CAMBRIDGE
International Education

Cambridge IGCSE™

CO-ORDINATED SCIENCES **0654/41**

Paper 4 Theory (Extended) **May/June 2024**

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 2024 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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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 descriptions 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

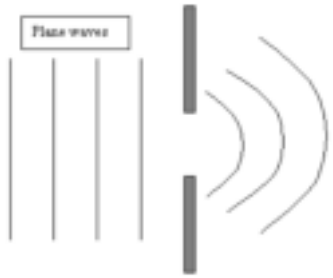
Multiples / fractions of coefficients used in chemical equations are acceptable unless stated otherwise in the mark scheme.

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

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>1(a)</td><td>B ;
A ;
E ;</td><td>3</td></tr>
<tr><td>1(b)(i)</td><td>46 chromosomes ;

arranged in pairs ;</td><td>2</td></tr>
<tr><td>1(b)(ii)</td><td>XX ;</td><td>1</td></tr>
<tr><td>1(b)(iii)</td><td>jelly coat ;</td><td>1</td></tr>
<tr><td>1(c)</td><td>shock absorber / protection (from mechanical harm/infection of fetus) / stabilises temperature ;</td><td>1</td></tr>
<tr><td>1(d)</td><td>
<table>
<tr><td>Carbon dioxide diffuses from the mother’s blood in the placenta to the fetus.</td><td></td></tr>
<tr><td>The blood of the fetus and the blood of the mother mix in the placenta.</td><td></td></tr>
<tr><td>The mother provides the fetus with excretory products from the placenta.</td><td></td></tr>
<tr><td>The placenta provides a barrier to toxins.</td><td>✓</td></tr>
<tr><td>The umbilical cord connects the fetus to the placenta.</td><td>✓</td></tr>
</table>
;;
</td><td>2</td></tr>
</table>

Question	Answer	Marks
2(a)(i)	$MgSO_4$;	**1**
2(a)(ii)	magnesium: idea that magnesium has electrons ; (electrons) can move ; magnesium sulfate: idea of that ions are held in fixed positions (in a solid) ;	**3**
2(b)(i)	test – lighted splint ; result – (squeaky) pop ;	**2**
2(b)(ii)	relative molecular mass of $MgCl_2$ = 95 ; $\frac{9.5 \times 1.2}{24}$ = 4.8 (g) ;	**2**
2(b)(iii)	**EITHER** Mg/magnesium is oxidised ; H^+ / hydrogen **ions** are reduced ; **OR** the Mg / magnesium atoms lose electrons ; H^+ / hydrogen **ions** gain electrons ;	**2**

Question	Answer	Marks
3(a)(i)	number of vibrations / oscillations (generated / passing a point) per unit time / second ;	**1**
3(a)(ii)	(λ=) v / f OR 0.20 / 5.0 ; (λ=) 0.04 ;	**2**
3(a)(iii)	place an obstacle with a gap (with a size similar to the wavelength) in the ripple tank ; circular waves produced **after** the gap ; 	**2**
3(b)	magnetic ; downwards ;	**2**
3(c)(i)	 ;	**1**
3(c)(ii)	E = IVt OR 24000 = 12 × It OR It = 24000 / 12 ; Q = It ; Q = 2000 ; C OR coulomb ;	**4**

Question	Answer	Marks
4(a)(i)	62 (g) ; kinetic ; (spongy) mesophyll ; water vapour ; stomata ;	**5**
4(a)(ii)	(both plants) would lose less mass ;	**1**
4(b)(i)	cohesion ;	**1**
4(b)(ii)	support ;	**1**
4(b)(iii)	phloem ;	**1**

Question	Answer	Marks
5(a)(i)	LiC*l* ;	**1**
5(a)(ii)	idea that lithium chloride has (strong electrostatic) forces of attraction / bonds between (oppositely charged) **ions** ; idea that the forces / bonds need lots of energy to overcome ;	**2**
5(b)(i)	Any two from: giant covalent ; layers (of carbon atoms) ; each carbon atom is (covalently) bonded / joined to 3 other (carbon) atoms ;	**2**
5(b)(ii)	idea that there are weak forces between the layers (of carbon atoms) ; (so) the layers can slide ;	**2**
5(c)(i)	–39 and 357 ✓;	**1**

Question	Answer	Marks
5(c)(ii)	protons: 80 neutrons: **121** ; electrons: **80** ;	**2**

Question	Answer	Marks
6(a)(i)	(arrangement:) liquid; molecules are random / not regular and (arrangement:) gas: molecules are random / not regular ; (separation:) liquid molecules are touching and (separation:) gas molecules are far apart ;	**2**
6(a)(ii)	(motion:) liquid molecules can move around / flow over each other AND gas molecules are completely free to move ; or (motion:) liquid molecules movement is slower / gas molecules movement is faster ;	**1**
6(b)(i)	(similarity:) number of protons ; (difference:) number of neutrons/nucleons ;	**2**
6(b)(ii)	300 (thousand years) ;	**1**
6(b)(iii)	${}^{36}_{17}Cl \; {}^{36}_{18}Ar + {}^{0}_{-1}\beta$;;	**2**
6(c)	(m_{cl} =) ρV OR 570×0.020 ; (m_{cl} =) 11.4 (kg) ; (m = 13 – 11.4 =) 1.6 (kg) ;	**3**

Question	Answer	Marks
7(a)(i)	cilia are shorter ; unable to move (as much) <u>mucus</u> (which traps pathogens) ; pathogens multiply / remain in the lungs / airway ;	**3**
7(a)(ii)	goblet (cell) ;	**1**
7(b)(i)	*any two from:* COPD ; coronary heart disease / CHD ; AVP ;	**2**
7(b)(ii)	tar ;	**1**
7(b)(iii)	change in, gene / chromosome ;	**1**
7(c)	thin – short(er) diffusion distance ; well ventilated – maintains a (steep) concentration gradient ;	**2**
7(d)	*any two from:* bronchi / bronchus ; bronchiole ; trachea ;	**2**

Question	Answer	Marks
8(a)	most reactive Z X W least reactive Y ;;	**2**

Question	Answer	Marks
8(b)(i)	heat the ore with carbon ; carbon is more reactive than copper or ORA / carbon displaces the copper (from the copper ore) ;	**2**
8(b)(ii)	idea that calcium atoms form positive (calcium) ions more easily (than magnesium) / idea that calcium atoms lose electrons more easily (than magnesium) ;	**1**
8(b)(iii)	zinc is more reactive than iron ; zinc corrodes or oxidises / reacts with oxygen or loses electrons **rather** than iron ;	**2**
8(c)(i)	$Fe + CuCl_2 \rightarrow FeCl_2 + Cu$ formula of $FeCl_2$; equation ;	**2**
8(c)(ii)	displacement ;	**1**
8(d)	idea that aluminium forms an oxide layer (which adheres to the metal) ; (oxide layer) prevents oxygen / water from reaching the aluminium / is impervious / impermeable (and prevents further reaction) ;	**2**

Question	Answer	Marks
9(a)(i)	weight / gravitational <u>force</u> ;	**1**
9(a)(ii)	(W= mg = 84 × 10 =) 840 N ;	**1**
9(a)(iii)	(F =) 840 – 760 / 80 ; (a =) F/m OR 80/84 ; (a =) 0.95 (m / s^2) ;	**3**

Question	Answer	Marks
9(b)	(140s to 180s) any two from ; deceleration / slows down / negative acceleration ; (deceleration is) non-constant ; air resistance greater than weight / Q / upwards resultant force ; (after 180 s) constant speed ; no resultant force / air resistance = weight/Q ;	**4**
9(c)	(GPE =) $84 \times 10 \times 7500 = 6\,300\,000$ (J) / 6.3 MJ ;	**1**

Question	Answer	Marks
10(a)(i)	fossilisation ;	**1**
10(a)(ii)	$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$;;	**2**
10(a)(iii)	arrow drawn from carbon compounds in plants to carbon compounds in animals ;	**1**
10(a)(iv)	chloroplast ;	**1**
10(b)	<table><tr><td>A decrease in the combustion of fossil fuels.</td><td></td></tr><tr><td>A decrease in the use of cars that use petroleum.</td><td></td></tr><tr><td>An increase in natural habitats being converted to land for intensive cattle farming.</td><td>✓</td></tr><tr><td>An increase in land used for housing.</td><td>✓</td></tr><tr><td>An increase in tree planting.</td><td></td></tr></table>;;	**2**

Question	Answer	Marks
10(c)	*any two from:* removal of animals, habitat / shelter / breeding grounds ; removal of animals food source ; AVP ;	**2**

Question	Answer	Marks
11(a)	hydrogen ; positive ; non-metals ;	**3**
11(b)(i)	copper electrodes – copper ions / Cu^{2+} ; graphite electrodes – oxygen (gas) / O_2 ;	**2**
11(b)(ii)	–0.10 g / the mass decreases by 0.10 g ;	**1**
11(b)(iii)	$Cu^{2+} + 2e^- \rightarrow Cu$;;	**2**

Question	Answer	Marks
12(a)(i)	(V=) 6.0 – 2.0 / 4.0 ; (R =) V / I OR 4.0 / 0.50 ; (R =) 8.0 (Ω) ;	**3**
12(a)(ii)	increase the (total) resistance / decrease the current ; by using the variable resistor ;	**2**
12(b)	(power input =) power output / efficiency ×100 / 8.0 / 0.16 ; (power input =) 50 (W) ;	**2**