



Cambridge IGCSE™

CO-ORDINATED SCIENCES

0654/41

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 **15** 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	<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

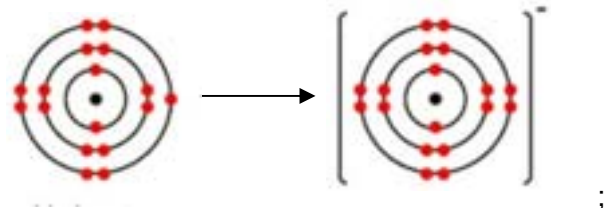
Question	Answer	Marks
1(a)(i)	A ; D ; B ;	3
1(a)(ii)	<i>any three from:</i> ref to <u>vasodilation</u> ; <u>arterioles</u> widen / dilate ; increase in blood flow to, skin surface / capillaries ; AVP ;	3
1(a)(iii)	negative feedback ;	1
1(b)(i)	insulin ;	1
1(b)(ii)	glands ;	1
1(c)(i)	brain ;	1
1(c)(ii)	sensitivity ;	1

Question	Answer	Marks
2(a)(i)	liquid to gas = evaporation / boiling ; liquid to solid = freezing / solidification ;	2
2(a)(ii)	(kinetic energy) increases / owtte ;	1
2(b)(i)	pencil is insoluble/does not dissolve in water / owtte ; OR ink is soluble/dissolves in water / owtte ;	1
2(b)(ii)	A, B and D ;;	2

Question	Answer	Marks
2(b)(iii)	idea that the substance is insoluble (in the solvent) ;	1
2(b)(iv)	($R_f =$) $2.6 \div 4.0$; 0.65 ;	2
2(c)	idea that pure substances have a specific or sharp melting point ; (but) mixtures melt over a range of temperatures ;	2

Question	Answer	Marks
3(a)(i)	(the forces are) the same size / equal ;	1
3(a)(ii)	(mass =) $750 / 10 / 75$ (kg) AND (speed =) $\sqrt{(2 \times 13.5) / 75}$; (speed =) 0.6 (m / s) ;	2
3(b)(i)	$45000 / 3600$ (=12.5 m / s) ;	1
3(b)(ii)	(a =) $\Delta v / t / 12.5 / 25$; (a =) 0.5 (m / s ²) ;	2
3(b)(iii)	$(0.5 \times 25 \times 12.5) + (12.5 \times 10)$; 281.25 (m) ;	2
3(b)(iv)	(force =) moment / distance / $35.7 / 0.17$; (force =) 210 (N) ;	2
3(c)	(thermal) energy is transferred (from skin / blood / capillaries) to water molecules (on skin surface) ; the most energetic molecules escape / evaporates from the surface ; average energy of remaining molecules decreases ;	3

Question	Answer	Marks
4(a)	$6\text{CO}_2 + 6\text{H}_2\text{O}$; $\text{C}_6\text{H}_{12}\text{O}_6$;	2
4(b)	light ; chemical ;	2
4(c)	palisade (mesophyll) ;	1
4(d)(i)	evidence of $14+15+17 / 3$ or $46 / 3$; $= 15$;	2
4(d)(ii)	as light intensity decreases the, (mean) number of bubbles of oxygen / rate of photosynthesis, decreases (initially) ; Accept ORA the (mean) number of bubbles of oxygen / the rate of photosynthesis, becomes constant after the lamp reaches 40 cm from the plant ;	2
4(d)(iii)	some of the oxygen is used in respiration ;	1

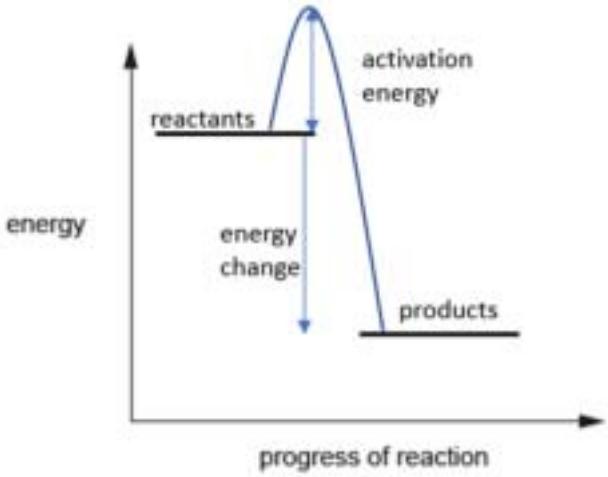
Question	Answer	Marks
5(a)(i)	(nucleus containing) protons ; (and) neutrons ; electron ;	3
5(a)(ii)	2.1 ;	1
5(b)(i)		2

Question	Answer	Marks																
5(b)(ii)	regular arrangement ; of alternating positive and negative ions ;	2																
5(c)(i)	<table border="1"> <thead> <tr> <th>isotope</th> <th>protons</th> <th>neutrons</th> <th>electrons</th> </tr> </thead> <tbody> <tr> <td>carbon-12</td> <td>6</td> <td>6</td> <td>6</td> </tr> <tr> <td>carbon-13</td> <td>6</td> <td>7</td> <td>6</td> </tr> <tr> <td>carbon-14</td> <td>6</td> <td>8</td> <td>6</td> </tr> </tbody> </table> ;;	isotope	protons	neutrons	electrons	carbon-12	6	6	6	carbon-13	6	7	6	carbon-14	6	8	6	2
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carbon-12	6	6	6															
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carbon-14	6	8	6															
5(c)(ii)	they have the same number of electrons in the outer shell ;	1																

Question	Answer	Marks
6(a)	(releases CO ₂) contributes to global warming / causes climate change / (enhanced) greenhouse effect ;	1
6(b)	(output =) efficiency × input / 0.9 × 1.50 ; (output =) 1.35 (kJ) ;	2
6(c)	density of water decreases as it is heated ; less dense / heated water rises ;	2
6(d)(i)	3×10^8 (m / s) ; (frequency =) speed / wavelength / $3 \times 10^8 / 4.6 \times 10^{-7}$; (frequency =) 6.5×10^{14} (Hz) ;	3
6(d)(ii)	perpendicular and parallel ; sound ;	2

Question	Answer	Marks
7(a)(i)	the bacteria with (antibiotic) resistance survive ; antibiotics kill the bacteria without (antibiotic) resistance ;	2
7(a)(ii)	the bacteria with (antibiotic) resistance, multiplies / divides ; passing on alleles / genes / (mutated) DNA to the next generation / the offspring all gain resistance (to antibiotics) ;	2
7(a)(iii)	natural selection ;	1
7(b)(i)	change in, gene / chromosome ;	1
7(b)(ii)	ionising ;	1
7(c)	white blood cells ; platelets ;	2

Question	Answer	Marks
8(a)	$\text{Mg} + 2 \text{HCl} \rightarrow \text{MgCl}_2 + \text{H}_2$ Correct formulae ; Correct balancing ;	2
8(b)(i)	(as the temperature increases) the time decreases / owtte ;	1

Question	Answer	Marks												
8(b)(ii)	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 80%;">reason</th> <th style="width: 20%;">tick (✓)</th> </tr> </thead> <tbody> <tr> <td>particles are closer together</td> <td></td> </tr> <tr> <td>particles collide more often</td> <td style="text-align: center;">✓</td> </tr> <tr> <td>particles have less energy</td> <td></td> </tr> <tr> <td>particles have a larger surface area</td> <td></td> </tr> <tr> <td>particles move faster</td> <td style="text-align: center;">✓</td> </tr> </tbody> </table> <p>;;</p>	reason	tick (✓)	particles are closer together		particles collide more often	✓	particles have less energy		particles have a larger surface area		particles move faster	✓	2
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particles are closer together														
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particles move faster	✓													
8(c)	 <p>products shown below reactants ;</p> <p>energy change or ΔH correctly labelled ;</p> <p>activation energy correctly labelled ;</p>	3												

Question	Answer	Marks
8(d)	M_r of $H_2 = 2$; moles of $H_2 = 0.1 \div 2 = 0.05 / M / M_r$; volume of $H_2 = 0.05 \times 24 = 1.2 \text{ dm}^3$;	3

Question	Answer	Marks
9(a)	(as length increases) resistance increases ; (as resistance increase) current decreases / resistance inversely proportional to resistance ;	2
9(b)(i)	variable resistor ;	1
9(b)(ii)	(resistance =) $V / I / 1.50 / 0.80$; (resistance =) $1.9 (\Omega)$;	2
9(c)	energy supplied / (electrical) work done (by a source) ; driving charge around a (complete) circuit / per (unit) charge around a (complete) circuit ;	2
9(d)	concentric circle(s) around wire ; direction shown anti-clockwise ;	2

Question	Answer	Marks
10(a)	water potential ; (cell) membrane ; dilute, concentrated ;	3
10(b)	any two from: less, surface area / (internal) volume ; so less oxygen transported ; AVP ;	2

Question	Answer	Marks
10(c)	<i>any two from:</i> surface area ; temperature ; diffusion distance/thickness of cell membrane ;	2
10(d)(i)	<i>any two from:</i> chloroplast ; (permanent) vacuole ; cell wall ;	2
10(d)(ii)	root hair (cell) ;	1

Question	Answer	Marks
11(a)(i)	B ;	1
11(a)(ii)	C ;	1
11(a)(iii)	A ;	1
11(a)(iv)	A ;	1
11(b)	<i>any three from:</i> idea that C on monomer X and N on monomer Y join ; idea that -OH group is lost from the monomer X ; idea that -H is lost from monomer Y ; idea that water is eliminated ; AVP ;	3

Question	Answer	Marks
12(a)(i)	beta ; (beta) can penetrate (air and) paper ; (beta) can't penetrate thin aluminium (and thicker materials) ;	3
12(a)(ii)	3 half lives ; ($t = 3 \times 29 =$) 87 (years) ;	2
12(b)	(forces between particles) decrease ;	1
12(c)	$d = m / v$ or $v = m / d$ or $v = 37.1 / 10.6$; $= 3.5 \text{ (cm}^3\text{)}$;	2