

GCE

Chemistry A

Unit **H032/01**: Breadth in chemistry

Advanced Subsidiary GCE

Mark Scheme for June 2018

OCR (Oxford Cambridge and RSA) is a leading UK awarding body, providing a wide range of qualifications to meet the needs of candidates of all ages and abilities. OCR qualifications include AS/A Levels, Diplomas, GCSEs, Cambridge Nationals, Cambridge Technicals, Functional Skills, Key Skills, Entry Level qualifications, NVQs and vocational qualifications in areas such as IT, business, languages, teaching/training, administration and secretarial skills.

It is also responsible for developing new specifications to meet national requirements and the needs of students and teachers. OCR is a not-for-profit organisation; any surplus made is invested back into the establishment to help towards the development of qualifications and support, which keep pace with the changing needs of today's society.

This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

© OCR 2018

Annotations available in RM Assessor

Annotation	Meaning
	Correct response
	Incorrect response
	Omission mark
	Benefit of doubt given
	Contradiction
	Rounding error
	Error in number of significant figures
	Error carried forward
	Level 1
	Level 2
	Level 3
	Benefit of doubt not given
	Noted but no credit given
	Ignore

Abbreviations, annotations and conventions used in the detailed Mark Scheme (to include abbreviations and subject-specific conventions).

Annotation	Meaning
DO NOT ALLOW	Answers which are not worthy of credit
IGNORE	Statements which are irrelevant
ALLOW	Answers that can be accepted
()	Words which are not essential to gain credit
—	Underlined words must be present in answer to score a mark
ECF	Error carried forward
AW	Alternative wording
ORA	Or reverse argument

Subject-specific Marking Instructions**INTRODUCTION**

Your first task as an Examiner is to become thoroughly familiar with the material on which the examination depends. This material includes:

- the specification, especially the assessment objectives
- the question paper
- the mark scheme.

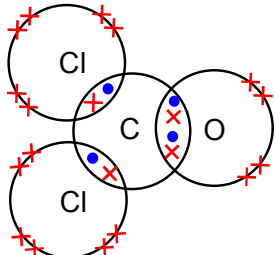
You should ensure that you have copies of these materials.

You should ensure also that you are familiar with the administrative procedures related to the marking process. These are set out in the OCR booklet **Instructions for Examiners**. If you are examining for the first time, please read carefully **Appendix 5 Introduction to Script Marking: Notes for New Examiners**.

SECTION A

Question	Answer	Marks	Guidance
1	C	1	
2	C	1	
3	B	1	
4	C	1	
5	A	1	
6	C	1	ALLOW +6
7	D	1	
8	C	1	
9	A	1	
10	D	1	
11	B	1	
12	B	1	
13	C	1	
14	B	1	
15	D	1	
16	C	1	ALLOW 3
17	A	1	
18	D	1	
19	C	1	
20	D	1	
	Total	20	

SECTION B

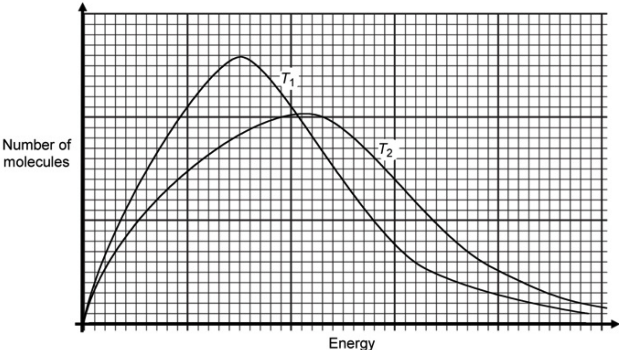
Question			Answer	Marks	Guidance										
21	(a)	(i)	<table><tr><td></td><td>Protons</td><td>Neutrons</td><td>Electrons</td><td></td></tr><tr><td>²⁹Si</td><td>14</td><td>16</td><td>14</td><td>✓</td></tr></table>		Protons	Neutrons	Electrons		²⁹ Si	14	16	14	✓	1	
	Protons	Neutrons	Electrons												
²⁹ Si	14	16	14	✓											
	(a)	(ii)	FIRST CHECK ANSWER ON THE ANSWER LINE IF answer = 28.11 (to 2 DP) award 2 marks $\frac{(28 \times 92.23) + (29 \times 4.68) + (30 \times 3.09)}{100}$OR 28.1086 OR 28.109 ✓ = 28.11 (to 2 DP) ✓	2	For 1 mark: ALLOW ECF → to 2 DP if: %s used with wrong isotopes ONCE OR - transposed decimal places for ONE %										
	(b)	(i)	 ✓ CARE: Check that lone pairs on Cl and O are included - Cl (×2) has 6 non-bonded electrons (3 LPs) - O has 4 non-bonded electrons (2 LPs)	1	NOTE: O and Cl electrons MUST be shown differently from C electrons (e.g. <i>expected answer</i>) IGNORE inner shells ALLOW diagram with missing C, O or Cl symbols. For C=O bond, ALLOW sequence × × • • ALLOW non-bonding electrons unpaired										

Question			Answer	Marks	Guidance
	(b)	(ii)	Shape Trigonal planar ✓ Number of bonded regions (C has) 3 electron (dense) regions OR 3 bonding regions ✓ Electron pair repulsion (<i>Seen anywhere</i>) electron pairs/bonded pairs/bonded regions repel OR electron pairs move as far apart as possible OR bonds repel ✓	3	ALLOW bp for bonded pair ALLOW 3 bonded pairs (BOD) OR 3 sigma bonds OR 2 bonded pairs and 1 double bond OR 4 bonded pairs including a double bond IGNORE bonded atoms IGNORE just 3 bonds ALLOW alternative phrases/words for repel e.g. 'push apart' IGNORE electrons repel (<i>pairs needed</i>) DO NOT ALLOW atoms repel
	(c)		Highest energy electron(s) in a p orbital/p sub-shell ✓	1	ALLOW outer electron(s) in a p orbital/sub-shell BUT IGNORE p shell ALLOW electron configuration ends in p OR the last electron is in a p orbital ALLOW valence electron(s) in p orbital/sub-shell
			Total	8	

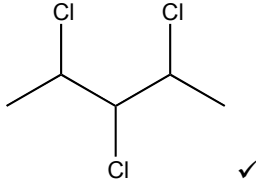
Question			Answer	Marks	Guidance
22	(a)	(i)	Oxidised AND (Mg) transfers/loses/donates 2 electrons ✓ <i>2 essential</i>	1	ALLOW Mg loses 6 electrons: <i>3 Mg in equation</i> ALLOW $\text{Mg} \rightarrow \text{Mg}^{2+} + 2\text{e}^-$ IGNORE oxidation numbers (even if wrong)
	(a)	(ii)	FIRST CHECK ANSWER ON THE ANSWER LINE IF answer = 2.26 (3 SF) award 3 marks ----- $n(\text{H}_3\text{PO}_4) = \frac{1.24 \times 50.0}{1000} = 0.062(0) \text{ (mol) } \checkmark$ $n(\text{Mg}) = \frac{3}{2} \times 0.062(0) = 0.093(0) \text{ (mol) } \checkmark$ mass of Mg = $0.0930 \times 24.3 = 2.26 \text{ (g) } \checkmark$ <i>3 SF required</i>	3	At least 3SF needed throughout BUT ALLOW no trailing zeroes (e.g. 0.062 for 0.0620) ALLOW ECF from $n(\text{H}_3\text{PO}_4)$ ALLOW ECF from $n(\text{Mg})$ ----- COMMON ERRORS for 2 marks 3:2 ratio omitted $\rightarrow n(\text{Mg}) = 0.062(0) \rightarrow 1.51 \text{ (g)}$ Inverted 2:3 ratio $\rightarrow n(\text{Mg}) = 0.0413 \rightarrow 1.00 \text{ (g)}$
	(a)	(iii)	Separation of solid Filter to obtain solid/precipitate ✓ <i>Requires realisation that solid is filtered off.</i> <i>Solid may be stated within in 'removal of water'</i> Removal of water Dry (solid) OR Evaporate (water/solution/liquid) ✓	2	ALLOW Removal of water Evaporate/ distil water/solution/liquid ✓ IGNORE 'distil' if product OR H_2 is distilled Collection of remaining solid ✓ <i>Requires realisation that solid remains</i> IGNORE 'Leave to crystallise' (<i>already solid</i>)
	(a)	(iv)	Formula MgO OR $\text{Mg}(\text{OH})_2$ OR MgCO_3 OR soluble Mg salt ✓ Equation $3\text{MgO} + 2\text{H}_3\text{PO}_4 \rightarrow \text{Mg}_3(\text{PO}_4)_2 + 3\text{H}_2\text{O}$ OR $3\text{Mg}(\text{OH})_2 + 2\text{H}_3\text{PO}_4 \rightarrow \text{Mg}_3(\text{PO}_4)_2 + 6\text{H}_2\text{O}$ OR $3\text{MgCO}_3 + 2\text{H}_3\text{PO}_4 \rightarrow \text{Mg}_3(\text{PO}_4)_2 + 3\text{CO}_2 + 3\text{H}_2\text{O} \checkmark$	2	In equation: NO ECF from incorrect formula ALLOW multiples IGNORE state symbols (even if incorrect) Soluble Mg salts include MgCl_2 , MgSO_4 , $\text{Mg}(\text{NO}_3)_2$, MgBr_2 , MgI_2 If unsure, check with TL e.g. $3\text{MgCl}_2 + 2\text{H}_3\text{PO}_4 \rightarrow \text{Mg}_3(\text{PO}_4)_2 + 6\text{HCl}$

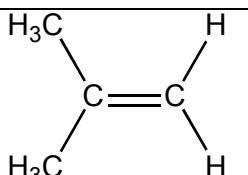
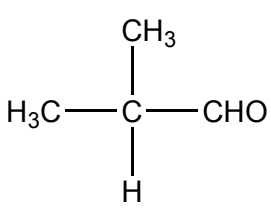
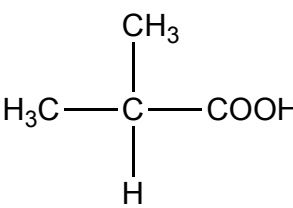
Question			Answer	Marks	Guidance
	(b)	(i)	FIRST CHECK ANSWER ON THE ANSWER LINE IF answer = 315 (cm³) award 4 marks Amount of PH₃ $n(\text{PH}_3) = \frac{3.20 \times 10^{-2}}{4}$ OR $8(.00) \times 10^{-3} \text{ (mol) } \checkmark$ Unit conversions $p \text{ conversion} \rightarrow \text{Pa} = 100 \times 10^3 \text{ (Pa)}$ AND $T \text{ conversion} \rightarrow \text{K} = 473 \text{ (K) } \checkmark$ Evidence of use of rearranged gas equation OR $V = \frac{nRT}{p}$ OR $V = \frac{8(.00) \times 10^{-3} \times 8.314 \times 473}{100 \times 10^3}$ OR $V = 3.15 \times 10^{-4} \checkmark$ <i>Calculator:</i> $= 3.1460176 \times 10^{-4}$ V conversion of m³ → cm³ $V = 3.15 \times 10^{-4} \times 10^6 = 315 \text{ cm}^3 \checkmark$ <i>Calculator from unrounded cm³:</i> 314.60176 cm³ Requires 3 OR MORE SF, correctly rounded ALLOW use of R = 8.31 → 314.4504 → 314 to 3SF	4	If there is an alternative answer, check to see if there is any ECF credit possible ALLOW ECF throughout Common Errors (3 marks) Use of $n(\text{H}_3\text{PO}_4) = 3.20 \times 10^{-2}$ (Very common) $V = \frac{3.2(0) \times 10^{-2} \times 8.314 \times 473}{100 \times 10^3} \times 10^6$ $= 1258.40704 \text{ cm}^3 \text{ (1260 to 3 SF)}$ No temperature conversion from °C to K $V = \frac{8(.00) \times 10^{-3} \times 8.314 \times 200}{100 \times 10^3} \times 10^6$ $= 133 \text{ cm}^3$ No p conversion from kPa to Pa $V = \frac{8(.00) \times 10^{-3} \times 8.314 \times 473}{100} \times 10^6$ $= 315000 \text{ cm}^3$ No volume conversion from m³ to cm³ $V = 3.15 \times 10^{-4}$ IGNORE use of 24/24000 for molar volume e.g. $3.2(0) \times 10^{-3} \times 24000 = 768$ scores zero $8(.00) \times 10^{-3} \times 24000 = 292$ scores 1st mark only
	(b)	(ii)	$4\text{PH}_3 + 8\text{O}_2 \rightarrow \text{P}_4\text{O}_{10} + 6\text{H}_2\text{O} \checkmark$	1	ALLOW multiples
			Total	13	

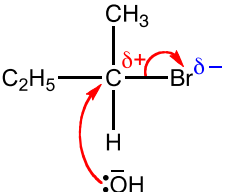
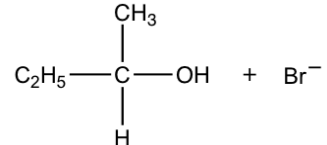
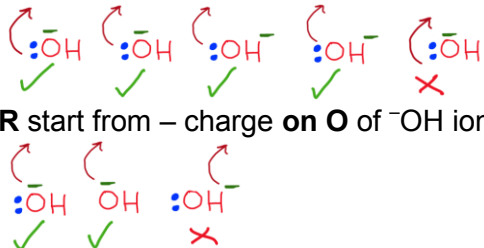
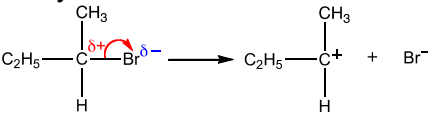
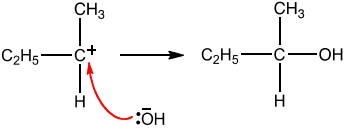
Question			Answer	Marks	Guidance
23	(a)	(i)	FIRST, CHECK THE ANSWER ON ANSWER LINE IF $\Delta_r H = -457$ OR -458 (kJ mol⁻¹) award 4 marks IF $\Delta_r H = \pm 229$ OR 457 (kJ mol⁻¹) award 3 marks ----- Energy released in J OR kJ $= 25.0 \times 4.18 \times 28.0 = 2926$ (J) OR 2.926 (kJ) ✓ Correctly calculates $n(\text{AgNO}_3)$ $= 0.512 \times \frac{25.0}{1000} = 1.28 \times 10^{-2}$ (mol) ✓ ΔH per mole AgNO_3 in kJ AND 3 SF Answer <i>MUST</i> divide energy by $n(\text{AgNO}_3)$ $\pm \frac{2.926}{1.28 \times 10^{-2}} = \pm 228.59375$ $= \pm 229$ (kJ) ✓ 3 SF needed Sign NOT needed ΔH for 2 mol AgNO_3 AND – sign AND 3 SF $\Delta H_r = 2 \times -228.59375 = -457$ (kJ mol⁻¹) OR $2 \times -229 = -458$ (kJ mol⁻¹) ✓	4	FULL ANNOTATIONS MUST BE USED ----- ALLOW ECF throughout ----- ALLOW 2930 J OR 2.93 kJ DO NOT ALLOW < 3 SF IGNORE any sign and units <i>i.e. ALLOW correctly calculated number in J OR kJ</i> ----- Alternative approach using 1 mol Mg Energy released = 2926 (J) OR 2.926 (kJ) ✓ $n(\text{AgNO}_3) = 1.28 \times 10^{-2}$ (mol) ✓ $n(\text{Mg}) = \frac{1.28 \times 10^{-2}}{2} = 6.4 \times 10^{-3}$ (mol) ✓ $\Delta H_r = \frac{2.926}{6.4 \times 10^{-3}} = -457$ (kJ mol⁻¹) ✓ – sign AND 3 SF needed
	(a)	(ii)	$\text{Ag}^+(\text{aq}) + \text{Cl}^-(\text{aq}) \rightarrow \text{AgCl}(\text{s})$ ✓ State symbols required White precipitate AND $\text{AgNO}_3/\text{Ag}^+$ NOT ALL reacted OR NO white precipitate AND $\text{AgNO}_3/\text{Ag}^+$ ALL reacted ✓	2	ALLOW $\text{AgNO}_3(\text{aq}) + \text{NaCl}(\text{aq}) \rightarrow \text{AgCl}(\text{s}) + \text{NaNO}_3(\text{aq})$ Observation needs to be linked to conclusion

Question	Answer	Marks	Guidance
(b)	Boltzmann distribution 3 marks  Curve Curve starts within one small square of origin AND curve does not touch x axis at high energy AND curve does not increase by more than one small square at higher energy ✓ Labels Axes labels correct: • Number of molecules AND Energy ✓ Curves for two temperatures Drawing of two curves with higher and lower temperature clearly identified in diagram or text AND higher T maximum to right AND at least one small square lower than lower T max ✓ Explanation 1 mark More molecules have energy greater than E_a OR Greater area under curve above E_a ✓ <i>Could be in diagram</i>	4	FULL ANNOTATIONS MUST BE USED THROUGHOUT NOTE: Look for marking criteria within annotations on Boltzmann distribution diagram IGNORE slight inflexion on the curve For labels, ALLOW number of particles ALLOW amount of molecules/particles IGNORE number of atoms ALLOW kinetic energy IGNORE enthalpy for energy IGNORE curves meeting at higher energy BUT DO NOT ALLOW crossing over by more than one small square ALLOW more molecules have the energy to react IGNORE more successful collisions OR collide more frequently DO NOT ALLOW explanation is in terms of two activation energies (i.e. 'catalyst explanation')
	Total	10	

Question			Answer	Marks	Guidance
24	(a)		Structural isomers: <i>1 mark</i> Different structural formulae AND same molecular formula ✓ Common molecular formula: <i>1 mark</i> C_5H_{12} for all 3 hydrocarbons ✓	5	For 'structural': ALLOW different structure OR different displayed/ skeletal formula DO NOT ALLOW any reference to spatial/space/3D Same formula is not sufficient (no 'molecular') Different arrangement of atoms is not sufficient (no 'structure'/'structural') ALLOW 5 carbons and 12 hydrogens ALLOW for 2 marks: Different structural formulae AND same molecular formula ✓ of C_5H_{12} ✓
			Boiling point and branching: <i>1 mark</i> Boiling point decreases with more branching OR more methyl/alkyl groups/side chains OR shorter carbon chain ✓ Branching and London forces: <i>1 mark</i> <i>Could be seen anywhere within response</i> More branching gives less (surface) contact AND fewer/weaker London forces ✓ Energy and intermolecular forces: <i>1 mark</i> Less energy to break London forces/ intermolecular forces/intermolecular bonds/ ✓		Comparisons needed throughout ORA throughout ALLOW comparison between any alcohols, e.g. A is least branched and has highest b pt C is most branched and has lowest b pt ALLOW induced dipole(–dipole) interactions IGNORE van der Waals'/vdw forces ALLOW SA for surface area ALLOW 'harder to overcome intermolecular forces' ALLOW more energy to separate the molecules IGNORE just 'bonds' intermolecular/London forces required

Question			Answer	Marks	Guidance				
	(b)	(i)	Radical substitution ✓	1	ALLOW Free radical substitution				
	(b)	(ii)	<table border="1"><tr><td>A</td><td>B</td></tr><tr><td>3 ✓</td><td>4 ✓</td></tr></table>	A	B	3 ✓	4 ✓	2	
A	B								
3 ✓	4 ✓								
	(b)	(iii)	Structure of D Structure of a trichloro isomer of A, e.g.  ALLOW any trichloro isomer of A CHECK carefully Equation $\text{C}_5\text{H}_{12} + 3\text{Cl}_2 \rightarrow \text{C}_5\text{H}_9\text{Cl}_3 + 3\text{HCl}$ ✓ Molecular formulae required NO ECF from incorrect structure of D	2	ALLOW correct structural OR displayed OR skeletal formula OR mixture of the above (as long as unambiguous) IGNORE molecular formula ALLOW multiples, e.g. $2\text{C}_5\text{H}_{12} + 6\text{Cl}_2 \rightarrow 2\text{C}_5\text{H}_9\text{Cl}_3 + 6\text{HCl}$				
			Total	10					

Question			Answer	Marks	Guidance
25	(a)	(i)	 F ✓  G ✓  H ✓	3	ALLOW correct structural OR displayed OR skeletal formulae OR mixture of the above (as long as unambiguous) IGNORE molecular formula ALLOW CH₃– ALLOW 1 mark for G AND H combined if structures are correct but in wrong boxes
	(a)	(ii)	2-methylpropan-1-ol ✓ <i>Both numbers required</i>	1	IGNORE absence of hyphen or use of dots or commas as separators DO NOT ALLOW OR OR 2-methylprop-1-ol 2-methpropan-1-ol 2-methypropan-1-ol

Question	Answer	Marks	Guidance
(b) (i)	ANNOTATE ANSWER WITH TICKS AND CROSSES Curly arrows 2 marks curly arrow from OH⁻ to C atom of C-Br bond ✓ dipole shown on C-Br bond, C^{δ+} and Br^{δ-}, AND curly arrow from C-Br bond to Br atom ✓  IGNORE incorrect R groups for curly arrow marks IGNORE presence of Na⁺/Na but OH⁻ needed i.e. Na⁺OH⁻; NaOH⁻ can be allowed with correct use of curly arrow Products 1 mark correct organic product AND Br⁻ ✓  IGNORE presence of Na⁺ but Br⁻ needed i.e. Na⁺Br⁻/NaBr⁻ can be allowed BUT NaBr does NOT show Br⁻ NOTE: curly arrows can be straight, snake-like, etc. but NOT double headed or half headed arrows	3	1st curly arrow must - go to the C of C-Br AND - start from, OR be traced back to any point across width of lone pair on O of OH⁻  OR start from – charge on O of ⁻OH ion (Lone pair NOT needed if curly arrow shown from O⁻) 2nd curly arrow must start from, OR be traced back to, any part of C-Br bond and go to Br  ALLOW S_N1 mechanism for 2 curly arrow marks First mark Dipole shown on C-Br bond, C^{δ+} and Br^{δ-}, AND curly arrow from C-Br bond to Br atom ✓  Second mark Curly arrow from OH⁻ AND to correct carbocation  Use curly arrow criteria in guidance above

Question			Answer	Marks	Guidance
	(b)	(ii)	Disappearance of peak at 500–800 cm⁻¹ OR C–Br peak ✓ Appearance of peak at 3200–3600 cm⁻¹ OR alcohol O–H peak ✓	2	ALLOW value within range 500–800 cm⁻¹ ALLOW value within range 3200–3600 cm⁻¹ DO NOT ALLOW responses that only describe the spectrum shown
			Total	9	

OCR (Oxford Cambridge and RSA Examinations)
The Triangle Building
Shaftesbury Road
Cambridge
CB2 8EA

OCR Customer Contact Centre

Education and Learning

Telephone: 01223 553998

Facsimile: 01223 552627

Email: general.qualifications@ocr.org.uk

www.ocr.org.uk

For staff training purposes and as part of our quality assurance programme your call may be recorded or monitored

Oxford Cambridge and RSA Examinations
is a Company Limited by Guarantee
Registered in England
Registered Office; The Triangle Building, Shaftesbury Road, Cambridge, CB2 8EA
Registered Company Number: 3484466
OCR is an exempt Charity

OCR (Oxford Cambridge and RSA Examinations)
Head office
Telephone: 01223 552552
Facsimile: 01223 552553

© OCR 2018

