



# Cambridge IGCSE™

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**CO-ORDINATED SCIENCES**

**0654/42**

Paper 4 Theory (Extended)

**May/June 2023**

MARK SCHEME

Maximum Mark: 120

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**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.

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This document consists of **17** 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 <b>two</b> reasons ...):</p> <ul style="list-style-type: none"><li>• The response should be read as continuous prose, even when numbered answer spaces are provided.</li><li>• Any response marked <i>ignore</i> in the mark scheme should not count towards <i>n</i>.</li><li>• Incorrect responses should not be awarded credit but will still count towards <i>n</i>.</li><li>• Read the entire response to check for any responses that contradict those that would otherwise be credited. Credit should <b>not</b> 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.</li><li>• Non-contradictory responses after the first <i>n</i> responses may be ignored even if they include incorrect science.</li></ul>

**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.

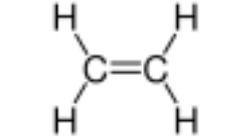
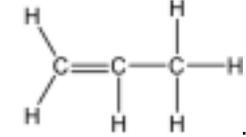
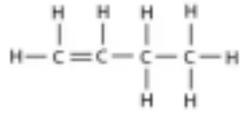
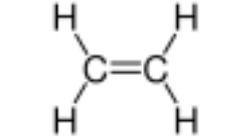
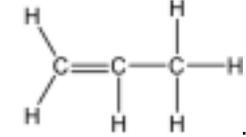
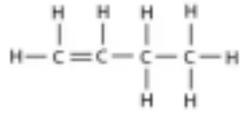
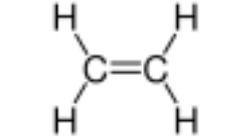
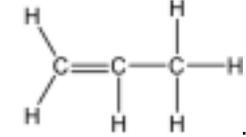
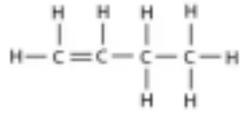
State symbols given in an equation should be ignored unless asked for in the question or stated otherwise in the mark scheme.

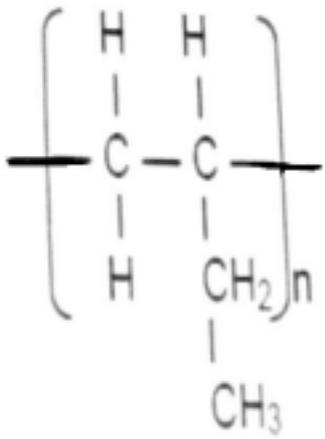
Acronyms and shorthand in the mark scheme

<b>Acronym / shorthand</b>	<b>Explanation</b>
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 <b>OR</b>	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)	<b>B</b> ; <b>H</b> ; <b>G / H</b> ;	<b>3</b>
1(a)(ii)	<b>X</b> drawn on blind spot ;	<b>1</b>
1(a)(iii)	<b>A</b> – narrows / gets thinner / less convex ; <b>E</b> – tightens ; <b>F</b> – relaxes ;	<b>3</b>
1(a)(iv)	adrenaline ;	<b>1</b>
1(b)	stimuli ; environment ;	<b>2</b>

Question	Answer	Marks
2(a)	(saturated) – contains <b>only</b> single (covalent) bonds ; (hydrocarbon) – contains <b>only</b> hydrogen and carbon atoms ;	<b>2</b>

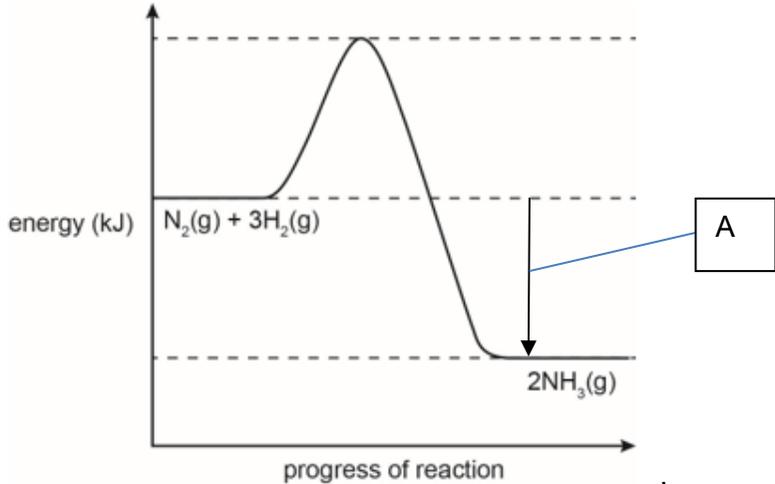
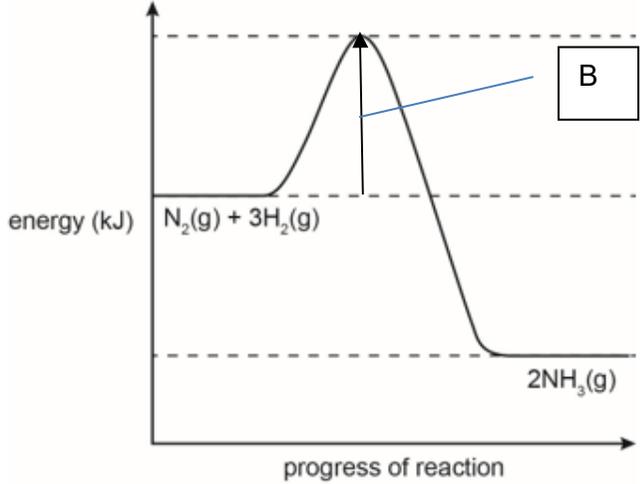
Question	Answer			Marks												
2(b)	<table border="1"> <thead> <tr> <th data-bbox="707 213 994 277">name</th> <th data-bbox="994 213 1281 277">molecular formula</th> <th data-bbox="1281 213 1568 277">structure</th> </tr> </thead> <tbody> <tr> <td data-bbox="707 277 994 456"><b>ethene</b> ;</td> <td data-bbox="994 277 1281 456"><math>C_2H_4</math></td> <td data-bbox="1281 277 1568 456">  </td> </tr> <tr> <td data-bbox="707 456 994 641">propene</td> <td data-bbox="994 456 1281 641"><math>C_3H_6</math></td> <td data-bbox="1281 456 1568 641">  ; </td> </tr> <tr> <td data-bbox="707 641 994 807"><b>butene</b> ;</td> <td data-bbox="994 641 1281 807"><math>C_4H_8</math></td> <td data-bbox="1281 641 1568 807">  </td> </tr> </tbody> </table>			name	molecular formula	structure	<b>ethene</b> ;	$C_2H_4$		propene	$C_3H_6$	 ;	<b>butene</b> ;	$C_4H_8$		<b>3</b>
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propene	$C_3H_6$	 ;														
<b>butene</b> ;	$C_4H_8$															
2(c)	test – aqueous bromine ; result with propane – (aqueous bromine) stays orange / brown <b>or</b> no change ; result with propene – (aqueous bromine) is decolourised / turns colourless ;			<b>3</b>												

Question	Answer	Marks
2(d)		2

Question	Answer	Marks
3(a)(i)	0.0025 N ; 0.0025 N and 0 (N) ;	2
3(a)(ii)	(P =) F / A or 0.0025 / (6 × 1.2 × 10 <sup>-7</sup> ) ; (P =) 3500 (Pa) ;	2
3(b)(i)	X placed between 4.0 and 8.0 s ;	1
3(b)(ii)	(a =) Δv / Δt or 0.03 / 4.0 ; (a =) 0.0075 (m / s <sup>2</sup> ) ;	2
3(c)(i)	1.6 / 100 ; 0.016 (m) ;	2

Question	Answer	Marks
3(c)(ii)	(f =) 2 (Hz) ; (v =) $f\lambda$ <b>or</b> $2 \times 0.016$ ; (v =) 0.032 (m / s) ;	3

Question	Answer	Marks
4(a)(i)	(increasing temperature) increases the kinetic energy of particles ; increased frequency of (effective) collisions / ref to increased rate of substrates entering, active site / enzyme ;	2
4(a)(ii)	(no photosynthesis) ref to denaturation (at extreme temperature) ; active site, changes <u>shape</u> / is deformed ; substrate no longer complementary to, active site / enzyme ;	3
4(b)	chlorophyll ;	1
4(c)	carbon dioxide ; water ;	2
4(d)	<i>any two from:</i> contain many, chloroplasts / chlorophyll ; near the surface of the leaf ; are tightly packed / arranged side by side ; column / AW, shaped ; large vacuoles / chloroplasts at edge of cell ; chloroplasts able to move ;	2

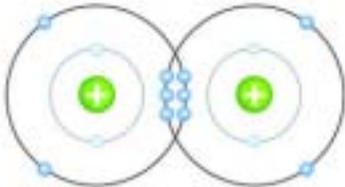
Question	Answer	Marks
5(a)	nitrogen – (from the) air ; hydrogen – from the reaction of methane / natural gas with steam ;	2
5(b)(i)	 <p>energy (kJ)</p> <p><math>\text{N}_2(\text{g}) + 3\text{H}_2(\text{g})</math></p> <p><math>2\text{NH}_3(\text{g})</math></p> <p>progress of reaction</p> <p>A</p>	1
5(b)(ii)	 <p>energy (kJ)</p> <p><math>\text{N}_2(\text{g}) + 3\text{H}_2(\text{g})</math></p> <p><math>2\text{NH}_3(\text{g})</math></p> <p>progress of reaction</p> <p>B</p>	1

Question	Answer	Marks
5(b)(iii)	(exothermic because) energy change is negative / energy is given out in the reaction / energy of reactants is higher than energy of products ; bond breaking is endothermic / owtte ; bond making is exothermic / owtte ; more energy is given out (in bond making) than is taken in (in bond breaking) ;	4
5(c)	$M_r$ of $\text{NH}_3 = 17$ ; moles of $\text{NH}_3 = 142\,800 \div 17 = 8400$ ; volume of $\text{NH}_3 = 8400 \times 24 = 201\,600 \text{ (dm}^3\text{)}$ ;	3

Question	Answer	Marks
6(a)(i)	12:00 ;	1
6(a)(ii)	the light is incident at (almost) $90^\circ$ / ref to maximum light intensity / the sun is highest in the sky / directly above the solar panel / AVP ;	1
6(b)	<b>R</b> <b>P</b> <b>P</b> ;;	2
6(c)(i)	(soft-iron) core ;	1
6(c)(ii)	alternating / changing, current / voltage, in primary coil ; produces a, changing / alternating, magnetic field (in the soft-iron core) ; which <u>induces</u> an, (alternating) voltage / emf / potential difference (in the secondary coil) ;	3
6(c)(iii)	$(V_s =) V_p \times N_s / N_p$ or $22 \times 17 / 8$ ; $(V_s =) 47 \text{ (kV)}$ ;	2

Question	Answer	Marks
7(a)(i)	grasshopper / fruit fly ; eagle / snake ; mango / corn ;	3
7(a)(ii)	<i>any three from:</i> respiration / heat / metabolic processes ; not all of the organism is eaten ; not all the organism is digested / excretion / faeces / urine ; movement ; synthesis of (named) biological molecules / growth ; AVP ;	3
7(a)(iii)	Sun ;	1
7(b)(i)	fertilisers contain nitrate ions ; (nitrate ions required) for protein synthesis / amino acid production ;	2
7(b)(ii)	ref to decomposers / decomposition ; ref to aerobic respiration ;	2

Question	Answer	Marks																								
8(a)	<table border="1"> <thead> <tr> <th>isotope</th> <th>proton (atomic) number</th> <th>nucleon (mass) number</th> <th>protons</th> <th>neutrons</th> <th>electrons</th> </tr> </thead> <tbody> <tr> <td>copper-63</td> <td>29</td> <td>63</td> <td>29</td> <td>34</td> <td><b>29</b></td> </tr> <tr> <td>copper-65</td> <td>29</td> <td>65</td> <td><b>29</b></td> <td><b>36</b></td> <td>29</td> </tr> <tr> <td>...</td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> </tbody> </table>	isotope	proton (atomic) number	nucleon (mass) number	protons	neutrons	electrons	copper-63	29	63	29	34	<b>29</b>	copper-65	29	65	<b>29</b>	<b>36</b>	29	...						3
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...																										
8(b)	element ; proton ; nucleon ;	3																								

Question	Answer	Marks
8(c)	2.8.2 <input checked="" type="checkbox"/> ;	1
8(d)	 ;;	2
8(e)	<p><i>any two from:</i></p> <p>nitrogen / covalent molecules, has weak intermolecular forces / weak attractions between (nitrogen) molecules ;</p> <p>calcium nitride / ionic compounds, has strong (electrostatic) forces of attraction between oppositely charged ions ;</p> <p>higher melting point due to more energy required to overcome stronger forces / ORA ;</p>	2

Question	Answer	Marks
9(a)(i)	2.0 (V) ;	1
9(a)(ii)	in a <u>series circuit</u> the current is the same (everywhere) ;	1
9(b)	<p>(I =) 0.3 (A) ;</p> <p>(R = ) V / I <b>or</b> 6.0 / 0.3 ;</p> <p>(R = ) 20 (<math>\Omega</math>) ;</p>	3
9(c)	<p>electromagnetic spectrum</p> <p>longer</p> <p>lower</p> <p>the same / <math>3 \times 10^8</math> <u>m/s</u> ;</p>	2

Question	Answer			Marks												
10(a)(i)	haploid ; nucleus ;			2												
10(a)(ii)	23 ;			1												
10(a)(iii)	(aerobic) respiration releases energy ; needed for sperm to, swim / move flagella / move (to egg) / locomotion ;			2												
10(b)	<table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th></th> <th style="text-align: center;">asexual reproduction</th> <th style="text-align: center;">sexual reproduction</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">involves formation of a zygote</td> <td></td> <td style="text-align: center;">✓</td> </tr> <tr> <td style="text-align: center;">no genetic variation</td> <td style="text-align: center;">✓</td> <td></td> </tr> <tr> <td style="text-align: center;">involves production of offspring</td> <td style="text-align: center;">✓</td> <td style="text-align: center;">✓</td> </tr> </tbody> </table> ;;				asexual reproduction	sexual reproduction	involves formation of a zygote		✓	no genetic variation	✓		involves production of offspring	✓	✓	2
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involves formation of a zygote		✓														
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involves production of offspring	✓	✓														
10(c)	<i>any two from:</i> more energy is required (to find a mate / produce gametes) ; longer process ; can't reproduce if isolated / have to have more than one organism ; not always successful ; <i>idea of new</i> , undesirable characteristics, can result in the offspring ;			2												

Question	Answer			Marks
11(a)	aqueous solution	product at anode	product at cathode	2
	copper chloride	<b>chlorine ;</b>	copper	
	magnesium sulfate	oxygen	<b>hydrogen ;</b>	
	sodium bromide	bromine	hydrogen	
11(b)	hydrogen is less reactive than sodium / ORA ;			1
11(c)	$\text{Cu}^{2+} + 2\text{e}^{-} \rightarrow \text{Cu} ; ;$			2
11(d)(i)	oxidation <b>and</b> ref to loss of electrons ;			1
11(d)(ii)	anode – copper dissolves / copper ions form ; cathode – copper forms / copper deposited ;			2

Question	Answer	Marks
12(a)(i)	He nucleus / 2 protons and 2 neutrons <b>and</b> low ; high ;	2
12(a)(ii)	alpha curves towards negative ; gamma does not deviate ;	2
12(b)	${}^{14}_6\text{C} \rightarrow {}^{14}_7\text{N} + {}^0_{-1}\beta ; ;$	2
12(c)(i)	in a gas the particles are far apart / in a solid the particles are touching ; <b>or</b> in a gas the particles can be pushed closer together / the particles in a solid can't be pushed closer together ;	1
12(c)(ii)	<i>(water cannot be compressed)</i> (because) the molecules are touching or there are no / small, gaps between molecules ;	1

<b>Question</b>	<b>Answer</b>	<b>Marks</b>
12(c)(iii)	(kinetic) energy / speed of molecules, increases ; molecules collide with the (walls of the) container, more often / harder ; the force per unit area increases / the pressure increases ;	<b>3</b>