



**Cambridge Assessment International Education**  
Cambridge International General Certificate of Secondary Education

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**CO-ORDINATED SCIENCES**

**0654/41**

Paper 4 Theory (Extended)

**May/June 2019**

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.

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This document consists of **14** 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:**

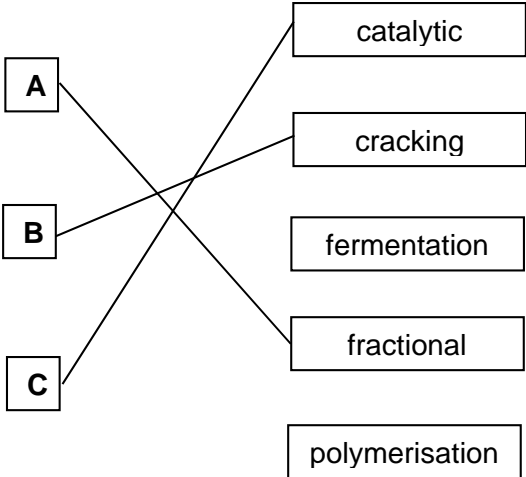
Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

<b>Question</b>	<b>Answer</b>	<b>Marks</b>
1(a)(i)	as light intensity increases the rate of photosynthesis increases ; then plateaus / levels off / remains constant ;	<b>2</b>
1(a)(ii)	Rate of photosynthesis cannot be increased further by <u>light</u> intensity ; other (named) factors (are limiting the rate of photosynthesis) ;	<b>2</b>
1(b)(i)	large (air) spaces (in the spongy mesophyll layer) ; guard cells / stoma / stomata (to allow entry and exit of gases) ;	<b>2</b>
1(b)(ii)	<u>palisade</u> (cell) ; labelled correctly ;	<b>2</b>
1(c)	$C_6H_{12}O_6$ and $O_2$ ;	<b>1</b>

Question	Answer	Marks
2(a)(i)	$C + 2ZnO \rightarrow CO_2 + 2Zn$ formulae ; balanced ;	2
2(a)(ii)	zinc (ions) / $Zn^{2+}$ gain electrons ;	1
2(a)(iii)	carbon is less reactive than aluminium ;	1
2(b)(i)	bauxite ;	1
2(b)(ii)	for mobility of ions ;	1
2(b)(iii)	(aluminium oxide is dissolved in molten cryolite) to reduce melting point ;	1
2(b)(iv)	$Al^{3+} + 3e^- \rightarrow Al$ correct charges on Al ; correct number of electrons ;	2
2(c)(i)	non-renewable / will run out / used faster than formed ;	1
2(c)(ii)	recycle / example of recycling ;	1

Question	Answer	Marks
3(a)(i)	$12/30 = 0.4$ (A) ;	1
3(a)(ii)	voltage $\times$ current <b>or</b> $12 \times 0.40$ ; = 4.8 (W) ;	2
3(a)(iii)	current $\times$ time <b>or</b> $0.4 \times 30$ ( $\times 60$ ) <b>or</b> $0.4 \times 1800$ ; =720 (C) ;	2
3(b)(i)	correct label ;	1
3(b)(ii)	correct label ;	1
3(b)(iii)	arrow drawn from N to S ;	1
3(b)(iv)	direct current goes in one direction / alternating current changes direction ;	1
3(c)	higher frequency / more waves produced per second ; shorter wavelength ; compressions and rarefactions get closer together ;	3

Question	Answer	Marks
4(a)	74 (%) ;	1
4(b)	combustion <u>releases</u> carbon dioxide ; photosynthesis removes carbon dioxide ; less carbon dioxide removed / less photosynthesis ;	3
4(c)	<u>soil erosion</u> / lack of roots to hold soil together / rainfall washes soil away / landslides ; loss of nutrients ; flooding ;	3
4(d)	(a unit containing all of the) <u>organisms</u> and their <u>environment</u> ; interacting together (in a given area) ;	2

Question	Answer	Marks
5(a)	 <p>1 correct ; 3 correct ;</p>	2
5(b)	a hydrocarbon consists of <u>only</u> hydrogen and carbon ;	1
5(c)(i)	Step 1: $(22/46 =) 0.48$ ; Step 2: $(0.48 \times 2 =) 0.96$ ; Step 3: $0.96 \times 44 = 42$ (g) ;	3
5(c)(ii)	(butane) least amount of greenhouse gas / carbon dioxide is a greenhouse gas; climate change / global warming / consequence of climate change ;	2



Question	Answer	Marks
6(a)(i)	visible placed correctly ;	1
6(a)(ii)	$3 \times 10^8$ (m/s) ;	1
6(b)(i)	value above 330 m/s and below 6000 m/s <b>and</b> sound travels faster in a liquid than in a gas <b>and</b> sound travels slower in a liquid than in a solid ;	1
6(b)(ii)	(time in air=) 500/330 <b>or</b> 1.515(s) <b>and</b> (time in steel =) 500/6000 <b>or</b> 0.0833(s) ; time difference = 1.4 (s) ;	2
6(b)(iii)	(wavelength =) velocity / frequency or 330/500 ; = 0.66 (m) ;	2
6(b)(iv)	transverse waves – direction of oscillation/vibration perpendicular to direction of wave travel ; longitudinal – direction of oscillation/vibration parallel to direction of wave travel ;	2

Question	Answer	Marks
7(a)(i)	0.1 (cm/min) ;	1
7(a)(ii)	as temperature decreases rate of diffusion decreases ;	1
7(a)(iii)	concentration of red dye ;	1
7(b)	concentration of red dye is higher outside the agar cube ; (movement is) from high to low concentration / down a concentration gradient ; by random motion of dye particles ;	max 2
7(c)	carbon dioxide ;	1

Question	Answer	Marks									
8(a)(i)	$M_r$ (nitrogen) = 28 $M_r$ (chlorine) = 71 ;	1									
8(a)(ii)	<u>nitrogen</u> rate of diffusion increases with decreasing molecular mass / lighter particles move faster than heavier particles (with same energy / in gas at same temperature) ;	1									
8(b)	<table border="1" data-bbox="347 448 1895 647"> <thead> <tr> <th data-bbox="347 448 728 513">isotope</th> <th data-bbox="728 448 1310 513">number of neutrons</th> <th data-bbox="1310 448 1895 513">number of electrons</th> </tr> </thead> <tbody> <tr> <td data-bbox="347 513 728 579">chlorine-35</td> <td data-bbox="728 513 1310 579">18</td> <td data-bbox="1310 513 1895 579">17</td> </tr> <tr> <td data-bbox="347 579 728 647">chlorine-37</td> <td data-bbox="728 579 1310 647">20</td> <td data-bbox="1310 579 1895 647">17</td> </tr> </tbody> </table> <p data-bbox="347 683 672 748">correct neutron column ; correct electron column ;</p>	isotope	number of neutrons	number of electrons	chlorine-35	18	17	chlorine-37	20	17	2
isotope	number of neutrons	number of electrons									
chlorine-35	18	17									
chlorine-37	20	17									
8(c)(i)	yellow / orange solution ; chlorine displaces bromine / chlorine is more reactive than bromine / bromine is formed ;	2									
8(c)(ii)	chlorine + sodium bromide $\rightarrow$ bromine + sodium chloride  bromine as product ; all else correct ;	2									
8(d)	no change in colour / paler (due to dilution) ; no reaction because bromine is less reactive than fluorine / reference to trend in reactivity down Group VII ;	2									

Question	Answer	Marks
9(a)(i)	straight line from 0,0 through 1.0, 1.6 ; stopping at t = 1.3 ;	<b>2</b>
9(a)(ii)	hammer falls faster on Earth than on the Moon ; gravity on Earth greater ;  feather falls slower on Earth than on Moon ; reference to air resistance on Earth ;  hammer falls faster than feather on Earth ; reference to air resistance on Earth ;	<b>max 4</b>
9(b)	astronaut stays cooler in white / would get very hot in black ; white surfaces are better reflectors of thermal radiation (than black surfaces) / black surfaces are better absorbers of thermal radiation (than white surfaces) ;	<b>2</b>
9(c)	cancer/mutation ;	<b>1</b>
9(d)	${}_{92}^{235}\text{U}$ ;  ${}_{2}^{4}\text{He}$ ;	<b>2</b>

<b>Question</b>	<b>Answer</b>	<b>Marks</b>
10(a)(i)	lumen labelled ; wall labelled ;	<b>2</b>
10(a)(ii)	valves ;	<b>1</b>
10(b)	carries blood at high pressure ; so it does not rupture / burst ;	<b>2</b>
10(c)	<i>any two from</i>  high stress ; smoking ; reference to poor / unbalanced diet ;	<b>max 2</b>
10(d)(i)	adrenalin ; insulin ;	<b>2</b>
10(d)(ii)	causes cells to elongate ;	<b>1</b>

Question	Answer	Marks
11(a)(i)	gas syringe / measuring cylinder inverted over water ; measure volume of carbon dioxide and <u>divide</u> by time ; <b>or</b> balance ; measure loss in mass and <u>divide</u> by time ;	<b>2</b>
11(a)(ii)	at higher temperature: (initial) rate of reaction / rate at which gas is collected, is higher ; more particles possess, activation energy / minimum energy to react, / there are more <u>successful</u> collisions ; greater frequency of collision ;	<b>3</b>
11(b)	lead nitrate ; calcium chloride / sodium chloride ; mix solutions ; filter ;	<b>4</b>
11(c)	Ionic lattice / giant ionic structure ; many bonds / strong bonds / strong forces / require a large amount of energy to break bonds ;	<b>2</b>

Question	Answer	Marks
12(a)	<i>any two from</i> geothermal nuclear tidal ;	<b>1</b>
12(b)	increase in pressure because molecules are moving faster / have more KE ; collide with walls of tyre more frequently / at greater speed / with greater force ;	<b>2</b>
12(c)	less stable ;	<b>1</b>
12(d)(i)	two straight rays brought to a focus on the light sensor ;	<b>1</b>
12(d)(ii)	speed of light in vacuum $\div$ speed of light in glass ;	<b>1</b>
12(d)(iii)	real image can be projected onto a screen / is formed where the light rays converge ; virtual image is one from which the light rays appear to come from that image ;	<b>max 1</b>
12(e)	(fixed shape because) strong forces (keep particles in regular / fixed arrangement) ;	<b>1</b>

Question	Answer	Marks
13(a)	ref to active site ; active site / enzyme, and substrate have <u>complementary shape</u> ; so substrate can bind to active site / enzyme ;	<b>3</b>
13(b)	C ; (C) contains proteins / enzymes are proteins ; proteins turn Biuret solution purple ;	<b>3</b>