



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

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**CO-ORDINATED SCIENCES**

**0654/04**

Paper 4 Theory (Extended)

**For examination from 2019**

MARK SCHEME

Maximum Mark: 120

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**Specimen**

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This document consists of **10** printed pages.

## 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.

mark scheme abbreviations

;	separates marking points
/	alternative responses for the same marking point
not	do not allow
allow	accept the response
ignore	mark as if this material was not present
ecf	error carried forward
avp	any valid point
ora	or reverse argument
owtte	or words to that effect
underline	actual word given must be used by candidate (grammatical variants excepted)
( )	the word/phrase in brackets is not required but sets the context
max	indicates the maximum number of marks
any [number] from:	accept the [number] of valid responses
note:	additional marking guidance

Question	Answer	Marks	Guidance
1(a)	group number: 8 or 0 ; number of electrons: <b>1 and 7</b> ; reactive and unreactive ;	<b>3</b>	note: award 1 mark for each column correct
1(b)	(D) Any two from: an alloy is a mixture of metals/D has two different atoms or elements that are not chemically combined ; D has a lattice structure/is a solid ; E is not a mixture/is only one substance/is pure/single metal ; F is a mixture of gases/is a mixture of molecules ;	<b>2</b>	max 2
1(c)(i)	$8.4 \div (24 \times 1000)$ ; $3.5 \times 10^{-4}$ <b>or</b> 0.00035 ; <b>or</b> volume of hydrogen $0.0084 \text{ dm}^3$ ; ( $0.0084 \div 24 =$ ) 0.00035 ;	<b>2</b>	allow: 1 mark for $8.4 \div 24 = 0.35$
1(c)(ii)	Any three from: reaction rate is lower ; (ethanol) molecules have lower (average) energy ; fewer molecules with activation energy ; frequency of collision with sodium is lower ; fewer successful collisions ;	<b>3</b>	max 3

Question	Answer	Marks	Guidance
2(a)	X = stigma/carpel ; Y = sepal ;	<b>2</b>	
2(b)	produces/releases pollen ;	<b>1</b>	
2(c)	ovule labelled ;	<b>1</b>	
2(d)	(large) petals ; anthers/stamens inside the flower ; stigma inside the flower ; lobed stigma ;	<b>2</b>	max 2 ignore: guidelines, nectary, scent, colour

Question	Answer	Marks	Guidance
2(e)(i)	elongated shape ; for larger surface area ; <b>or</b> thin/permeable, cell walls ; to allow water through ;	2	max 2
2(e)(ii)	absorption of, minerals / ions / nitrate / magnesium / other named mineral ion ;	1	

Question	Answer	Marks	Guidance
3(a)(i)	1500 m/s ;	1	
3(a)(ii)	20–20,000 Hz ;	1	
3(b)(i)	wavelength = velocity ÷ frequency <b>or</b> $v = f\lambda$ <b>or</b> $3.0 \times 10^8 \div 6.7 \times 10^{14}$ ; $= 4.5 \times 10^{-7}$ (m) ;	2	
3(b)(ii)	(wavelength) decreases ; (frequency) stays the same ; (speed) decreases ;	3	
3(b)(iii)	$n = \frac{\sin i}{\sin r}$ <b>or</b> $1.5 = \frac{\sin 45}{\sin r}$ <b>or</b> $= \sin^{-1} \left( \sin \frac{45}{1.5} \right)$ ; 28.1° ;	2	

Question	Answer	Marks	Guidance
4(a)(i)	any correct equation for a metal above zinc ;	1	e.g. $\text{Mg} \rightarrow \text{Mg}^{2+} + 2\text{e}^-$
4(a)(ii)	$\text{Zn} + \text{Cu}^{2+} \rightarrow \text{Zn}^{2+} + \text{Cu}$ ;	2	note: award 1 mark for correct formulae award 1 mark for correctly balanced
4(b)(i)	$\text{Cu}^{2+}$ or copper ;	1	note: charge not essential but if given must be correct
4(b)(ii)	$\text{Cu}^{2+}$ or copper ;	1	
4(c)(i)	(iron/steel/metal) coated with thin layer of zinc ; zinc stops/acts as a barrier to oxygen <b>and</b> water reaching metal (under zinc) ; zinc is more reactive than iron/steel <b>or</b> zinc oxidises in preference to iron/steel ;	3	

Question	Answer	Marks	Guidance
4(c)(ii)	paint/oiling/greasing ;	1	

Question	Answer	Marks	Guidance
5(a)	lipase ;	1	
5(b)(i)	37 ;	1	
5(b)(ii)	molecules/particles move slowly/have less kinetic energy ; so lower rate of collisions/collisions are less frequent/fewer successful collisions in a given period of time ;	2	max 2
5(b)(iii)	Any two from: denatured/destroyed by heat ; the shape of the active site has changed ; substrate no longer fits the active site ;	2	max 2
5(c)(i)	YES because it uses less energy at lower temperature ; less fossil fuel/less global warming ; <b>or</b> NO because it uses more energy for longer programme ; more fossil fuel/more global warming ; <b>or</b> NO DIFFERENCE because increase in energy usage for extended programme leads to decrease in energy usage for temperature reduction ;;	2	note: Yes/No/No difference must be linked to correct explanation.
5(c)(ii)	(enzyme 1) works better/more active <u>at 30°C/lower temperature</u> (than enzyme 2)/30°C is (close to) <u>optimum temperature</u> /owtte ;	1	note: enzyme 1 – no mark

Question	Answer	Marks	Guidance
6(a)	change in velocity ; (change in velocity) per unit time ; <b>or</b> rate of change of velocity ;;	2	note: award 1 mark for change in speed per unit time
6(b)	(a) = $\Delta v \div t$ <b>or</b> speed change $\div$ time <b>or</b> $18 \div 12$ ; 1.5 ;	2	

Question	Answer	Marks	Guidance
7(a)	reversible ;	1	
7(b)	<i>nitrogen:</i> air ;  <i>hydrogen:</i> from methane <b>or</b> natural gas ; react with steam ;	3	
7(c)	(finely divided) iron ;	1	
7(d)	displacement ;	1	

Question	Answer	Marks	Guidance
8(a)	meiosis ;	1	
8(b)	Any two from: only two colours ; no intermediates ; genetically determined ;	2	max 2
8(c)	homozygous ;	1	
8(d)	G, g, g, g ; Gg, Gg, gg, gg ; purple, purple, yellow, yellow ; 50% purple, 50% yellow / 1 : 1 ;	4	
8(e)	produces variation ; (species) can adapt to changes in the environment ;	2	

Question	Answer	Marks	Guidance
9(a)(i)	the Sun ;	1	
9(a)(ii)	useful power output ÷ total power input <b>or</b> $1.2 \div 4.0$ <b>or</b> 0.3 ; ( $\times 100$ ) = 30(%) ;	2	allow: useful energy output ÷ total energy input

Question	Answer	Marks	Guidance
9(a)(iii)	total energy output = energy input/energy cannot be created or destroyed/no energy is lost/all input energy transferred to another form ; 1.2 + 2.8 = 4 ;	2	allow: power
9(a)(iv)	chemical energy (in coal) to heat energy ; heat to kinetic energy ; kinetic to electrical ;	3	allow: chemical to heat to kinetic to electrical
9(b)(i)	to reduce current ; reduces energy loss/power loss ;	2	note: award 1 mark for more efficient
9(b)(ii)	$(V_p/V_s) = (N_p/N_s)$ ; output voltage = $500\,000 \times 33\,000 \div 40\,000 = 412\,500$ (V) ;	2	

Question	Answer	Marks	Guidance
10(a)(i)	a compound which contains carbon and hydrogen <u>only</u> ;	1	
10(a)(ii)	alkanes contain only C—C single bonds <b>or</b> they are saturated (hydrocarbons) <b>or</b> have the general formula $C_nH_{2n+2}$ ;  alkenes contain at least one C=C double bond <b>or</b> they are unsaturated (hydrocarbons) <b>or</b> have the general formula $C_nH_{2n}$ ;	2	
10(b)	$C_8H_{18}$	1	
10(c)(i)	any unambiguous structure of $BrCH_2CH_2Br$ ;	1	not: just $C_2H_4Br_2$
10(c)(ii)	$C_4H_8 + H_2O \rightarrow C_4H_9OH$ ;	2	note: award 1 mark for correct reactants note: award 1 mark for correct product
10(c)(iii)	$C_2H_4 + H_2 \rightarrow C_2H_6$ ;	2	note: award 1 mark for correct reactants note: award 1 mark for correct product
10(d)(i)	150 (cm <sup>3</sup> ) ;	1	
10(d)(ii)	100 (cm <sup>3</sup> ) ;	1	
10(d)(iii)	formulae of any alkene ; any <b>balanced</b> equation of the combustion of an alkene ;	2	e.g. $C_2H_4 + 3O_2 \rightarrow 2CO_2 + 2H_2O$



Question	Answer	Marks	Guidance
10(e)(i)	greenhouse (gases) ;	1	
10(e)(ii)	methane/CH <sub>4</sub> ;	1	allow: any valid greenhouse gas

Question	Answer	Marks	Guidance
11(a)	nitrate/magnesium/potassium/phosphate/sulfate ;		ignore: NPK
11(b)	leaching/runoff/washed through by rain/blown by wind ;		
11(c)(i)	rapid/increased, growth/population increase (followed by death) ;	1	
11(c)(ii)	Any two from: blocking of light so no photosynthesis/outcompeted by algae ; so die ; more growth initially due to increased nutrients ;	2	max 2
11(c)(iii)	Any two from: increase in numbers ; feed on the dead matter ; use up oxygen ;	2	max 2
11(c)(iv)	Any two from: initially increases (as a result of more photosynthesis) ; decreases ; due to respiration by bacteria ;	2	max 2
11(c)(v)	die ; due to lack of oxygen ;	2	
11(d)	apply fertiliser at peak growing time/avoid applying when raining or windy/use appropriate amount/use less ;	1	

Question	Answer	Marks	Guidance
12(a)(i)	4.5 (V) ;	1	
12(a)(ii)	(charge =) current × time <b>or</b> 0.9 × 60 ; = 54 ; coulombs/C ;	3	

Question	Answer	Marks	Guidance
12(b)	working or $1/R_T = 1/R_1 + 1/R_2$ or $(R =) R_1 R_2 / R_1 + R_2$ ; $(R =) 2.5(\Omega)$ ;	2	note: or correct substitution note: award 2 marks for correct numerical answers
12(c)	higher temperature lower resistance ; lower resistance means higher current ; higher current means faster motor ;	3	allow: ora for lower temperature for 2nd and 3rd marking points note: missing steps out in the logical sequence will reduce the mark only by the missed step note: failure to recognise direction of change can score 2 max

Question	Answer	Marks	Guidance
13(a)(i)	top plate + and bottom plate – ;	1	
13(a)(ii)	curving upwards ; steeper curve ;	2	
13(b)	${}^4_2\alpha + {}^{234}_{92}\text{U} \dots$	3	note: award 1 mark for alpha correct note: award 1 mark for 234 correct note: award 1 mark for 92 correct