

GCE

Chemistry A

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

Advanced Subsidiary GCE

Mark Scheme for June 2017

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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 will not enter into any discussion or correspondence in connection with this mark scheme.

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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

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**.

Please ask for help or guidance whenever you need it. Your first point of contact is your Team Leader.

SECTION A

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

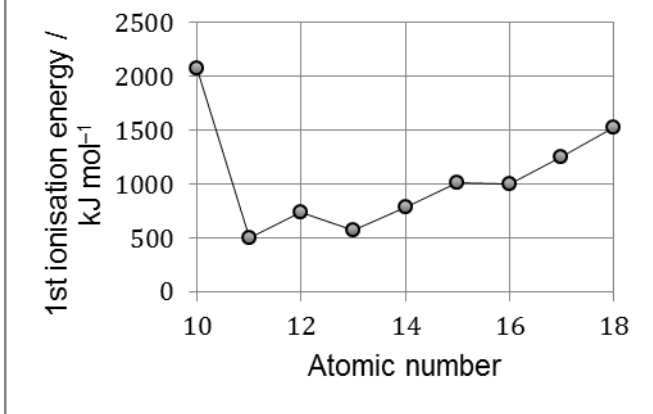
SECTION B

Question			Answer	Marks	Guidance
21	(a)	(i)		3	<p>ALLOW structural OR displayed OR skeletal formula OR mixture of the above (as long as unambiguous)</p> <p>For connectivity,</p> <p>ALLOW $\begin{array}{c} \\ \text{OH} \end{array} \quad \begin{array}{c} \\ \text{CH}_3 \end{array} \quad \text{CH}_3\text{---} \quad \text{C}_3\text{H---}$</p> <p>DO NOT ALLOW OH---</p>
		(ii)	$\text{H}^+/\text{acid}/\text{H}_2\text{SO}_4/\text{H}_3\text{PO}_4 \checkmark$	1	<p>ALLOW HCl</p> <p>IGNORE (aq) OR 'dilute' OR concentrated</p>
	(b)	(i)	<p>Correct repeat unit (<i>n</i> and brackets not required) ✓</p> <p>Equation balanced with <i>n</i> ✓</p> <p>TAKE CARE of '<i>n</i>' position on both sides of equation.</p>	2	<p>For monomer, ALLOW correct molecular OR structural OR displayed OR skeletal formula OR mixture of the above (as long as unambiguous)</p> <p>For repeat unit, DO NOT ALLOW molecular formula</p> <p>NOTE: 'side bonds' ARE required on either side of repeat unit from C atoms</p> <p>ALLOW section of polymer containing more than one repeat unit</p> <p>NO ECF from incorrect repeat unit</p>

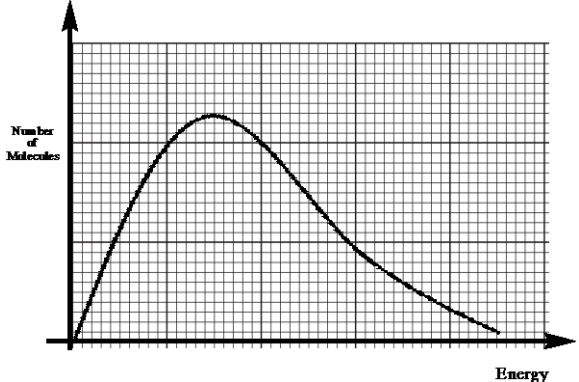
Question			Answer	Marks	Guidance
		(ii)	Formation of HCl/hydrochloric acid/ OR chlorine ✓	1	ALLOW Cl or Cl ₂ for chlorine IGNORE toxic waste products <i>Response must reflect chlorine in some way</i>
Total				7	

Question			Answer				Marks	Guidance
22	(a)	(i)	<i>m/z</i>	protons	neutrons	electrons	2	
			24	12	12	11		
			25	12	13	11		
			26	12	14	11		
			Mark vertically: protons AND neutrons ✓ electrons ✓					
		(ii)	FIRST CHECK THE ANSWER ON THE ANSWER LINE If answer = 24.32 award 2 marks $\frac{(24 \times 78.99) + (25 \times 10.00) + (26 \times 11.01)}{100}$ OR 24.320 OR 24.3202 ✓ = 24.32 (to 2 DP) ✓				2	ALLOW ECF for a correct calculation to 2 DP if: • %s have been used with wrong isotopes ONCE OR • decimal places for ONE % have been transposed

Question	Answer	Marks	Guidance
(b)	<p>Observations linked to anion identifications ✓ Bubbles/effervescence/fizzing/gas AND carbonate (white OR precipitate) AND sulfate ✓</p> <p>Use of molar mass in reasoning Molar mass used ONCE with carbonate OR sulfate ✓</p> <p>Identification</p> <p>B: K_2CO_3 ✓ C: Na_2SO_4 ✓</p>	5	<p>FULL ANNOTATIONS WITH TICKS, CROSSES, CON, etc MUST BE USED For bubbles, ALLOW carbon dioxide/CO_2 BUT DO NOT ALLOW hydrogen/H_2</p> <p>For carbonate, ALLOW CO_3 For sulfate, ALLOW SO_4</p> <p>e.g. Carbonate: $140 - (12 + 48)$; $140 - 60$ Sulfate: $140 - (32.1 + 64)$; $140 - 96.1$ $K_2CO_3 = 138.1$ $Na_2SO_4 = 142.1$</p> <p>ALLOW ONE of the two identification marks for:</p> <ul style="list-style-type: none"> • Correct names: B potassium carbonate AND C sodium sulfate • Incorrect formulae i.e. B KCO_3 AND C $NaSO_4$ <i>Communicates the same as names</i>

Question	Answer	Marks	Guidance
(c) (i)	 <p>Ne (Z = 10) shown higher than 1500 (i.e. > Ar) ✓</p>	1	<p>Look carefully for small dots on the y axis</p> <p>IGNORE no straight line from Ne (10) to Na (11)</p>
(c) (ii)	$\frac{500}{6.02 \times 10^{23}} = 8.3 \times 10^{-22} \text{ (kJ) } \checkmark$ <p>Answer MUST be to 2 SF AND in standard form.</p>	1	<p>ALLOW use of IEs close to 500 giving a range: $8.0 \times 10^{-22} - 8.6 \times 10^{-22}$ i.e. $8.3 \pm 0.3 \times 10^{-22}$</p>
(c) (iii)	<p><i>Nuclear charge</i> number of protons/proton number increases OR greater nuclear charge ✓</p> <p><i>Distance/shielding</i> (Outer) electrons are in the same shell OR (Outer) electrons experience the same/similar shielding OR Atomic radius decreases ✓</p> <p><i>Attraction</i> Greater nuclear attraction (on outer electrons) OR (outer) electrons are attracted more strongly (to the</p>	3	<p>FULL ANNOTATIONS WITH TICKS, CROSSES, CON, etc MUST BE USED</p> <p>Comparison should be used for each mark IGNORE atomic number increases IGNORE nucleus gets bigger IGNORE 'effective nuclear charge increases'</p> <p>IGNORE same sub-shell OR same orbital</p> <p>IGNORE 'there is shielding' ALLOW 'greater repulsion from inner shells'</p> <p>ALLOW 'pull' for 'attraction'</p> <p>IGNORE just 'greater attraction' OR greater force</p>

Question		Answer	Marks	Guidance
		nucleus) ✓		IGNORE 'held' for attracted, e.g. IGNORE 'held more strongly'
(c)	(iv)	<p>Sub-shells Mg electron is removed from (3)s AND Al electron is removed from (3)p ✓</p> <p>Energy levels Al electron has a higher energy OR (3)p has higher energy than (3)s ✓</p>	2	<p>IGNORE number before s and p e.g. ALLOW (2)s and (2)p ALLOW response implying that orbitals/sub-shell changes from s to p</p> <p>IGNORE comments about distance from nucleus IGNORE 'less energy to remove'</p> <p>DO NOT ALLOW unpaired electron removed more easily (ORA)</p>
Total			16	

Question		Answer	Marks	Guidance
23	(a)	 <p>Correct drawing of Boltzmann distribution Curve starts within two small squares of origin AND not touching the x axis at high energy ✓</p> <p>axes labels: y: (number of) molecules/particles</p>	4	<p>FULL ANNOTATIONS WITH TICKS, CROSSES, CON, etc MUST BE USED</p> <p>IGNORE a slight inflexion on the curve</p> <p>DO NOT ALLOW two curves <i>Confusion with effect of temperature</i></p>

Question	Answer	Marks	Guidance
	<p>AND x: (kinetic) energy ✓</p> <p>Catalyst and activation energy Catalyst provides a lower activation energy OR E_c shown below E_a on Boltzmann distribution ✓</p> <p>More molecules/particles/collisions have energy above activation energy (with catalyst) OR greater area under curve above activation energy ✓</p>		<p>DO NOT ALLOW 'atoms' as y-axis label</p> <p>DO NOT ALLOW 'enthalpy' for x-axis label</p> <p>ALLOW 'more molecules have enough energy to react'</p> <p>IF y axis labelled as 'atoms' ALLOW ECF for atoms (instead of molecules/particles)</p> <p>IGNORE (more) successful collisions IGNORE response implying 'more collisions' (<i>confusion with effect of greater temperature</i>)</p>
(b)	<p>Two max ✓✓ from:</p> <ul style="list-style-type: none"> • Lower temperatures/less heat/less thermal energy • Less fossil fuels/oil/coal/gas/non-renewable fuels • Reduces CO₂ emissions 	2	<p>IGNORE lower pressures OR less energy (<i>in question</i>)</p> <p>IGNORE just 'less fuel'</p> <p>IGNORE less global warming IGNORE less greenhouse gases, less CO, less NO <i>CO₂ required</i></p>
(c)	<p>FIRST, CHECK THE ANSWER ON ANSWER LINE IF answer = 14.6 (dm² mol⁻⁶) award 2 marks</p> <hr/> <p>K_c expression $(K_c =) \frac{[\text{CH}_3\text{OH}]}{[\text{CO}] [\text{H}_2]^2}$ OR $\frac{0.26}{0.31 \cdot 0.24^2}$ OR 14.56 ✓</p>	2	<p>FULL ANNOTATIONS MUST BE USED</p> <hr/> <p>IF there is an alternative answer, check to see if there is any ECF credit possible using working below.</p> <hr/> <p>ALLOW calculated value 14.5609319 correctly rounded to 3 or more SF for 1st marking point</p> <p>ALLOW ECF to 3 SF ONLY from inverted K_c expression</p>

Question			Answer	Marks	Guidance
			Answer to 3 SF 14.6 (dm ⁶ mol ⁻²) ✓		→ 0.0687 DO NOT ALLOW $\frac{[\text{CH}_3\text{OH}]}{[\text{CO}] + [\text{H}_2]^2} = 0.707$ (no marks)
			Total	8	

Question		Answer	Marks	Guidance	
24	(a)	(Acid) releases H ⁺ ions/ H ⁺ donor AND (weak acid) partially dissociates/ionises ✓	1	ALLOW H ⁺ OR proton IGNORE vague responses that do not imply a number, e.g. <ul style="list-style-type: none"> poor proton donor IGNORE 'doesn't easily dissociate' IGNORE 'a strong acid completely dissociates' <i>Question is about a weak acid</i>	
	(b)	(i)	$2 \text{ Al(s)} + 6 \text{ CH}_3\text{COOH(aq)} \rightarrow 2 \text{ (CH}_3\text{COO)}_3\text{Al(aq)} + 3 \text{ H}_2\text{(g)} \checkmark$	1	ALLOW multiples, e.g. $\text{Al(s)} + 3\text{CH}_3\text{COOH(aq)} \rightarrow \text{(CH}_3\text{COO)}_3\text{Al(aq)} + 1\frac{1}{2}\text{H}_2\text{(g)}$
		(ii)	Element oxidised: aluminium/Al 0 to +3 ✓ Element reduced: hydrogen/H +1 to 0 ✓	2	ALLOW 3+ for +3 and 1+ for +1 ALLOW H ₂ for hydrogen ALLOW 1 mark for elements AND all oxidation numbers correct, but H in oxidised line and Al in reduced line '+' is required in +3 and +1 oxidation numbers IGNORE numbers around equation <i>(treat as rough working)</i>

Question	Answer	Marks	Guidance
(c) (i)	<p>FIRST CHECK THE ANSWER ON THE ANSWER LINE If answer = 2.21 (mol dm⁻³) award 4 marks</p> <p>-----</p> <p>TITRATION</p> <p>M1 $n(\text{Ba}(\text{OH})_2)$ in 25.0 cm³ = 1.125×10^{-3} (mol) ✓</p> <p>M2 $n(\text{CH}_3\text{COOH})$ in 25.45 cm³ diluted vinegar = $2 \times 1.125 \times 10^{-3}$ = 2.25×10^{-3} (mol) ✓</p> <p>-----</p> <p>SCALING ALLOW ECF from $n(\text{CH}_3\text{COOH})$</p> <p>M3 $[\text{CH}_3\text{COOH}]$ in diluted vinegar = $\frac{2.25 \times 10^{-3} \times 1000}{25.45}$ = 0.0884 (mol dm⁻³) ✓ Calculator: 0.0884086</p> <p>M4 $[\text{CH}_3\text{COOH}]$ in original vinegar = $\frac{0.0884 \times 250}{10.0}$ = 2.21 (mol dm⁻³) ✓</p>	4	<p>FULL ANNOTATIONS MUST BE USED</p> <p>-----</p> <p>ALLOW 3 SF or more correctly rounded throughout Apply ECF where appropriate</p> <p>ALLOW ECF from $n(\text{Ba}(\text{OH})_2)$</p> <p>-----</p> <p>ALTERNATIVE APPROACHES FOR M3 AND M4:</p> <p>-----</p> <p>M3 $n(\text{CH}_3\text{COOH})$ in 25.45 cm³ original vinegar = $\frac{2.25 \times 10^{-3} \times 250}{10.0}$ = 0.05625 (mol) ✓</p> <p>M4 $[\text{CH}_3\text{COOH}]$ in original vinegar = $\frac{0.05625 \times 1000}{25.45}$ = 2.21 (mol dm⁻³) ✓</p> <p>-----</p> <p>M3 $n(\text{CH}_3\text{COOH})$ in 250 cm³ diluted vinegar = $\frac{2.25 \times 10^{-3} \times 250}{25.45}$ = 0.0221 (mol) ✓</p> <p>M4 $[\text{CH}_3\text{COOH}]$ in original vinegar = $0.0221 \times \frac{1000}{250} \times \frac{250}{10.0}$ = 2.21 (mol dm⁻³) ✓</p>
(c) (ii)	<p>Assumption: Vinegar contains (ethanoic acid and) no other acids ✓</p> <p>Prediction: Experimental result is greater than conc of CH₃COOH OR conc of CH₃COOH is less than experimental result ✓</p>	2	<p>For credit, the response must refer to other acids IGNORE impurities, solution is pure, etc</p> <p>ONLY award the 'prediction' mark if 'assumption' mark is correct</p>
	Total	10	

Question		Answer	Marks	Guidance
2 5	(a) (i)	More energy is released by forming bonds than energy required when breaking bonds ✓	1	ORA Response needs link between energy, breaking and making bonds ALLOW 'bond breaking is endothermic' AND 'bond making is exothermic' ALLOW within labelled energy diagram
	(ii)	FIRST, CHECK THE ANSWER ON ANSWER LINE IF bond enthalpy = (+)612 (kJ mol⁻¹) award 3 marks IF bond enthalpy = (-)316 (kJ mol⁻¹) award 2 marks <i>Energy for bonds made (4 × C=O + 4 × O-H)</i> 4 × 805 + 4 × 464 OR 3220 + 1856 OR 5076 (kJ) ✓ <i>Energy for bonds broken (4 × C-H + 3 × O=O)</i> 4 × 413 + 3 × 498 OR 1652 + 1494 OR 3146 (kJ) ✓ <i>C=C bond enthalpy correctly calculated</i> C=C bond enthalpy = -1318 - 3146 + 5076 = (+)612 kJ mol ⁻¹ ✓ <i>Mark is for answer</i>	3	FULL ANNOTATIONS MUST BE USED ----- - IGNORE sign IGNORE sign ----- ALLOW ECF DO NOT ALLOW – sign COMMON ERRORS + 2106 omission of 3O=O 2 marks -3248 -1318 + 3146 - 5076 2 marks
	(b)	FIRST check the molar mass on answer line MUST be derived from $pV = nRT$, Award 4 marks for calculation for: • answer = 70 • OR answer that rounds to 69.9 OR 70.0	5	FULL ANNOTATIONS MUST BE USED ----- - If there is an alternative answer, check to see if there is any ECF credit possible using working

Question	Answer	Marks	Guidance
	<p>-----</p> <p>Rearranging ideal gas equation to make n subject</p> $n = \frac{pV}{RT} \checkmark$ <p>Substituting all values including conversion to Pa and m^3</p> $n = \frac{(101 \times 10^3) \times (82.5 \times 10^{-6})}{8.314 \times 373} \checkmark$ <p>$n = 2.68693073 \times 10^{-3} \rightarrow 2.69 \times 10^{-3}$ (mol) \checkmark unrounded rounded to 3 SF</p> <p>Calculation of molar mass, M</p> $M = \frac{m}{n} = \frac{0.1881}{2.68693073 \times 10^{-3}} = 70(.0) \text{ (g mol}^{-1}\text{)}$ $\rightarrow \frac{0.1881}{2.69 \times 10^{-3}} = 69.9 \text{ (g mol}^{-1}\text{)} \checkmark$ <p>Molecular formula of D $C_5H_{10} \checkmark$</p> <p>-----</p> <p>IF candidate has failed to derive suitable value of n, ALLOW value of M from 0.1881 AND 24000 with alkene closest to calculated value for last 2 marks See Guidance column.</p>		<p>below</p> <p>1st mark may be implicit by direct substitution of correct values below into rearranged equation.</p> <p>ONLY award this mark if n has been derived from correct rearranged ideal gas equation ALLOW 3 SF up to calculator value, correctly rounded</p> <p>NOTE: ALLOW 69.9 \rightarrow 70.0 AND 70 (2 SF) <i>Calculator from unrounded: 70.00552634</i></p> <p>ALLOW any unambiguous structure ALLOW ECF provided that formula given is an alkene and matches M calculated from 0.1881 AND $pV = nRT$</p> <p>-----</p> $M = \frac{0.1881}{82.5/24000} \text{ OR } \frac{0.1881}{3.4375 \times 10^{-3}}$ $= 54.72 \text{ OR } 54.7 \text{ OR } 55 \checkmark$ <p>ALLOW 54.68 from use of 3.44×10^{-3}</p> <p>From 54.72, ONLY ALLOW = $C_4H_8 \checkmark$</p>
	Total	9	

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