



Cambridge IGCSE™

CO-ORDINATED SCIENCES

0654/31

Paper 3 Theory (Core)

May/June 2022

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 2022 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.

PUBLISHED**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 'List rule' guidance
For questions that require *n* responses (e.g. State **two** reasons ...):
 - The response should be read as continuous prose, even when numbered answer spaces are provided.
 - Any response marked *ignore* in the mark scheme should not count towards *n*.
 - Incorrect responses should not be awarded credit but will still count towards *n*.
 - 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 *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 ruleState **three** reasons.... [3]

| | | | | |
|----------|---|---------|---|----------|
| A | 1 | Correct | ✓ | 2 |
| | 2 | Correct | ✓ | |
| | 3 | Wrong | ✗ | |

| | | | | |
|----------------------|---|------------------|--------|----------|
| B | 1 | Correct, Correct | ✓, ✓ | 3 |
| (4 responses) | 2 | Correct | ✓ | |
| | 3 | Wrong | ignore | |

| | | | | |
|----------------------|---|----------------|--------|----------|
| C | 1 | Correct | ✓ | 2 |
| (4 responses) | 2 | Correct, Wrong | ✓, ✗ | |
| | 3 | Correct | ignore | |

| | | | | |
|----------------------|---|----------------------|-----------------|----------|
| D | 1 | Correct | ✓ | 2 |
| (4 responses) | 2 | Correct, CON (of 2.) | ✗, (discount 2) | |
| | 3 | Correct | ✓ | |

| | | | | |
|----------------------|---|----------------|---|----------|
| E | 1 | Correct | ✓ | 3 |
| (4 responses) | 2 | Correct | ✓ | |
| | 3 | Correct, Wrong | ✓ | |

| | | | | |
|----------------------|---|------------------------|-------------------|----------|
| F | 1 | Correct | ✓ | 2 |
| (4 responses) | 2 | Correct | ✓ | |
| | 3 | Correct CON (of 3.) | ✗ (discount 3) | |

| | | | | |
|----------------------|---|-----------------------------------|-----------------------|----------|
| G | 1 | Correct | ✓ | 3 |
| (5 responses) | 2 | Correct | ✓ | |
| | 3 | Correct Correct CON (of 4.) | ✓ ignore ignore | |

| | | | | |
|----------------------|---|------------------------|-------------------|----------|
| H | 1 | Correct | ✓ | 2 |
| (4 responses) | 2 | Correct | ✗ | |
| | 3 | CON (of 2.) Correct | (discount 2) ✓ | |

| | | | | |
|----------------------|---|------------------------|-------------------|----------|
| I | 1 | Correct | ✓ | 2 |
| (4 responses) | 2 | Correct | ✗ | |
| | 3 | Correct CON (of 2.) | ✓ (discount 2) | |

| Question | Answer | Marks |
|-----------------|--|--------------|
| 1(a) | running ; cycling and walking ; sleeping ; | 3 |
| 1(b)(i) | X on one of the ventricles ; | 1 |
| 1(b)(ii) | ensures one-way flow of the blood ; | 1 |
| 1(b)(iii) | septum ; | 1 |
| 1(b)(iv) | muscle ; | 1 |
| 1(b)(v) | pump blood (around the body) ; | 1 |
| 1(c) | lung – pulmonary, artery / vein ; kidney – renal, artery / vein ; | 2 |

| Question | Answer | Marks |
|-----------------|---|--------------|
| 2(a) | coal ; natural gas; | 2 |
| 2(b) | hydrocarbons; fractional distillation; naphtha; | 3 |
| 2(c)(i) | two ; | 1 |
| 2(c)(ii) | 26; | 1 |
| 2(c)(iii) | exothermic; | 1 |
| 2(c)(iv) | limewater; goes milky; | 2 |

| Question | Answer | Marks |
|-----------|--|----------|
| 3(a)(i) | normal ; | 1 |
| 3(a)(ii) | angle of incidence correctly labelled; | 1 |
| 3(a)(iii) | 40° ; | 1 |
| 3(b)(i) | V= IR or V = 3 × 8; 24 (V); | 2 |
| 3(b)(ii) | 4 (Ω); the combined resistance of two resistors in parallel is less than that of either resistor by itself; | 2 |
| 3(b)(iii) | cell variable resistor lamp switch 2 or 3 correct ; 4 correct ; | 2 |
| 3(c) | 24cm = 0.24 m ; moment = force × distance or 12 × 0.24 ; 2.9 (Nm); | 3 |

| Question | Answer | | | Marks | | | | | | | | | | | | | | | | |
|------------------|---|-------------------------|-----------|-------------------------|----------|------------------|----------------------|----------|----|----------------|----------|------------------|----------|-----------|-----------|--|----------|-----------|-----------|----------|
| 4(a)(i) | <table border="1"> <tr> <td data-bbox="383 213 882 277">pea</td> <td data-bbox="882 213 1391 277">genotype</td> <td data-bbox="1391 213 1890 277">description of genotype</td> </tr> <tr> <td data-bbox="383 277 882 341">A</td> <td data-bbox="882 277 1391 341">rr ;</td> <td data-bbox="1391 277 1890 341">homozygous recessive</td> </tr> <tr> <td data-bbox="383 341 882 405">B</td> <td data-bbox="882 341 1391 405">Rr</td> <td data-bbox="1391 341 1890 405">heterozygous ;</td> </tr> </table> | pea | genotype | description of genotype | A | rr ; | homozygous recessive | B | Rr | heterozygous ; | | 2 | | | | | | | | |
| pea | genotype | description of genotype | | | | | | | | | | | | | | | | | | |
| A | rr ; | homozygous recessive | | | | | | | | | | | | | | | | | | |
| B | Rr | heterozygous ; | | | | | | | | | | | | | | | | | | |
| 4(a)(ii) | <table border="1"> <tr> <td colspan="2" data-bbox="383 443 1135 507"></td> <td colspan="2" data-bbox="1135 443 1890 507">parental gametes</td> </tr> <tr> <td colspan="2" data-bbox="383 507 1135 571"></td> <td data-bbox="1135 507 1512 571">R</td> <td data-bbox="1512 507 1890 571">r</td> </tr> <tr> <td data-bbox="383 571 759 639">parental gametes</td> <td data-bbox="759 571 1135 639">R</td> <td data-bbox="1135 571 1512 639">RR</td> <td data-bbox="1512 571 1890 639">Rr</td> </tr> <tr> <td data-bbox="383 639 759 703"></td> <td data-bbox="759 639 1135 703">r</td> <td data-bbox="1135 639 1512 703">Rr</td> <td data-bbox="1512 639 1890 703">rr</td> </tr> </table> | | | | | parental gametes | | | | R | r | parental gametes | R | RR | Rr | | r | Rr | rr | 2 |
| | | parental gametes | | | | | | | | | | | | | | | | | | |
| | | R | r | | | | | | | | | | | | | | | | | |
| parental gametes | R | RR | Rr | | | | | | | | | | | | | | | | | |
| | r | Rr | rr | | | | | | | | | | | | | | | | | |
| 4(a)(iii) | smooth 3 : wrinkled 1 ; | | | 1 | | | | | | | | | | | | | | | | |
| 4(b) | pollen ; ovule ; | | | 2 | | | | | | | | | | | | | | | | |
| 4(c) | egg / ovum ; | | | 1 | | | | | | | | | | | | | | | | |
| 4(d) | chromosome ; length of DNA ; that codes for a protein ; allele ; | | | 4 | | | | | | | | | | | | | | | | |

| Question | Answer | Marks |
|-----------|--|----------|
| 5(a) | high melting point; high boiling point; malleable; ductile; Max 2 marks | 2 |
| 5(b)(i) | 950 (kg); | 1 |
| 5(b)(ii) | low density / high tensile strength; | 1 |
| 5(c)(i) | bauxite; | 1 |
| 5(c)(ii) | breakdown of an ionic compound; when molten or in aqueous solution; by the passage of electricity; Max 2 marks | 2 |
| 5(c)(iii) | iron; | 1 |
| 5(d)(i) | finite resource / material being used at a faster rate than it can be replaced; | 1 |
| 5(d)(ii) | recycling; | 1 |

| Question | Answer | Marks |
|----------|--|----------|
| 6(a)(i) | infrared placed in third box from the right; | 1 |
| 6(a)(ii) | γ -radiation linked to treating cancer and X-rays linked to diagnosing broken bones; | 1 |
| 6(b)(i) | α β γ ; | 1 |

| Question | Answer | Marks |
|----------|--|-------|
| 6(b)(ii) | cancer / mutation; | 1 |
| 6(c)(i) | (atoms of an element that have the) same number of protons but different numbers of neutrons; | 1 |
| 6(c)(ii) | 2 half-lives (or evidence of 2×2); mass at start = 0.2 g; | 2 |
| 6(d) | statement of average range; 100 Hz is higher than average low value; 15 000 Hz is lower than average high value; Max 2 marks | 2 |
| 6(e) | chemical; kinetic; | 2 |

| Question | Answer | Marks |
|----------|--------|-------|
| 7(a) | | 3 |

| Question | Answer | Marks |
|----------|---|-------|
| 7(b) | glucose + oxygen → carbon dioxide + water LHS 1; RHS 1; | 2 |
| 7(c) | cell membrane and cytoplasm circled ; | 1 |
| 7(d) | zygote ; | 1 |
| 7(e) | nucleus ; | 1 |

| Question | Answer | Marks |
|-----------|--|-------|
| 8(a)(i) | chlorine; | 1 |
| 8(a)(ii) | carbon monoxide; | 1 |
| 8(a)(iii) | nitrogen; | 1 |
| 8(a)(iv) | methane; | 1 |
| 8(a)(v) | helium; | 1 |
| 8(b)(i) | carbon dioxide; | 1 |
| 8(b)(ii) | pH decreases; non-metal oxide / carbon dioxide is acidic; | 2 |
| 8(b)(iii) | increase acid concentration; increase temperature of acid; increase surface area of calcium carbonate; Max 2 marks | 2 |

| Question | Answer | Marks |
|-----------|---|-------|
| 9(a)(i) | surfboard is moving at constant speed; | 1 |
| 9(a)(ii) | gravitational (force) / weight; | 1 |
| 9(a)(iii) | force; distance; | 2 |
| 9(b)(i) | amplitude correctly labelled; | 1 |
| 9(b)(ii) | one wave passes every 10 seconds; | 1 |
| 9(c)(i) | less energetic molecules ; <i>owtte</i> | 1 |
| 9(c)(ii) | decrease / cool ; | 1 |
| 9(d) | density = mass / volume or $5120 / 5$; density = $1024 \text{ (kg / m}^3\text{)}$; | 2 |

| Question | Answer | Marks |
|-----------|---|-------|
| 10(a)(i) | 57 (g) ; | 1 |
| 10(a)(ii) | The decrease in mass will be less than in the first investigation ticked ; | 1 |
| 10(b) | evaporation ; | 1 |
| 10(c) | stomata ; | 1 |
| 10(d) | <i>any three from</i> water enters root hair cells ; by osmosis ; ref to root cortex cells ; transferred to leaves by xylem ; Max 3 marks | 3 |

| Question | Answer | Marks |
|-----------|--|-------|
| 10(e)(i) | support / as a solvent / AVP ; | 1 |
| 10(e)(ii) | <p>any two from: light ; warm / suitable, temperature ; carbon dioxide ; chlorophyll ;</p> <p>Max 2 marks</p> | 2 |

| Question | Answer | Marks | | | | | | | | | | | | |
|------------|--|---------------|--------|---------------|--------|-----|---|----------|----|---------------|---------|---|---|---|
| 11(a)(i) | 2.8.8.1; | 1 | | | | | | | | | | | | |
| 11(a)(ii) | number of outer shell electrons is the same as group number; | 1 | | | | | | | | | | | | |
| 11(a)(iii) | electrons = 19; neutrons = 20; | 2 | | | | | | | | | | | | |
| 11(a)(iv) | <table border="1"> <thead> <tr> <th>particle</th> <th>charge</th> <th>relative mass</th> </tr> </thead> <tbody> <tr> <td>proton</td> <td>+ 1</td> <td>1</td> </tr> <tr> <td>electron</td> <td>-1</td> <td>0 or 1 / 2000</td> </tr> <tr> <td>neutron</td> <td>0</td> <td>1</td> </tr> </tbody> </table> | particle | charge | relative mass | proton | + 1 | 1 | electron | -1 | 0 or 1 / 2000 | neutron | 0 | 1 | 2 |
| particle | charge | relative mass | | | | | | | | | | | | |
| proton | + 1 | 1 | | | | | | | | | | | | |
| electron | -1 | 0 or 1 / 2000 | | | | | | | | | | | | |
| neutron | 0 | 1 | | | | | | | | | | | | |
| 11(b) | element – contains only one type of atom; compound –contains two or more elements chemically combined ; | 2 | | | | | | | | | | | | |
| 11(c) | $2K + 2H_2O \rightarrow 2KOH + H_2$ LHS 1 ; RHS 1; | 2 | | | | | | | | | | | | |

| Question | Answer | Marks |
|-----------------|--|--------------|
| 12(a) | area is less ; so pressure is greater; | 2 |
| 12(b) | Z (no mark) molecules are separated; | 1 |
| 12(c)(i) | kinetic; | 1 |
| 12(c)(ii) | gravitational potential; | 1 |
| 12(d) | speed = distance / time or correct numbers from graph; 0.5 (m / s); | 2 |