



# Cambridge IGCSE™

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CO-ORDINATED SCIENCES

0654/42

Paper 4 Theory (Extended)

May/June 2022

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 2022 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 **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 '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 rule**State **three** reasons.... [3]

<b>A</b>	1	Correct	✓	<b>2</b>
	2	Correct	✓	
	3	Wrong	✗	

<b>B</b> (4 responses)	1	Correct, Correct	✓, ✓	<b>3</b>
	2	Correct	✓	
	3	Wrong	ignore	

<b>C</b> (4 responses)	1	Correct	✓	<b>2</b>
	2	Correct, Wrong	✓, ✗	
	3	Correct	ignore	

<b>D</b> (4 responses)	1	Correct	✓	<b>2</b>
	2	Correct, CON (of 2.)	✗, (discount 2)	
	3	Correct	✓	

<b>E</b> (4 responses)	1	Correct	✓	<b>3</b>
	2	Correct	✓	
	3	Correct, Wrong	✓	

<b>F</b> (4 responses)	1	Correct	✓	<b>2</b>
	2	Correct	✓	
	3	Correct CON (of 3.)	✗ (discount 3)	

<b>G</b> (5 responses)	1	Correct	✓	<b>3</b>
	2	Correct	✓	
	3	Correct Correct CON (of 4.)	✓ ignore ignore	

<b>H</b> (4 responses)	1	Correct	✓	<b>2</b>
	2	Correct	✗	
	3	CON (of 2.) Correct	(discount 2) ✓	

<b>I</b> (4 responses)	1	Correct	✓	<b>2</b>
	2	Correct	✗	
	3	Correct CON (of 2.)	✓ (discount 2)	

Question	Answer	Marks
1(a)(i)	58 (beats per minute) ;	1
1(a)(ii)	faster ; muscular ; (aerobic) respiration ; glucose <b>and</b> oxygen ;	4
1(b)(i)	<i>any two from:</i> don't consume too much fat ; don't consume, too much carbohydrate / energy / calories ; don't consume too much, salt ; don't consume excessive alcohol ; consume, a balanced diet ; consume plenty of fibre ;	2
1(b)(ii)	XY ;	1
1(c)	<u>genetically</u> different (to each other) ; contain half the number of chromosomes / are haploid / contains 23 chromosomes / contains unpaired chromosomes ;	2

Question	Answer	Marks
2(a)	<b>nitrogen gas</b> – 78% ; <b>oxygen gas</b> – 21% ;	2
2(b)(i)	$N_2 + O_2 \rightarrow 2NO$ ;;	2
2(b)(ii)	<i>any two from:</i> particles move faster / particles have more kinetic energy ; more particles have, activation energy / sufficient energy, to react ; increased <u>rate</u> of (successful) collisions ;	2
2(b)(iii)	more particles per unit volume / less space <u>between</u> particles ; increased <u>rate</u> of (successful) collisions ;	2

Question	Answer	Marks
2(c)(i)	$2\text{N} \begin{array}{c} \ominus \\ \text{---} \\ \oplus \end{array} + 2\text{C} \begin{array}{c} \ominus \\ \text{---} \\ \oplus \end{array} ;$	1
2(c)(ii)	bond breaking, is endothermic / absorbs energy owtte ; bond making, is exothermic / releases energy owtte ; more energy is given out (in bond making) than is taken in (in bond breaking) ;	3

Question	Answer	Marks
3(a)(i)	(GPE = mgh =) $35 \times 10 \times 18$ (= 6300 J) ;	1
3(a)(ii)	(KE =) $\frac{1}{2} mv^2$ or $\frac{1}{2} 35 \times 14^2$ ; 3430 (J) ;	2
3(b)(i)	friction ;	1
3(b)(ii)	conduction ;	1
3(b)(iii)	<i>idea of vibrations / oscillations</i> , from particle to particle ; transferred by electrons ;	2
3(c)	( $\rho$ =) $m / V$ or $4.2 / 5.0 \times 10^{-4}$ ; 8400 ( $\text{kg} / \text{m}^3$ ) ;	2
3(d)(i)	P at 100,0.5 ;	1
3(d)(ii)	(k =) $F / x$ or $100\,000 / 0.0005$ ; 200 000 000 ( $\text{N} / \text{m}$ ) ;	2

Question	Answer	Marks
4(a)(i)	fossilisation ;	1
4(a)(ii)	arrow drawn from carbon in plants to carbon in animals ;	1
4(a)(iii)	$6\text{CO}_2 + 6\text{H}_2\text{O} \xrightarrow[\text{chlorophyll}]{\text{light}} \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2 ; ;$	2
4(a)(iv)	combustion (of fossil fuels) ; <u>increases</u> concentration of carbon dioxide (in the atmosphere) ;	2
4(b)(i)	kwashiorkor / marasmus ;	1
4(b)(ii)	amino acids ;	1

Question	Answer	Marks												
5(a)	<table border="1"> <thead> <tr> <th>particle</th> <th>relative mass</th> <th>relative charge</th> </tr> </thead> <tbody> <tr> <td>electron</td> <td><b>almost 0 or negligible or 1 / 1850 or 1 / 1836</b></td> <td><b>-1</b></td> </tr> <tr> <td>proton</td> <td><b>1</b></td> <td><b>+1</b></td> </tr> <tr> <td>neutron</td> <td><b>1</b></td> <td><b>0 or no charge</b></td> </tr> </tbody> </table> ;;	particle	relative mass	relative charge	electron	<b>almost 0 or negligible or 1 / 1850 or 1 / 1836</b>	<b>-1</b>	proton	<b>1</b>	<b>+1</b>	neutron	<b>1</b>	<b>0 or no charge</b>	2
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5(b)(i)	loses <b>one</b> electron / owtte ;	1												
5(b)(ii)	$\text{Na} \rightarrow \text{Na}^+ + \text{e}^- ;$	1												



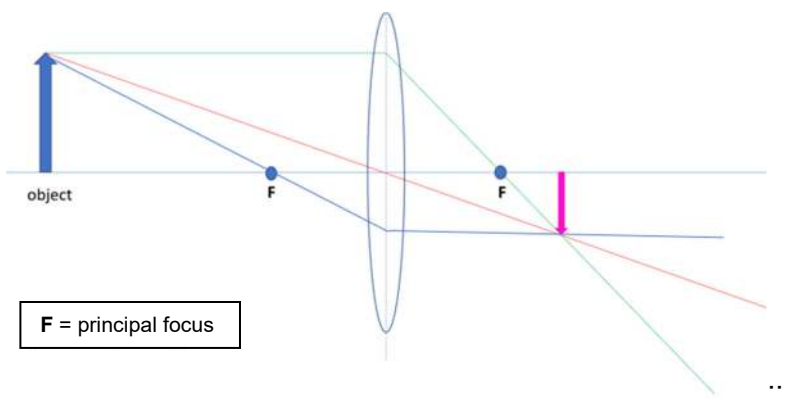
Question	Answer	Marks												
5(c)	<table border="1"> <tr> <td>halogen</td> <td>atomic number</td> <td>electronic structure</td> </tr> <tr> <td>fluorine</td> <td>9</td> <td><b>2.7 ;</b></td> </tr> <tr> <td>chlorine</td> <td>17</td> <td>2.8.7</td> </tr> <tr> <td>bromine</td> <td><b>35 ;</b></td> <td>2.8.18.7</td> </tr> </table>	halogen	atomic number	electronic structure	fluorine	9	<b>2.7 ;</b>	chlorine	17	2.8.7	bromine	<b>35 ;</b>	2.8.18.7	<b>2</b>
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5(d)(i)	$2\text{Na} + \text{Cl}_2 \rightarrow 2\text{NaCl} ; ;$	<b>2</b>												
5(d)(ii)	<p>sodium ion, chloride ion, ; ;</p>	<b>2</b>												

Question	Answer	Marks
6(a)	480 kg is the mass / weight should be in Newtons ;	<b>1</b>
6(b)	(d =) $v \times t$ or $11 \times 120$ ; 1320 (m) ;	<b>2</b>
6(c)(i)	switch controls all lamps ; 4 lamps in parallel and all else correct ;	<b>2</b>
6(c)(ii)	4 A ;	<b>1</b>
6(c)(iii)	(P =) $IV / 4 \times 240$ ; 960 (W) ;	<b>2</b>

Question	Answer	Marks
7(a)(i)	temperature on x-axis ; line showing an increase (and levelling off) ;	2
7(a)(ii)	<i>any three from:</i> transpiration rate decreases ; increase in water (vapour) in the, atmosphere / air ; <i>idea of</i> decreases the, water potential / concentration, gradient ; (so) less, evaporation / diffusion ;	3
7(b)(i)	<u>transpiration pull</u> ; causes, a <u>water potential gradient</u> / a difference in <u>water potential</u> ;	2
7(b)(ii)	<u>cohesion</u> ;	1
7(c)	spongy mesophyll (cells) ; guard (cells) ;	2
7(d)	<i>translocation linked to:</i> occurs in the phloem ; involves the movement of amino acids ; transport substances to regions of storage in a plant ;	3

Question	Answer	Marks
8(a)	to, improve quality / increase yield / for growth, (of crop / plant) ;  prevents discolouration of leaves / synthesis of (named) proteins or amino acids / replaces (named) minerals or ions in soil ;	2
8(b)	relative formula mass of $K_2CO_3 = 138$ <b>and</b> of $K_2SO_4 = 174$ ;  $\frac{174 \times 2.76}{138} = 3.48 \text{ g ;}$	2
8(c)	(flame test gives) a lilac / purple (flame) ;	1

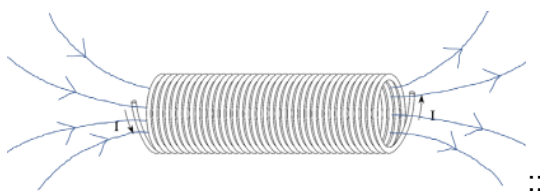
Question	Answer	Marks
8(d)(i)	(catalyst) increases rate of reaction ;	1
8(d)(ii)	<i>idea that</i> reaction can go both ways / can go in both directions ;	1
8(e)(i)	decreases / owtte ;	1
8(e)(ii)	350 °C <b>and</b> 125 atm OR 400 °C <b>and</b> 210 atm OR 450 °C <b>and</b> 325 atm ;	1

Question	Answer	Marks
9(a)(i)	Brownian (motion) ;	1
9(a)(ii)	ref to collisions (of pollen grains) ; with, light fast-moving particles / water particles or molecules ;	2
9(b)(i)	 <p>F = principal focus</p> <p>image labelled ;</p>	3
9(b)(ii)	real image can be projected on to a screen / is formed when rays of light actually meet / ORA ;	1

Question	Answer	Marks																		
9(c)(i)	$3 \times 10^8 \text{ m/s}$ ;	1																		
9(c)(ii)	<table border="1"> <thead> <tr> <th></th> <th><math>\gamma</math> radiation</th> <th>radiowaves</th> </tr> </thead> <tbody> <tr> <td>is used in communication</td> <td></td> <td>✓</td> </tr> <tr> <td>is used in medicine</td> <td>✓</td> <td></td> </tr> <tr> <td>can cause cancer</td> <td>✓</td> <td></td> </tr> <tr> <td>is higher frequency than visible light</td> <td>✓</td> <td></td> </tr> <tr> <td>has a longer wavelength than visible light</td> <td></td> <td>✓</td> </tr> </tbody> </table> <p style="text-align: center;">...</p>		$\gamma$ radiation	radiowaves	is used in communication		✓	is used in medicine	✓		can cause cancer	✓		is higher frequency than visible light	✓		has a longer wavelength than visible light		✓	3
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Question	Answer	Marks								
10(a)	age ; sex ;	2								
10(b)	increased percentage of COPD (across all age groups) ; because smoking causes COPD ;	2								
10(c)	<table border="1"> <thead> <tr> <th>component of tobacco smoke</th> <th>effect</th> </tr> </thead> <tbody> <tr> <td>nicotine ;</td> <td>causes addiction</td> </tr> <tr> <td>carbon monoxide</td> <td>causes, blood / red blood cells, to carry less oxygen ;</td> </tr> <tr> <td>tar ;</td> <td>causes cancer</td> </tr> </tbody> </table>	component of tobacco smoke	effect	nicotine ;	causes addiction	carbon monoxide	causes, blood / red blood cells, to carry less oxygen ;	tar ;	causes cancer	3
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nicotine ;	causes addiction									
carbon monoxide	causes, blood / red blood cells, to carry less oxygen ;									
tar ;	causes cancer									
10(d)	increased rate of breathing ;	1								
10(e)	ciliated epithelial cells ;	1								

Question	Answer	Marks
11(a)	$  \begin{array}{cccc}  \text{H} & \text{H} & \text{H} & \text{H} \\    &   &   &   \\  \text{H}-\text{C} & -\text{C} & -\text{C} & -\text{C}-\text{H} \\    &   &   &   \\  \text{H} & \text{H} & \text{H} & \text{H}  \end{array}  $ ;;	2
11(b)	<i>any two from:</i> (named) catalyst ; high temperature ; high pressure ;	2
11(c)	<i>idea that</i> any bond within the molecule can break ;	1
11(d)	$\text{C}_n\text{H}_{2n+2}$ ;	1
11(e)	$M_r$ of $\text{CO}_2 = 44$ ; Moles of $\text{CO}_2 = 352 \div 44 = 8$ ; Volume of $\text{CO}_2 = 8 \times 24 = 192 \text{ dm}^3$ ;	3

Question	Answer	Marks
12(a)(i)	soft-iron core correctly labelled ;	1
12(a)(ii)	use of $V_p / V_s = N_p / N_s$ ; 16 000 (V) ;	2
12(b)	 ;;	2
12(c)(i)	$  {}_{92}^{238}\text{U} \rightarrow {}_{90}^{234}\text{Th} + {}_2^4\alpha  $ ;;	2

Question	Answer	Marks
12(c)(ii)	(alpha particle is) charged ; so experiences a <u>force</u> ;	<b>2</b>