Cambridge Assessment International Education

Cambridge IGCSE™

CO-ORDINATED SCIENCES **0654/43**

Paper 4 Theory (Extended) **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.

[Turn over

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 rule
State **three** reasons…. [3]

A

1	Correct	✓	**2**
2	Correct	✓	
3	Wrong	×	

B (4 responses)

1	Correct, Correct	✓, ✓	**3**
2	Correct	✓	
3	Wrong	ignore	

C (4 responses)

1	Correct	✓	**2**
2	Correct, Wrong	✓, ×	
3	Correct	ignore	

D (4 responses)

1	Correct	✓	**2**
2	Correct, CON (of 2.)	×, (discount 2)	
3	Correct	✓	

E (4 responses)

1	Correct	✓	**3**
2	Correct	✓	
3	Correct, Wrong	✓	

F (4 responses)

1	Correct	✓	**2**
2	Correct	✓	
3	Correct CON (of 3.)	× (discount 3)	

G (5 responses)

1	Correct	✓	**3**
2	Correct	✓	
3	Correct Correct CON (of 4.)	✓ ignore ignore	

H (4 responses)

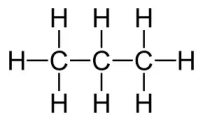
1	Correct	✓	**2**
2	Correct	×	
3	CON (of 2.) Correct	(discount 2) ✓	

I (4 responses)

1	Correct	✓	**2**
2	Correct	×	
3	Correct CON (of 2.)	✓ (discount 2)	

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>1(a)</td><td>E ;
A ;
D ;
E ;</td><td>4</td></tr>
<tr><td>1(b)</td><td>sperm ;</td><td>1</td></tr>
<tr><td>1(c)</td><td><table><tr><td></td><td>male gamete</td><td>female gamete</td></tr><tr><td>relative size</td><td>small</td><td>large</td></tr><tr><td>number released at one time</td><td>millions / many</td><td>usually one</td></tr><tr><td>motility</td><td>motile</td><td>non-motile</td></tr></table>;;;</td><td>3</td></tr>
<tr><td>1(d)</td><td>energy ;
jelly ;</td><td>2</td></tr>
</table>

Question	Answer	Marks
2(a)(i)	(fractions have) different boiling points ;	**1**
2(a)(ii)	**X** marked inside the top of the column, above the top dotted line ;	**1**

Question	Answer	Marks
2(b)	<table><tr><td>fraction</td><td>use</td></tr><tr><td>refinery gas</td><td>bottled gas for heating</td></tr><tr><td>gasoline</td><td>**fuel in cars ;**</td></tr><tr><td>naphtha</td><td>feedstock for making chemicals</td></tr><tr><td>diesel oil</td><td>**fuel in diesel engines ;**</td></tr><tr><td>bitumen</td><td>**road surfaces ;**</td></tr></table>	**3**
2(c)	 ;;	**2**
2(d)	$2C_4H_{10} + 13O_2 \rightarrow 8CO_2 + 10H_2O$ correct formulae ; correct balancing ;	**2**
2(e)	(in a chemical change) a new substance is made / owtte ;	**1**

Question	Answer	Marks
3(a)(i)	submerge graphite in water ; measure volume of water displaced ; OR measure the mass of graphite ; look up density and apply V = m / d ;	**2**
3(a)(ii)	(density =) m / V OR 33 / 15 ; 2.2 (g / cm^3) ;	**2**

Question	Answer	Marks
3(b)(i)	reduce friction ; less heat is generated ; less wasted energy / more useful energy ;	**3**
3(b)(ii)	(efficiency =) $\frac{\text{useful output}}{\text{total input}} \times 100$ OR $\frac{900}{1200} \times 100$; 75 (%) ;	**2**
3(b)(iii)	(P=) I × V OR 25 × 18 ; (P =) 450 (W) ;	**2**

Question	Answer	Marks
4(a)	30 (°C) **;**	**1**
4(b)(i)	(increasing temperature) increases the energy / speed of molecules **;** increases number of molecules reaching activation energy ; increases frequency of (effective) collisions **;** faster rate of photosynthesis **;** **max 3**	**3**
4(b)(ii)	40 (°C) **;**	**1**
4(c)(i)	as sucrose **;** in the phloem **;** by translocation **;**	**3**
4(c)(ii)	starch **;**	**1**
4(d)	light **;** chemical **;**	**2**

Question	Answer	Marks
5(a)	Cu^{2+} / H^{+} ;	**1**
5(b)	(copper(II) sulfate solution) contains ions ; (ions) that can move ;	**2**
5(c)(i)	anode ;	**1**
5(c)(ii)	Any **three** from: copper(II) sulfate or any soluble copper salt as electrolyte ; impure copper as anode ; pure copper as cathode ; copper deposited at the cathode ; copper anode dissolves ; **AND** Any **one** from: $Cu^{2+} + 2e^{-} \rightarrow Cu$; $Cu \rightarrow Cu^{2+} + 2e^{-}$; **max 4**	**4**
5(d)	reduction because reduction is the gain of electrons ;	**1**

Question	Answer	Marks
6(a)	velocity has direction / ORA ;	**1**
6(b)	acceleration ; constant followed by non-constant ; constant speed / zero acceleration ;	**3**
6(c)	(KE =) ½ mv^2 OR ½ × 42 × 30^2 ; 18 900 (J);	**2**
6(d)(i)	Any **one** from evaporation can occur at any temperature / boiling only happens at the boiling point ; evaporation happens only at the surface / boiling happens throughout the liquid; during evaporation only the molecules with the highest (kinetic) energy leave / during boiling all molecules have enough energy to leave ; 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 ;	**1**
6(d)(ii)	increase temperature ; increase surface area ; increase draught ; **max 2**	**2**

Question	Answer	Marks
7(a)(i)	65 (beats per minute) **;**	**1**
7(a)(ii)	(steep) increase **;** to 98 beats per minute / by 33 beats per minute **;**	**2**
7(b)(i)	pupils widen **;**	**1**
7(b)(ii)	optic (nerve) ;	**1**
7(c)(i)	insulin **;**	**1**
7(c)(ii)	pancreas **;**	**1**
7(c)(iii)	liver **;**	**1**
7(d)	hormonal actions are slower to act **;** hormonal actions last longer **;**	**2**

Question	Answer	Marks
8(a)	**Changes in arrangement**: idea that arrangement of particles becomes more random / becomes irregular ; **Changes in movement**: (idea that particles change from vibrating about fixed positions and start) moving around each other ;	**2**
8(b)	randomly arranged particles not touching each other ;	**1**
8(c)(i)	48 (cm^3) ;	**1**
8(c)(ii)	acid is more concentrated at the start / the magnesium has a greater surface area at the start ;	**1**
8(c)(iii)	graph steeper initially ; levels off at 58 cm^3 ;	**2**

Question	Answer	Marks
8(d)	more particles per unit volume / less space between particles ; increased rate of (successful) collisions ;	**2**
8(e)	$MgCl_2$;	**1**

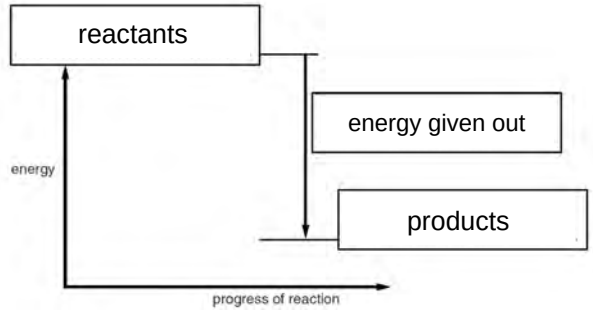
Question	Answer	Marks
9(a)(i)	resistance increases as light intensity decreases ; increase is smallest for lower light intensity ;	**2**
9(a)(ii)	(R =) 700 (kΩ) ; (I =) V / R OR 14 / 700000 / 0.00002 (A) ; (Q =) It OR 0.00002 × 60 ; 0.0012 (C) ;	**4**
9(b)(i)	The number of oscillations per second / number of waves passing a point per second ;	**1**
9(b)(ii)	(v =) 3×10^8 (m / s) ; (λ =) v / f OR $\frac{3 \times 10^8}{5.0 \times 10^{14}}$; 6.0×10^{-7} (m) ;	**3**
9(b)(iii)	any one of: gamma / X-rays / UV ;	**1**

Question	Answer	Marks
10(a)(i)	AB **;**	**1**
10(a)(ii)	O **;**	**1**
10(a)(iii)	limited number of phenotypes **;** no intermediates **;**	**2**
10(a)(iv)	genes / alleles **;**	**1**

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>10(b)</td><td>
<table>
<tr><th></th><th>involves passing on of alleles to offspring</th><th>is used to improve domesticated animals</th><th>occurs over many generations</th><th>keeps the features best suited to the environment</th></tr>
<tr><td>natural selection</td><td>✓</td><td></td><td>✓</td><td>✓</td></tr>
<tr><td>selective breeding</td><td>✓</td><td>✓</td><td>✓</td><td></td></tr>
</table>
;;
</td><td>2</td></tr>
<tr><td>10(c)</td><td>takes longer ;
more energy required ;
has to find a mate ;
idea that genetic variation may result in harmful phenotypes ;
AVP ;

max 2</td><td>2</td></tr>
</table>

Question	Answer	Marks
11(a)	sulfur ; oxygen ;	**2**
11(b)(i)	vanadium(V) oxide / vanadium pentoxide ;	**1**
11(b)(ii)	Due to an issue with question 11(b)(ii), the question has been removed from the question paper	

Question	Answer	Marks
11(c)	 ;;	**2**
11(d)	moles of SO_3 = 200 ÷ 80 = 2.5 ; volume of SO_3 = 2.5 × 24 = 60 dm^3 ;	**2**

Question	Answer	Marks
12(a)	(m =) W / gh OR $\frac{2750}{10 \times 2.2}$; 125 (kg) ;	**2**
12(b)	lower centre of mass ;	**1**
12(c)(i)	X arrow pointing up AND Z arrow pointing down ;	**1**
12(c)(ii)	the current is parallel to the magnetic field ;	**1**
12(d)(i)	experiences a force ; it is a charged particle ;	**2**

Question	Answer	Marks
12(d)(ii)	opposite direction ; because the charge is opposite / α is positive and β is negative ; OR less deflection ; due to (much) larger mass ; **max 2**	**2**