molecules) increase ; (molecules) become free to move / move out of container ; | 3 |

| Question | Answer | Marks |
|----------|---|-------|
| 4(a)(i) | evaporation ; diffuses ; stomata ; | 3 |
| 4(a)(ii) | line drawn showing a decreased rate of transpiration ; | 1 |
| 4(b)(i) | <i>any three from:</i> ref to transpiration pull ; <u>creation</u> of a water potential gradient / <u>reduction</u> of water potential at top of the xylem ; that draws up a column of water molecules / AW ; water molecules held together by cohesion ; | 3 |
| 4(b)(ii) | support / AW ; | 1 |
| 4(c) | sucrose ; amino acids ; | 2 |

| Question | Answer | Marks |
|----------|---|-------|
| 5(a) | increases / owtte ; | 1 |
| 5(b) | melting point of potassium = 64 / 38 to 97 (°C) ; density of rubidium = 1.63 / 0.90 to 1.92 (g / cm ³) ; | 2 |
| 5(c) | yellow ; | 1 |
| 5(d) | → 2KOH(aq) + H ₂ (g) correct formulae ; correct balancing ; correct state symbols ; | 3 |
| 5(e) | transfer of electrons / loss and gain of electrons ; the Br ⁻ / bromide / bromine ions lose electrons AND chlorine atoms / chlorine gain(s) electrons ; | 2 |

| Question | Answer | Marks |
|----------|---|-------|
| 5(f) | 2.8.8 <input checked="" type="checkbox"/> ; | 1 |

| Question | Answer | Marks |
|----------|--|-------|
| 6(a) | (P =) 50 (kW) ; (E =) $P \times t / 50\,000 \times 3600$; (E =) 1.8×10^8 (J) ; | 3 |
| 6(b)(i) | coil turns / rotates ; magnetic field through the coil changes / coil, moves across / cuts, magnetic field ; (e.m.f. / voltage output is) induced / ref to induction ; | 3 |
| 6(b)(ii) | sinusoidal wave ; with constant amplitude and constant time period ; | 2 |
| 6(c)(i) | (KE =) $1400 / 0.8 / 1750$ (J) ; (m =) $2KE / v^2 / 2 \times 1750 / 25$; (m =) 140 (kg) ; OR: $\frac{1}{2} m \cdot 5^2 \times 0.8 = 1400$; $m = \frac{1400}{25 \times 0.8} \times 2$; $= 140$ (kg) ; | 3 |
| 6(c)(ii) | doesn't release, CO ₂ / greenhouse gases, / doesn't contribute to, global warming / climate change, / won't run out / renewable ; | 1 |

| Question | Answer | Marks | | | | |
|-----------|---|-------|----|----|----|---|
| 7(a)(i) | aa ; Aa ; XX ; | 3 | | | | |
| 7(a)(ii) | <table><tr><td>AA</td><td>Aa</td></tr><tr><td>Aa</td><td>aa</td></tr></table> ; 25 (%) ; | AA | Aa | Aa | aa | 2 |
| AA | Aa | | | | | |
| Aa | aa | | | | | |
| 7(b)(i) | any two from: growth ; repair (of damaged tissues) ; replacement of cells ; asexual reproduction ; | 2 | | | | |
| 7(b)(ii) | testes / ovary ; | 1 | | | | |
| 7(b)(iii) | 16 ; | 1 | | | | |

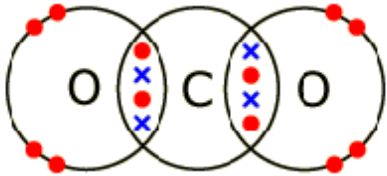
| Question | Answer | Marks |
|----------|--|-------|
| 8(a)(i) | road surfaces ; | 1 |
| 8(a)(ii) | $\frac{225 \times 26}{100}$; = 59 (kg) ; | 2 |
| 8(b) | fractions are separated according to their boiling point ; petroleum is heated AND idea that vapours rise (and cool) ; idea that vapours condense when they become cool enough ; | 3 |
| 8(c) | idea that sulfur impurities cause acid rain ; | 1 |

| Question | Answer | Marks |
|----------|--|-------|
| 8(d) | idea that nitrogen monoxide is removed from exhaust emissions by reaction over a hot catalyst / at high temperature ; AND ONE EQUATION FROM $2\text{NO} + 2\text{CO} \rightarrow \text{N}_2 + 2\text{CO}_2$ or $2\text{NO} \rightarrow \text{N}_2 + \text{O}_2$ correct formulae ; correct balancing ; | 3 |

| Question | Answer | Marks |
|----------|--|-------|
| 9(a)(i) | weight ; | 1 |
| 9(a)(ii) | (weight =) moment / distance / 0.14 / 5.0 ; (weight =) 0.028 (N) ; (mass = $W/g = 0.028 / 10 = 0.0028$ (kg) ; | 3 |
| 9(b) | first ray drawn ; second ray drawn ; image drawn and labelled ; | 3 |
| 9(c)(i) | correct symbols ; in series and all else correct ; | 2 |
| 9(c)(ii) | <i>any three from:</i> (as voltage increases) current increases ; (initially) straight line / gradient is constant, so resistance is constant ; (then) line curves / gradient reduces, so resistance increases ; (resistance increases because) the temperature (of the filament) increases ; | 3 |

| Question | Answer | Marks |
|-----------|--|----------|
| 10(a)(i) | <u>0.50</u> ; | 1 |
| 10(a)(ii) | not enough oxygen (for aerobic respiration) ; ref to anaerobic respiration ; increasing lactic acid (reduces the pH) ; | 3 |
| 10(b)(i) | (an action by,) an organism / part of an organism ; (causing a) change of, position / place ; | 2 |
| 10(b)(ii) | white blood (cell) ; ciliated (cell) ; palisade (mesophyll cell) ; | 3 |

| Question | Answer | | | | | | Marks | | | | | | | | | | | | | | | | | | |
|-----------|--|-----------------------------|---------|-----------|-----------|--|-------|------------------------------|-----------------------------|---------|----------|-----------|-----------|----|----|----|-----------|----|-------|---|----|---|----|-----------|---|
| 11(a) | X^{2+} ; | | | | | | 1 | | | | | | | | | | | | | | | | | | |
| 11(b) | $(NH_4)_2CO_3$; | | | | | | 1 | | | | | | | | | | | | | | | | | | |
| 11(c) | <table><tr><td>ion</td><td>proton (atomic) number</td><td>nucleon (mass) number</td><td>protons</td><td>neutrons</td><td>electrons</td></tr><tr><td>Al^{3+}</td><td>13</td><td>27</td><td>13</td><td>14</td><td>10</td></tr><tr><td>F^-</td><td>9</td><td>19</td><td>9</td><td>10</td><td>10</td></tr></table> ;; | | | | | | ion | proton (atomic) number | nucleon (mass) number | protons | neutrons | electrons | Al^{3+} | 13 | 27 | 13 | 14 | 10 | F^- | 9 | 19 | 9 | 10 | 10 | 2 |
| ion | proton (atomic) number | nucleon (mass) number | protons | neutrons | electrons | | | | | | | | | | | | | | | | | | | | |
| Al^{3+} | 13 | 27 | 13 | 14 | 10 | | | | | | | | | | | | | | | | | | | | |
| F^- | 9 | 19 | 9 | 10 | 10 | | | | | | | | | | | | | | | | | | | | |

| Question | Answer | Marks |
|-----------|---|-------|
| 11(d) |  <p>double bonds between C and O atoms ; rest of structure correct ;</p> | 2 |
| 11(e)(i) | (graphite has) weak forces between the layers ; layers can slide over each other / owtte ; | 2 |
| 11(e)(ii) | any two from: (diamond) has many strong bonds ; bonds are covalent bonds ; (diamond has) giant molecular / macromolecular / giant tetrahedral / lattice / giant covalent, structure ; | 2 |

| Question | Answer | Marks |
|-----------|--|-------|
| 12(a)(i) | 3×10^8 (m / s) ; | 1 |
| 12(a)(ii) | (f =) $v / \lambda / 3 \times 10^8 / 2.0 \times 10^{-11}$; (f =) 1.5×10^{19} (Hz) ; | 2 |
| 12(b)(i) | parallel AND perpendicular ; | 1 |
| 12(b)(ii) | solid liquid gas ; | 1 |
| 12(c)(i) | 4 half-lives ; 6.25 (%) ; | 2 |
| 12(c)(ii) | ${}_{-1}^0\beta$; | 1 |