



Cambridge IGCSE™

COMBINED SCIENCE

0653/41

Paper 4 Theory (Extended)

May/June 2023

MARK SCHEME

Maximum Mark: 80

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.

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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
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- 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.

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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	<u>'List rule' guidance</u> For questions that require <i>n</i> responses (e.g. State two reasons ...): • The response should be read as continuous prose, even when numbered answer spaces are provided. • Any response marked <i>ignore</i> in the mark scheme should not count towards <i>n</i>. • Incorrect responses should not be awarded credit but will still count towards <i>n</i>. • 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 <i>n</i> responses may be ignored even if they include incorrect science.

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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'.

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7 Guidance for chemical equations

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

Mark scheme abbreviations

;	separates marking points
/	separates alternative responses for the same marking point
ecf	error carried forward
AVP	any valid point
ORA	or reverse argument
AW	alternative wording
<u>underline</u>	actual word given must be used by candidate (grammatical variants accepted)
()	the word / phrase in brackets is not required but sets the context

Question	Answer	Marks
1(a)(i)	artery ;	1
1(a)(ii)	any one from: frog has only 3 chambers / frog has one ventricle ; humans have four chambers / humans have two ventricles ; no septum in frog / AW ;	1
1(a)(iii)	oxygenated and deoxygenated blood kept separate ; high blood pressure around body / low blood pressure to lungs ;	2
1(b)(i)	(lack of) physical activity ;	1
1(b)(ii)	$(54 \times 350) \div 100$; 189 ;	2
1(b)(iii)	age / genetics / inheritance ;	1
1(c)	scurvy – (fruit and vegetables) are a source of Vit C / Vit C prevents scurvy ; constipation – (vegetables) are a source of fibre / fibre needed for bulk ;	2

Question	Answer	Marks
2(a)(i)	H ⁺ ; hydroxide and water ; Na ⁺ and sodium chloride ;	3
2(a)(ii)	decreases , because used up / forms chlorine ;	1

Question	Answer	Marks
2(b)	(test) lighted splint AND (observation) pops ;	1
2(c)(i)	shows an acid (produced) ;	1
2(c)(ii)	(red to) colourless ; (because litmus is) bleached by chlorine (formed) ;	2

Question	Answer	Mark
3(a)	<u>radiation</u> ;	1
3(b)	reference to molecules moving faster ; reference to expansion of air or gases / gases or air occupy greater volume / molecules move further apart ; the idea that lower density (air) rises / hot air displaced by heavier or denser cool air ;	3
3(c)(i)	vibrating (string) ;	1
3(c)(ii)	speed = frequency $\times$ wavelength / $v = f \lambda$ (<i>in any form</i>) / $\lambda = 330 \div 256$; 1.29 (m) ;	2
3(c)(iii)	compression means, particles or molecules are close together / (air) density is greater / air pressure is greater / ORA for rarefaction ; succession refers to the idea that compressions and rarefactions form a repeating, pattern / (longitudinal) wave ;	2

Question	Answer	Marks																								
4(a)(i)	<table><tr><td>organism</td><td>producer</td><td>herbivore</td><td>secondary consumer</td></tr><tr><td>flying squirrel</td><td></td><td>✓</td><td></td></tr><tr><td>owl</td><td></td><td></td><td>✓</td></tr><tr><td>cougar</td><td></td><td></td><td>✓</td></tr><tr><td>beaver</td><td></td><td>✓</td><td></td></tr><tr><td>fruit</td><td>(✓)</td><td></td><td></td></tr></table> one mark for each correct column	organism	producer	herbivore	secondary consumer	flying squirrel		✓		owl			✓	cougar			✓	beaver		✓		fruit	(✓)			2
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beaver		✓																								
fruit	(✓)																									
4(a)(ii)	cougar is in a higher trophic level / beaver is in lower trophic level ; energy lost (between levels) ; example of energy loss, e.g. respiration / heat / waste / incomplete digestion ;	3																								
4(b)	any two from : large / heavy (compared to wind pollinated) ; has spikes ; sticky ;	2																								

Question	Answer	Marks
5(a)	C_nH_{2n} ;	1
5(b)	C_2H_6 ; C_8H_{16} ;	2
5(c)(i)	(unsaturated because) they contain a (carbon-carbon) double bond ; (hydrocarbons) contain hydrogen and carbon only ;	2
5(c)(ii)	(the idea that methene would contain) only one carbon atom / an alkene needs (at least) two carbon atoms ; the idea that a (C = C) double bond cannot form ;	2
5(d)(i)	bottled gas / heating / cooking ;	1
5(d)(ii)	similar boiling point ;	1

Question	Answer	Marks
6(a)(i)	weight ;	1
6(a)(ii)	force arrow parallel to belt in contact with box pointing up the belt ;	1
6(b)	time = distance $\div$ speed (<i>stated or evidence of use</i>) / (time =) $5 \div 0.2$; 25 (s) ;	2
6(c)(i)	(gain in GPE =) $mg\Delta h$ (<i>stated or evidence of use</i>) / $45 \times 10 \times 2$; 900 (J) ;	2

6(c)(ii)	pressure = force ÷ area (<i>in any form</i>) ; = 450 ÷ 3000 OR 450 ÷ 0.3 ; (pressure =) 0.15 (N/cm²) OR 1500 (N/m² or Pa) ; N/cm² OR N/m² OR Pa (<i>to match numerical answer</i>) ;	4
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Question	Answer	Marks
7(a)(i)	chlorophyll ; chemical ; carbohydrates ;	3
7(a)(ii)	<i>any three from:</i> responds to gravity / gravitropism ; auxin is produced at the shoot tip ; increased (concentration of) auxin on underside (of stem) ; auxin causes cell elongation ;	3
7(b)	large surface area ; increased absorption of, water / mineral (ions) ;	2
7(c)	decomposers feed on / break down, (aquatic) plants ; (aerobic) respiration of decomposers (uses oxygen) ;	2

Question	Answer	Marks
8(a)(i)	3 and 2 ;	1
8(a)(ii)	Fe^{3+} ;	1
8(b)(i)	excludes, oxygen / air ; excludes water ;	2
8(b)(ii)	paint / grease / oil / other suitable coating ;	1
8(c)	4 ; it has a double bond with two electrons in each bond / two pairs of electrons are shared ;	2
8(d)	oxygen, is covalent / has a simple (molecular) structure <u>and</u> iron oxide, is ionic / has a giant structure ; forces between particles / ions, in iron oxide, are stronger than in oxygen (particles / molecules) ;	2

Question	Answer	Marks
9(a)	angle of incidence = angle of reflection AND angles measured to the normal ;	1
9(b)(i)	resistance = voltage $\div$ current (<i>stated or evidence of use</i>) / $5 \div 0.020$; $250 (\Omega)$;	2
9(b)(ii)	$P = I \times V$ (<i>stated or evidence of use</i>) / ($P = $) 0.020×5.0 ; $0.1(0) (\text{W})$;	2
9(b)(iii)	LEDs in parallel, using LED symbol provided ; circuit symbol for resistor and switch ; resistor and switch in main circuit, circuit completed with no additional components or extra wiring causing a short circuit ;	3

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Question	Answer	Marks
1(a)(i)	mango (fruit) → (fruit) flies → thrushes → eagle ;; <i>correct order = one mark</i> <i>arrows in correct direction = one mark</i>	2
1(a)(ii)	secondary ; three ;	2
1(b)(i)	$\frac{0.82}{100} \times 85$; 0.697 ; 0.7 ;	3
1(b)(ii)	lipase ; fatty acids and glycerol ;	2
1(b)(iii)	contains fibre ;	1

Question	Answer	Marks
2(a)(i)	water ;	1
2(a)(ii)	hydrogen ions attracted to / move to, cathode / negative electrode ; reference to gain of electrons ; (two) hydrogen atoms join to form a molecule (of hydrogen gas) ;	3
2(b)(i)	chlorine ;	1

Question	Answer	Marks
2(b)(ii)	(damp) litmus (paper) and bleached / goes white ;	1
2(c)(i)	is inert / is unreactive and conducts (electricity) ;	1
2(c)(ii)	transition (elements / metals) ;	1

Question	Answer	Marks
3(a)(i)	at constant speed / at 20 m / s ;	1
3(a)(ii)	X at top / bottom of line between t = 45 s and t = 50 s / between t = 58 s and t = 60 s ;	1
3(b)	max speed of car = 25 m / s ; (unit conversions) $100 \times 1000 \div 3600$ / 27.8 m / s (so limit not broken) ; OR max speed of car = 25 m / s ; (unit conversions) $25 \times 3600 \div 1000$ / 90 km / h (less than 100 km / h (so limit not broken) ;	2
3(c)	use of area under graph (stated or evidence) ; (implementation): $20 \times 10 + \frac{1}{2} \times 20 \times 15$; 350 (m) ;	3
3(d)(i)	focal length ;	1
3(d)(ii)	<i>speed = distance ÷ time</i> (stated or evidence of use) / $t = 15 \div 3 \times 10^8$; $5(.0) \times 10^{-8}$ (s) ;	2

Question	Answer	Marks												
4(a)	<table border="1"> <thead> <tr> <th>letter</th><th>name of part</th><th>function</th></tr> </thead> <tbody> <tr> <td>(A)</td><td>palisade (mesophyll cell / layer)</td><td>(photosynthesis)</td></tr> <tr> <td>(D)</td><td>stoma / stomata</td><td>to allow gas exchange</td></tr> <tr> <td>C</td><td>(phloem)</td><td>transport (sucrose / amino acids)</td></tr> </tbody> </table> ... ''' one mark for each correct row	letter	name of part	function	(A)	palisade (mesophyll cell / layer)	(photosynthesis)	(D)	stoma / stomata	to allow gas exchange	C	(phloem)	transport (sucrose / amino acids)	3
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4(b)(i)	$6 \text{ (H}_2\text{O)} + 6 \text{ (CO}_2\text{)} ;$ $\text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2 ;$	2												
4(b)(ii)	any three from: photosynthesis stops / slows down ; enzymes denature ; active site changes shape ; substrate no longer fits active site ;	3												
4(c)	phototropism ; auxin ; elongation ;	3												

Question	Answer	Marks
5(a)	temperature: < 20 ; concentration of acid: < 1.0 ;	2
5(b)	experiment 2 is faster because it is at a higher temperature ; particles, have more energy / move faster / have more frequent collisions ; more particles have energy greater than the activation energy / more successful collisions ;	3
5(c)	experiment 3 ; it is the highest concentration ;	2
5(d)(i)	(no gas given off because) copper, is unreactive / does not react with acids ;	1
5(d)(ii)	named metal, more reactive than calcium / any of the metals in the table ;	1

Question	Answer	Marks
6(a)(i)	nuclear fusion ;	1
6(a)(ii)	nuclear (fission) / tidal ;	1
6(b)(i)	boils / turns to steam ; (temperature of rock is) above 100 °C / boiling point of water is 100 °C / higher than the b.pt of water ;	2
6(b)(ii)	pressure = force ÷ area / $F = p \times A$ (stated or evidence of use) ; area of borehole $A = \pi r^2 / 3.14 \times 0.12 \times 0.12 / 0.045 \text{ (m}^2\text{)} ;$ $F = 6 \times 10^6 \times 3.14 \times 0.12 \times 0.12 / 6 \times 10^6 \times 0.045 ;$ $0.27 \times 10^6 \text{ N} / 270\,000 \text{ N} / 270 \text{ kN} ;$	4

Question	Answer	Marks
6(c)(i)	gravitational potential ;	1
6(c)(ii)	(PE stored =) $mg\Delta h$ (stated or evidence of use) / $1000 \times 10 \times 200$; 2 000 000 (J) ;	2

Question	Answer	Marks
7(a)(i)	diffusion ;	1
7(a)(ii)	<i>any two from:</i> large surface area ; thin surface ; good ventilation ; AVP, e.g. moist / short diffusion distance ;	2
7(b)	produce mucus ; (mucus) traps, particles / pathogens / microbes ;	2
7(c)	chronic obstructive pulmonary disease / COPD ;	1

Question	Answer	Marks
8(a)	decane and pentane ; <i>reason:</i> they are saturated (hydrocarbons) / do not contain double (C=C) bonds / contain only single bonds ;	2
8(b)	<i>any two from:</i> high temperature ; high pressure ; catalyst ;	2
8(c)	(some carbon – carbon single) bonds break ; (some) carbon atoms form double bonds (with each other) ;	2
8(d)	they have different boiling points ;	1
8(e)(i)	bottled gas / heating and cooking ;	1
8(e)(ii)	(source / reactant for) making (other) chemicals ;	1

Question	Answer	Marks
9(a)(i)	resistance = p.d. $\div$ current (stated or evidence of use) / (R =) $6.0 \div 0.75$; 8(.0) (Ω) ;	2
9(a)(ii)	correct symbol connected in parallel ; connection to right of battery made between battery and bell push ;	2
9(b)	resistance of wiring increases with length / idea that resistance in the bell branch is too high ; p.d. across bell now less (than 6.0 V while still 6.0 V across lamp) / current in the bell decreases ;	2



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Question	Answer			Marks
1(a)	letter	name	function	3
	D	(scrotum)	hold testes outside body	
	(B)	testes	(produce male) gametes / sperm	
	C	urethra	(carries urine and semen out of the body)	
	one mark for each correct row			
1(b)	jelly ; nuclei ;			2
1(c)	any two from: allows nutrients / oxygen, to pass to fetus ; allows toxins / excretory products, to pass from fetus ; provides barrier for toxins ;			2

Question	Answer	Marks
2(a)(i)	hydroxide (ions) ; lose electrons ; to form (water and) oxygen ;	3
2(a)(ii)	+ 2e ; →H ₂ ;	2

Question	Answer	Marks
2(b)	<i>any two from:</i> (molten or aqueous solution of) an ionic compound / a liquid (molten or solution) that contains ions ; the idea that an electrolyte, conducts electricity / contains mobile ions ; the idea that the compound in the electrolyte is broken down (into elements) ;	2
2(c)	(aqueous) sodium chloride / other correct ;	1

Question	Answer	Marks
3(a)(i)	25 (m/s) ;	1
3(a)(ii)	X marked at any point between $t = 0 \text{ s}$ and $t = 0.3 \text{ s}$;	1
3(a)(iii)	<i>any two from:</i> air resistance ; kinetic energy is transferred into gravitational potential energy ; reference to gravitational force (downwards as ball is going upwards) ;	2
3(b)(i)	gravitational force on ball / weight of ball = $mg / 0.4 \times 10$; 4(.0) (N) ;	2
3(b)(ii)	forces are balanced / no resultant force (when ball is not moving) ;	1
3(c)	unit conversions: 0.45 kg or 0.0041 m^3 ; (density =) mass $\div$ volume / (=) $0.45 \div 0.0041$; $110 \text{ (kg / m}^3\text{)}$;	3

Question	Answer	Marks
4(a)(i)	<i>any two from:</i> (large) vacuole ; cell membrane ; cell wall ; nucleus ; cytoplasm ;	1
4(a)(ii)	large surface area ; increases (rate of) absorption of, water / mineral ions ;	2
4(a)(iii)	ref to (large numbers of) chloroplasts ; that contain chlorophyll ; transfers light energy to chemical energy ;	3
4(b)(i)	$170 - 54 / 116$; $(170 - 54) \div 54 \times 100 / 116 \div 54 \times 100 / (170 \div 54 \times 100) - 100 / 214.814$; 215 (%) ;	3
4(b)(ii)	<i>any three from:</i> rate of transpiration decreases ; (idea of higher humidity causes) increased concentration of water surrounding leaves / lower concentration gradient ; decrease in evaporation (from mesophyll cells) ; decrease in diffusion from, stomata / leaves ;	3

Question	Answer	Marks
5(a)	(solute) ammonium nitrate ; (solvent) water ;	2
5(b)(i)	endothermic / energy taken in ; the idea expressed that the energy of products is greater than reactants / products at higher energy level ;	2
5(b)(ii)	A bonds are breaking ; B bonds are forming ; A energy is taken in / B energy is given out ;	3
5(c)	all non-metals ; atoms in one molecule: 2,4,3 ;	2

Question	Answer	Marks
6(a)	parallel ;	1
6(b)	kinetic energy (of rotating blades / blown air) ;	1
6(c)(i)	power (rating of lamp) = $V \times I$ / ($I = 11 \div 12$) ;	1
6(c)(ii)	(power rating of whole circuit = $V \times I = 12 \times 8.0 / 96$; (power rating of fan = $(12 \times 8) - 11 = 85$ (W) ; OR (current in fan circuit = $8.0 - 0.92 / 7.1$; (power rating of fan = $12 \times 7.1 = 85(.2)$ (W) ;	2

Question	Answer	Marks
6(d)	rating of fuse (10 A) much higher than lamp current but closer to the fan current OR fuse allows (up to) 10 A to flow with no damage to fan but causes damage to lamp ;	1
6(e)	second lamp in series ; two fuse symbols correct, and one in each branch ; battery symbol and connecting wiring complete with no short circuits ;	3

Question	Answer	Marks
7(a)(i)	either atrium labelled ;	1
7(a)(ii)	<i>any two from:</i> mixing of blood from lungs and body ; less oxygen transported (to body) ; decrease in blood pressure (to body) ; AVP, e.g. reduction in (aerobic) respiration in cells ;	max 2
7(b)(i)	blockage of coronary artery ;	1
7(b)(ii)	<i>any two from:</i> stress ; smoking ; genetic predisposition ; age ; gender / sex ; AVP, e.g. lack of exercise ;	2

Question	Answer	Marks
7(c)	(respiration is a) reaction with oxygen ; breakdown of nutrient (molecules) to release energy ;	2

Question	Answer	Marks
8(a)	ethene and butene ; they both contain a double bond / are unsaturated / are alkenes ;	2
8(b)	<i>either order:</i> carbon dioxide CO ₂ ; water H ₂ O ;	2
8(c)	alkanes ;	1
8(d)	cannot be reversed by physical means ; new products formed ;	2
8(e)(i)	butane has weaker forces between its molecules ;	1
8(e)(ii)	similar boiling points ;	1

Question	Answer	Marks
9(a)(i)	(peaks represent) particles closer together ; (troughs represent) particles further apart ;	2
9(a)(ii)	(transferred to) thermal energy ;	1

Question	Answer	Marks
9(b)	<i>any two from, and in any order:</i> shorter wavelength ; higher frequency ; electromagnetic (as opposed to pressure waves) ; transverse ; can travel in a vacuum ;	2
9(c)	speed = frequency $\times$ wavelength / $v = f\lambda$ OR $f = 3 \times 10^8 \div 0.030$; 1.0×10^{10} ; Hz ;	3