



# Cambridge IGCSE™

---

**CO-ORDINATED SCIENCES**

**0654/42**

Paper 4 Theory (Extended)

**October/November 2023**

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 October/November 2023 series for most Cambridge IGCSE, Cambridge International A and AS Level components, and some Cambridge O Level components.

---

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 '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.

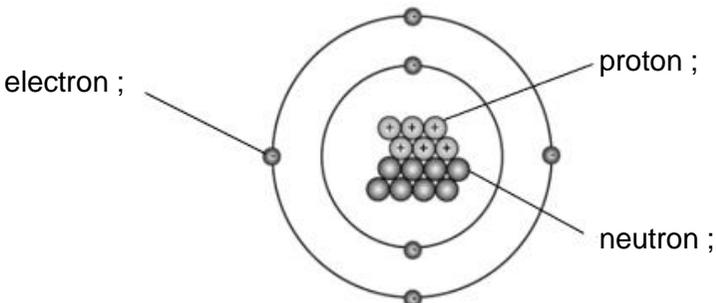
Unless a separate mark is given for a unit, a missing or incorrect unit will normally mean that the final calculation mark is not awarded. Exceptions to this general principle will be noted in the mark scheme.

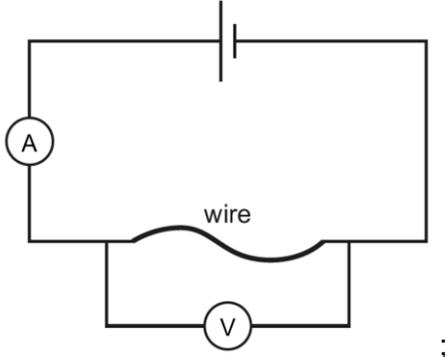
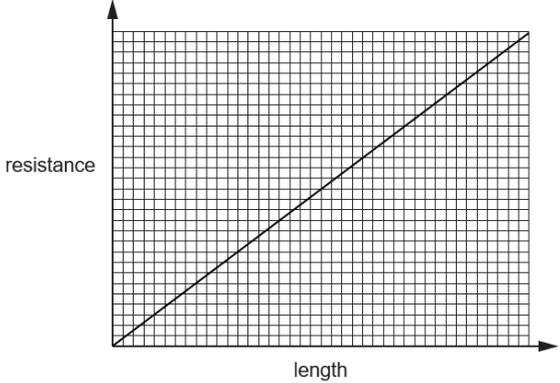
**7** Guidance for chemical equations

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

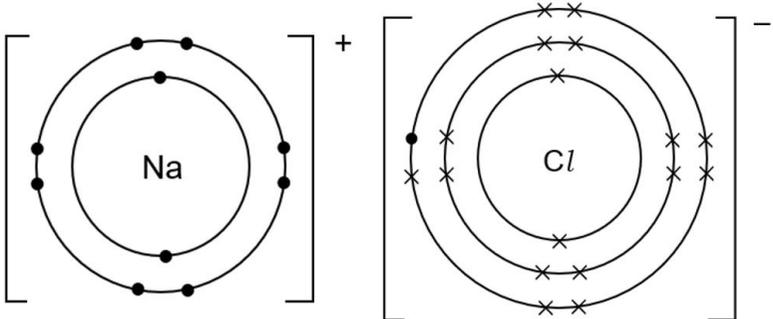
State symbols given in an equation should be ignored unless asked for in the question or stated otherwise in the mark scheme.

Question	Answer	Marks
1(a)	B ; A ; E ; B ;	<b>4</b>
1(b)	<i>any three from:</i> <u>mitosis</u> ; nuclear division ; production of <u>genetically</u> identical cells ; ref to duplication of chromosomes (before mitosis) ;	<b>3</b>
1(c)(i)	protection (from mechanical damage) ;	<b>1</b>
1(c)(ii)	<i>any three from:</i> placenta provides a barrier to toxins ; umbilical cord passes, oxygen / nutrients, to fetus (blood) ; umbilical cord passes, excretory products / carbon dioxide, to mothers (blood) ; ref to exchange of materials by <u>diffusion</u> (across the placenta) ;	<b>3</b>

Question	Answer	Marks
2(a)(i)	 <p>electron ;</p> <p>proton ;</p> <p>neutron ;</p>	<b>3</b>
2(a)(ii)	6 protons ; 6 <b>or</b> 7 neutrons ;	<b>2</b>
2(a)(iii)	same number of electrons in the <b>outer</b> shell ;	<b>1</b>
2(b)	<i>test:</i> limewater ; <i>observation:</i> milky / cloudy / white precipitate ;	<b>2</b>
2(c)	saturated ; hydrocarbons ;	<b>2</b>

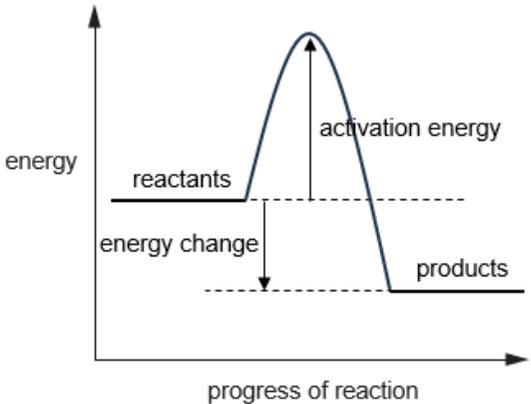
Question	Answer	Marks
3(a)(i)	 ;	1
3(a)(ii)	$(R =) V \div I / 3(.0) \div 0.8(0) ;$ $R =) 3.8 ;$ ohms / $\Omega ;$	3
3(a)(iii)	 <p>positive gradient ;                      straight line ;</p>	2
3(b)	atoms vibrate ; (idea that) vibrations passed on to next atom ; (idea of) transfer by (free) electrons ;	3

<b>Question</b>	<b>Answer</b>	<b>Marks</b>
4(a)(i)	10.5 (mm / min) ;	<b>1</b>
4(a)(ii)	6(.0) (mm) ; gradient ; transpiration / evaporation ; stomata ;	<b>4</b>
4(a)(iii)	used in photosynthesis / used to support cells ;	<b>1</b>
4(a)(iv)	temperature / AVP ;	<b>1</b>
4(b)(i)	creates a difference in <u>water potential</u> (gradient between top and bottom of xylem) ;	<b>1</b>
4(b)(ii)	cohesion ;	<b>1</b>
4(b)(iii)	mineral ions ;	<b>1</b>

Question	Answer	Marks
5(a)(i)	answer in the inclusive range – 122 to – 30 °C ;	1
5(a)(ii)	liquid ;	1
5(b)	the forces between bromine molecules are weaker <input checked="" type="checkbox"/> ;	1
5(c)(i)	$Cl_2 + 2NaBr \rightarrow 2NaCl + Br_2$ formulae ; balancing ;	2
5(c)(ii)	 <p>electronic structure of sodium ion as 2.8 ; electronic structure of chloride ion as 2.8.8 ; sodium + (1) and chloride – (1) ;</p>	3
5(c)(iii)	concentrated aqueous sodium chloride contains ions which can move <input checked="" type="checkbox"/> ;	1
5(c)(iv)	chlorine ;	1

Question	Answer	Marks
6(a)(i)	$\sin r = \frac{\sin 45}{1.55} ;$ <p><math>(r =) 27(^{\circ}) ;</math></p>	2
6(a)(ii)	 <p>only TIR ; correct angles ;</p>	2
6(a)(iii)	minimum angle of <b>incidence</b> for TIR to occur ;	1
6(b)(i)	$(\text{efficiency} =) \frac{0.0060}{40} \times 100 \text{ or } (\text{efficiency} =) \frac{\text{power output}}{\text{power input}} \times 100 ;$ <p>(power input =) 0.015 (W) ;</p>	2
6(b)(ii)	$(I =) P / V \text{ or } 0.015 / 4.5 \text{ or } 0.00333 \text{ (A)} ;$ $(t = Q / I =) 20.0 / 0.00333 ;$ $(t =) 6000 \text{ (s)} ;$	3

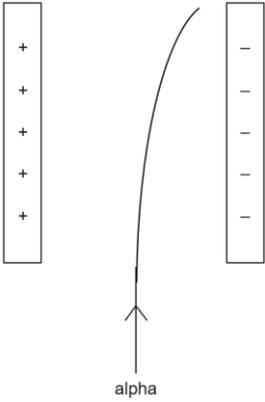
Question	Answer	Marks									
7(a)(i)	capillary ;	1									
7(a)(ii)	<u>absorption</u> of fats ;	1									
7(a)(iii)	<u>small</u> intestine ;	1									
7(b)	smaller surface area (of villi / small intestine) ; (idea of) less nutrients <u>absorbed</u> ;	2									
7(c)	<table border="1" data-bbox="338 507 1249 727"> <thead> <tr> <th data-bbox="338 507 642 580">enzyme</th> <th data-bbox="642 507 947 580">substrate</th> <th data-bbox="947 507 1249 580">product(s)</th> </tr> </thead> <tbody> <tr> <td data-bbox="338 580 642 652"><b>amylase</b></td> <td data-bbox="642 580 947 652"><b>starch</b></td> <td data-bbox="947 580 1249 652">simpler sugars</td> </tr> <tr> <td data-bbox="338 652 642 727">protease</td> <td data-bbox="642 652 947 727"><b>protein</b></td> <td data-bbox="947 652 1249 727"><b>amino acids</b></td> </tr> </tbody> </table> <p data-bbox="338 735 719 898">           ;            ;            four correct = 2 marks            two or three correct = 1 mark            one correct = 0 marks         </p>	enzyme	substrate	product(s)	<b>amylase</b>	<b>starch</b>	simpler sugars	protease	<b>protein</b>	<b>amino acids</b>	2
enzyme	substrate	product(s)									
<b>amylase</b>	<b>starch</b>	simpler sugars									
protease	<b>protein</b>	<b>amino acids</b>									
7(d)	any two from: stomach ; pancreas ; <u>small intestine</u> ;	2									

Question	Answer	Marks
8(a)(i)	240 (s) ;	1
8(a)(ii)	line starting at the origin but steeper than the original ; levels off at 80 (cm <sup>3</sup> ) ;	2
8(b)	particles are more crowded / more particles per unit volume / more particles per cm <sup>3</sup> ; more collisions ; more frequent collisions / more collisions per second ;	3
8(c)	 <p>products shown below reactants ; energy change or <math>\Delta H</math> correctly clearly indicated and labelled ; activation energy clearly indicated and labelled ;</p>	3
8(d)	$M_r$ of CO <sub>2</sub> = 44 ; moles of CO <sub>2</sub> = 0.05 ; volume of H <sub>2</sub> (= 0.05 × 24) = 1.2 dm <sup>3</sup> ;	3

Question	Answer	Marks
9(a)(i)	(3.5 cm $\Rightarrow$ 0.035 (m) ; (moment $\Rightarrow$ ) $f \times d / 1.2 \times 0.035$ ; (moment $\Rightarrow$ ) 0.042 (N m) ; <b>or</b> (35 cm $\Rightarrow$ ) 0.35 (m) ; (moment $\Rightarrow$ ) $f \times d / 1.2 \times 0.35$ ; (moment $\Rightarrow$ ) 0.42 (N m);	<b>3</b>
9(a)(ii)	increases ; by a factor of 4;	<b>2</b>
9(b)	(kinetic energy $\Rightarrow$ ) $\frac{1}{2} mv^2$ <b>or</b> $\frac{1}{2} \times 0.60 \times 3.0^2$ ; (kinetic energy = ) 2.7 ; J / joules ;	<b>3</b>
9(c)(i)	initially / in first 1.5 mins, <b>constant</b> acceleration ; then / after 1.5 min, acceleration is zero / <b>constant</b> speed ;	<b>2</b>
9(c)(ii)	(idea that) change in acceleration would take some time / change more gradually / graph would be a curve at 1.5 mins ;	<b>1</b>

Question	Answer	Marks
10(a)(i)	$(1200 - 800) = 400$ ; $((400/800) \times 100) = 50$ (%) ;	<b>2</b>
10(a)(ii)	liver ;	<b>1</b>
10(a)(iii)	<i>any two from:</i> widen pupils / pupils dilate ; increases pulse rate / increases heart rate ; AVP ;;	<b>2</b>
10(a)(iv)	plasma ;	<b>1</b>
10(b)(i)	phototropism / gravitropism ;	<b>1</b>
10(b)(ii)	auxin ;	<b>1</b>
10(b)(iii)	<u>dry</u> mass ; cell size / cell number ;	<b>2</b>

Question	Answer	Marks
11(a)	<b>B and C ;</b>	<b>1</b>
11(b)	$(R_f =) 5.4 \div 6(.0) ;$ $(R_f =) 0.90 ;$	<b>2</b>
11(c)	$(\text{distance} =) R_f \times \text{distance moved by solvent} / 0.44 \times 6(.0) ;$ $(\text{distance} =) 2.64 \text{ or } 2.6 \text{ (cm)} ;$	<b>2</b>
11(d)	$(\text{moles} =) 0.005 ;$ $(\text{conversion of } 200 \text{ cm}^3 \text{ to dm}^3 =) 0.2(00) \text{ (dm}^3) ;$ $(\text{concentration} = 0.005 \div 0.200 =) 0.025 \text{ (mol / dm}^3) ;$ <b>or</b> $(\text{conversion of } 200 \text{ cm}^3 \text{ to dm}^3 =) 0.2(00) \text{ (dm}^3) ;$ $(\text{concentration} =) 12.15 \text{ g / dm}^3 ;$ $(\text{concentration in mol / dm}^3 = 12.15 \div 486 =) 0.025 \text{ (mol / dm}^3) ;$	<b>3</b>

Question	Answer	Marks											
12(a)(i)	${}_{86}^{222}\text{Ra} \rightarrow {}_{84}^{218}\text{Po} + 4 {}_2^4\alpha$ Po correct ; α correct ;	<b>2</b>											
12(a)(ii)	<div style="display: flex; align-items: center; justify-content: center;"> <div style="border: 1px solid black; padding: 5px; margin-right: 20px;">alpha particle</div> <table border="1" style="border-collapse: collapse; text-align: center;"> <tr><td>has a charge of 0</td></tr> <tr><td>has a charge of -1</td></tr> <tr><td>has a charge of +2</td></tr> <tr><td>has a mass of 0</td></tr> <tr><td>has a mass of 2</td></tr> <tr><td>has a mass of 4</td></tr> <tr><td>has a low ionizing ability</td></tr> <tr><td>has a high ionizing ability</td></tr> <tr><td>can penetrate paper</td></tr> <tr><td>can penetrate aluminium</td></tr> <tr><td>can penetrate lead</td></tr> </table> </div> <p>has a mass of 4 <b>and</b> has a high ionising ability ;</p>	has a charge of 0	has a charge of -1	has a charge of +2	has a mass of 0	has a mass of 2	has a mass of 4	has a low ionizing ability	has a high ionizing ability	can penetrate paper	can penetrate aluminium	can penetrate lead	<b>1</b>
has a charge of 0													
has a charge of -1													
has a charge of +2													
has a mass of 0													
has a mass of 2													
has a mass of 4													
has a low ionizing ability													
has a high ionizing ability													
can penetrate paper													
can penetrate aluminium													
can penetrate lead													
12(a)(iii)	 <p>line curved to the right ;</p>	<b>1</b>											

Question	Answer	Marks
12(b)(i)	kinetic energy/speed of atoms increases ; atoms collide with walls of container more often ; which exerts a larger force per unit area ;	<b>3</b>
12(b)(ii)	$(m = \rho V;$ $(m = 9.7 \times 0.05) 0.485 \text{ (kg) ;}$ $(W = mg = 0.485 \times 10 =) 4.9 \text{ (N) ;}$	<b>3</b>