



## Cambridge IGCSE™

---

CO-ORDINATED SCIENCES

0654/41

Paper 4 Theory (Extended)

May/June 2021

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 2021 series for most Cambridge IGCSE™, Cambridge International A and AS Level components and some Cambridge O Level components.

---

This document consists of **12** 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.

Question	Answer					Marks
1(a)	type of respiration	oxygen is a reactant	glucose is a reactant	lactic acid is a product	carbon dioxide is a product	4
	aerobic	✓	✓		✓	
	anaerobic respiration in muscles		✓	✓		
	anaerobic respiration in yeast		✓		✓	
; ; ; ;						
1(b)	bread making / AVP ;					1
1(c)	less energy is released <u>per glucose molecule</u> than aerobic respiration ;					1

Question	Answer	Marks
2(a)(i)	pencil does not dissolve in the solvent / AW ;	1
2(a)(ii)	( $R_f =$ ) 14.2 ÷ 15.3 ; 0.928 ;	2
2(b)(i)	X ;	1
2(b)(ii)	Z ; (because) it has the most spots, <u>above the line / that have moved</u> / AW ;	2
2(c)	(It is impure because) it melts over a range of temperatures / melts at different melting points ; the melting point is not the same as the 'standard' reference melting point / AW ;	2

Question	Answer	Marks
3(a)	to reduce the potential difference across wire / to reduce the current through the wire / to stop wire melting / heating ;	1
3(b)(i)	$R = V / I$ or 1.2 / 0.40 ; 3.0 ( $\Omega$ ) ;	2
3(b)(ii)	(E=) $VIt$ or $0.40 \times 1.2 \times 15$ ; 7.2 ; joules / J ;	3
3(b)(iii)	electrical and thermal ;	1
3(c)	1.5 ( $\Omega$ ) ;	1
3(d)	measure the diameter ; use a micrometer screw gauge ;	2
3(e)(i)	downwards arrow ;	1
3(e)(ii)	increase current ; increase strength of the magnetic field ;	2

Question	Answer	Marks
4(a)(i)	$\frac{15.0 \times 100}{4.0}$ 380 (g) ;	2
4(a)(ii)	plant-based foods / tofu / soya milk, contain less vitamin D than (equivalent) animal products ; they would need to eat a larger amount of food to get enough vitamin D / comparison of data / ref. to per 100 g ;	2
4(b)	(vitamin D is needed) for (the formation of) bones ; by the (growing) baby ;	2
4(c)	marasmus / kwashiorkor ;	1

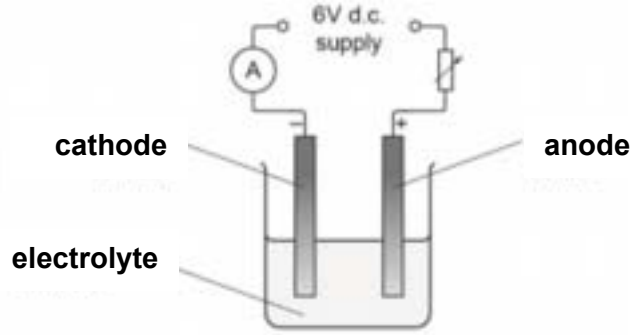
Question	Answer	Marks
4(d)	large / insoluble <u>molecules</u> broken down to small / soluble molecules ; to form amino acids ; by protease ; ref to acidic conditions (in the stomach) ;  <b>max 3</b>	<b>3</b>
4(e)	food is broken into smaller <u>molecules</u> / involves enzymes ;	<b>1</b>

Question	Answer	Marks								
5(a)(i)	<table border="1"> <thead> <tr> <th>particle</th> <th>number</th> </tr> </thead> <tbody> <tr> <td>proton</td> <td><b>17</b></td> </tr> <tr> <td>neutron</td> <td><b>20</b></td> </tr> <tr> <td>electron</td> <td><b>17</b></td> </tr> </tbody> </table>	particle	number	proton	<b>17</b>	neutron	<b>20</b>	electron	<b>17</b>	<b>3</b>
particle	number									
proton	<b>17</b>									
neutron	<b>20</b>									
electron	<b>17</b>									
5(a)(ii)	(chlorine has) 7 (electrons in the outer shell) ;	<b>1</b>								
5(a)(iii)	(atoms with) same proton or atomic number / same number of protons ; different nucleon or mass number / different number of neutrons ;	<b>2</b>								
5(b)	sodium chloride has strong (electrostatic) forces of attraction between (oppositely charged) <u>ions</u> ;  chlorine has weak intermolecular forces / weak attractions between (chlorine) molecules ;  strong (electrostatic) forces of attraction take more energy to break than weak intermolecular forces / ORA ;	<b>3</b>								
5(c)	$\text{Cl}_2 + 2\text{NaBr} \rightarrow \text{Br}_2 + 2\text{NaCl}$ correct formulae ; then correct balancing ;	<b>2</b>								

Question	Answer	Marks
6(a)(i)	electron ;	1
6(a)(ii)	${}_{39}^{90}\text{Y}$ ; ;	2
6(b)	reading would decrease ; fewer beta particles would penetrate paper / more absorbed ;	2
6(c)(i)	30 (years) ;	1
6(c)(ii)	does not need replacing regularly / activity will remain high for a long time ;	1

Question	Answer	Marks
7(a)(i)	<b>H</b> ; <b>C</b> ; <b>B</b> ;	3
7(a)(ii)	<b>A</b> thickens / gets wider / AW ; <b>E</b> slackens / loosens / AW ; <b>F</b> contracts ;	3
7(b)(i)	retina ;	1
7(b)(ii)	circular / radial, muscles ;	1
7(c)	sneezing ticked ; sweating ticked ;	2
7(d)	brain and spinal cord ;	1



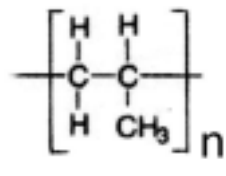
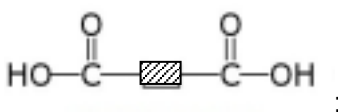
Question	Answer	Marks
8(a)	 <p>The diagram shows an electrolysis cell. A beaker contains an electrolyte. Two electrodes are immersed in it: a cathode on the left and an anode on the right. The cathode is connected to the negative terminal of a 6V d.c. supply, and the anode is connected to the positive terminal. An ammeter (A) is connected in series with the negative terminal, and a switch is connected in series with the positive terminal.</p>	3
8(b)(i)	oxygen ;	1
8(b)(ii)	$\text{Cu}^{2+} + 2\text{e}^{-} \rightarrow \text{Cu}$ LHS ; RHS ;	2
8(c)(i)	oxidation because electrons are lost (from bromide ions) ;	1
8(c)(ii)	$M_r$ of $\text{Br}_2 = 160$ ; (moles of $\text{Br}_2 =$ ) mass $\div$ molar mass <b>or</b> $20 \div 160$ <b>or</b> 0.125 ; (volume of $\text{Br}_2 = 0.125 \times 24 =$ ) 3 ( $\text{dm}^3$ ) ;	3

Question	Answer	Marks
9(a)	stationary ;	1
9(b)	(a =) $8.0 / 4.0$ ;	1
9(c)	(m =) $F / a$ <b>or</b> $160 / 2.0$ ; 80 (kg) ;	2
9(d)(i)	first diagram ticked ;	1
9(d)(ii)	constant velocity / no acceleration, so forces must be balanced / no resultant force ;	1

Question	Answer	Marks
9(e)(i)	(water) evaporates ; most energetic particles leave (surface) ; average energy of the remaining particles is lower ;	3
9(e)(ii)	evaporation can occur at any temperature / boiling only happens at the boiling point ; evaporation happens only at the surface / boiling happens throughout the liquid ; boiling takes energy in (endothermic) to occur / evaporation lets only the molecules with the highest kinetic energy out ; evaporation can occur using the internal energy of the system / boiling requires an external source of heat ; evaporation produces cooling / boiling does not ; evaporation is a slow process / boiling is a rapid process ; <b>max 2</b>	2
10(a)	nitrate ; photosynthesis ; decomposed ; oxygen ;	4
10(b)	increased, soil erosion / described ; soil contains nitrate (ions) ;	2
10(c)	loss of food / disruption to food chain / web ; loss of habitat ; extinction ; migration ;	2
10(d)	producer ;	1

Question	Answer	Marks
10(e)	carbon dioxide ; water ; chlorophyll ; (named) mineral <u>ions</u> ;  <b>max 3</b>	<b>3</b>

Question	Answer	Marks
11(a)	both have <u>same</u> functional group / both have (carbon to carbon) double bond ; both have <u>same</u> general formula / $C_nH_{2n}$ ; both have similar (chemical) reactions ; trend in / <u>similar</u> , physical properties ;  <b>max 2</b>	<b>2</b>
11(b)(i)	high temperature / specified elevated temperature ; high pressure / specified elevated pressure ; catalyst / named catalyst ; AVP ;  <b>max 2</b>	<b>2</b>
11(b)(ii)	butane ;  $  \begin{array}{cccc}  & H & H & H & H \\  &   &   &   &   \\  H & - C & - C & - C & - C - H \\  &   &   &   &   \\  & H & H & H & H  \end{array}  $ ; ;	<b>3</b>
11(c)	$C_2H_4 + Br_2 \rightarrow C_2H_4Br_2$  $C_2H_4Br_2$ ; then all else correct ;	<b>2</b>

Question	Answer	Marks
11(d)	 $\left[ \begin{array}{cc} \text{H} & \text{H} \\   &   \\ -\text{C} & -\text{C}- \\   &   \\ \text{H} & \text{CH}_3 \end{array} \right]_n ;$	1
11(e)	 $\text{HO}-\text{C}(=\text{O})-\text{[shaded box]}-\text{C}(=\text{O})-\text{OH} ;$	1

Question	Answer	Marks
12(a)	0.0015 or $1.5 \times 10^{-3}$ ; (v =) d / t or $6 / 1.5 \times 10^{-3}$ ; 4000 (m / s) ;	3
12(b)	wood is a solid / air is a gas ; particles in a solid are close together / touching / ORA ; vibrations are transferred more quickly in a solid / ORA ;	3
12(c)	vibrations / oscillations are, parallel to / in the same direction as, the direction of, energy transfer / wave travel ;	1
12(d)	spreading out of waves ; circular waves shown on right hand side of boundary ;	2