Oxford Cambridge and RSA

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.

Annotations available in RM Assessor

Annotation	Meaning
✓	Correct response
✗	Incorrect response
^	Omission mark
BOD	Benefit of doubt given
CON	Contradiction
RE	Rounding error
SF	Error in number of significant figures
ECF	Error carried forward
L1	Level 1
L2	Level 2
L3	Level 3
NBOD	Benefit of doubt not given
SEEN	Noted but no credit given
I	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.

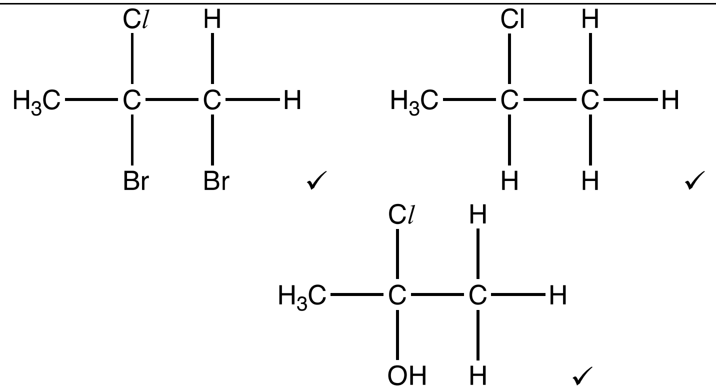
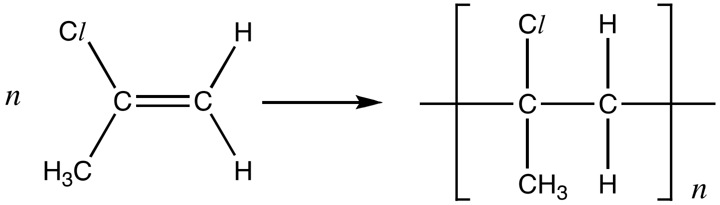
You should ensure also that you are familiar with the administrative procedures related to the marking process. These are set out in the OCR booklet **Instructions for Examiners**. If you are examining for the first time, please read carefully **Appendix 5 Introduction to Script Marking: Notes for New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

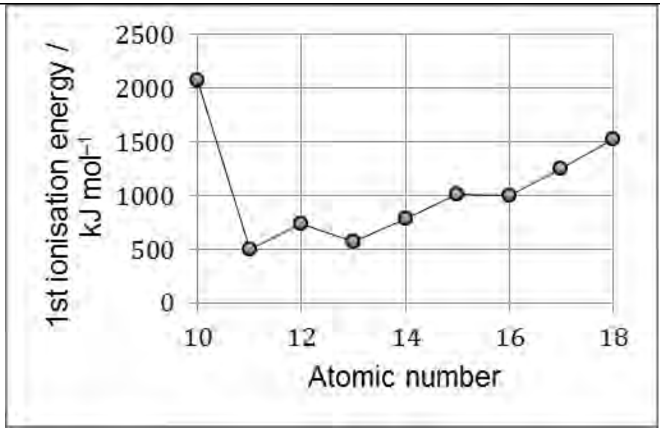
SECTION B

Question			Answer	Marks	Guidance
21	(a)	(i)		3	**ALLOW** structural **OR** displayed **OR** skeletal formula **OR** mixture of the above (as long as unambiguous) For connectivity, **ALLOW** | OH | CH_3 CH_3– C_3H– **DO NOT ALLOW** OH—
		(ii)	H^+/acid/H_2SO_4/H_3PO_4 ✓	1	**ALLOW** HCl **IGNORE** (aq) **OR** 'dilute' **OR** concentrated
	(b)	(i)	 Correct repeat unit (*n* and brackets not required) ✓ Equation balanced with *n* ✓ **TAKE CARE** of '*n*' position on both sides of equation.	2	**For monomer,** **ALLOW** correct molecular **OR** structural **OR** displayed **OR** skeletal formula **OR** mixture of the above (as long as unambiguous) **For repeat unit,** **DO NOT ALLOW** molecular formula **NOTE**: 'side bonds' **ARE** required on either side of repeat unit from C atoms **ALLOW** section of polymer containing more than one repeat unit **NO ECF** from incorrect repeat unit

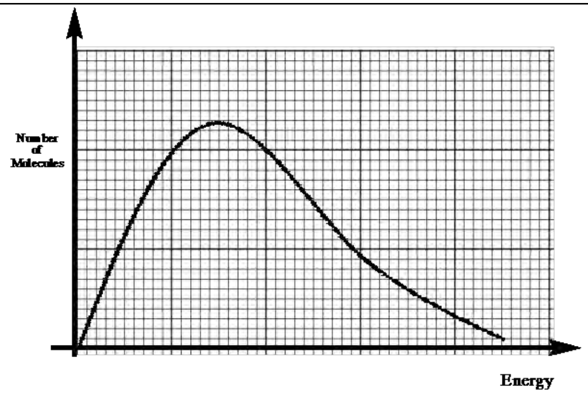
Question			Answer	Marks	Guidance
		(ii)	Formation of HCl/hydrochloric acid/ **OR** chlorine ✓	1	**ALLOW** Cl or Cl_2 for chlorine **IGNORE** toxic waste products *Response must reflect chlorine in some way*
			Total	7	

Question			Answer	Marks	Guidance
22	(a)	(i)	*m/z* | protons | neutrons | electrons 24 | 12 | 12 | 11 25 | 12 | 13 | 11 26 | 12 | 14 | 11 Mark vertically: protons **AND** neutrons ✓ electrons ✓	2	
		(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)		**Observations linked to anion identifications** Bubbles/effervescence/fizzing/gas **AND** carbonate ✓ (white **OR** precipitate) **AND** sulfate ✓ **Use of molar mass in reasoning** Molar mass used **ONCE** with carbonate **OR** sulfate ✓ **Identification** **B:** K_2CO_3 ✓ **C:** Na_2SO_4 ✓	5	**FULL ANNOTATIONS WITH TICKS, CROSSES, CON, etc MUST BE USED** For bubbles, **ALLOW** carbon dioxide/CO_2 **BUT** **DO NOT ALLOW** hydrogen/H_2 For carbonate, **ALLOW** CO_3 For sulfate, **ALLOW** SO_4 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 **ALLOW ONE** of the two identification marks for: • Correct names: **B** potassium carbonate **AND C** sodium sulfate • Incorrect formulae i.e. **B** KCO_3 **AND C** $NaSO_4$ *Communicates the same as names*

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

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

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

Question			Answer	Marks	Guidance
			AND x: (kinetic) energy ✓ ***Catalyst and activation energy*** Catalyst provides a lower activation energy **OR** E_c shown below E_a on Boltzmann distribution ✓ More molecules/particles/collisions have energy above activation energy (with catalyst) **OR** greater area under curve above activation energy ✓		**DO NOT ALLOW** 'atoms' as y-axis label **DO NOT ALLOW** 'enthalpy' for x-axis label **ALLOW** 'more molecules have enough energy to react' **IF** y axis labelled as 'atoms' **ALLOW ECF** for atoms (instead of molecules/particles) **IGNORE** (more) successful collisions **IGNORE** response implying 'more collisions' *(confusion with effect of greater temperature)*
	(b)		***Two max ✓✓ from:*** • Lower temperatures/less heat/less **thermal** energy • Less fossil fuels/oil/coal/gas/non-renewable fuels • Reduces CO_2 emissions	2	**IGNORE** lower pressures **OR** less energy *(in question)* **IGNORE** just 'less fuel' **IGNORE** less global warming **IGNORE** less greenhouse gases, less CO, less NO *CO_2 required*
	(c)		**FIRST, CHECK THE ANSWER ON ANSWER LINE** **IF answer = 14.6 ($dm^2\ mol^{-6}$) award 2 marks** --- ***K_c* expression** $(K_c =)\ \frac{[CH_3OH]}{[CO]\,[H_2]^2}$ **OR** $\frac{0.26}{0.31 \times 0.24^2}$ **OR** 14.56 …… ✓	2	**FULL ANNOTATIONS MUST BE USED** --- **IF** there is an alternative answer, check to see if there is any **ECF** credit possible using working below. --- **ALLOW** calculated value 14.5609319 correctly rounded to 3 or more SF for 1st marking point **ALLOW ECF to 3 SF ONLY** from inverted K_c expression

Question			Answer	Marks	Guidance
			Answer to 3 SF 14.6 ($dm^6\ mol^{-2}$) ✓		$\rightarrow$ 0.0687 **DO NOT ALLOW** $\frac{[CH_3OH]}{[CO] + [H_2]^2}$ = 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. • poor proton donor **IGNORE** 'doesn't easily dissociate' **IGNORE** 'a strong acid completely dissociates' *Question is about a weak acid*
	(b)	(i)	**2** Al(s) + **6** $CH_3COOH(aq) \rightarrow$ **2** $(CH_3COO)_3Al(aq)$ + **3** $H_2(g)$ ✓	1	**ALLOW** multiples, e.g. Al(s) + **3**$CH_3COOH(aq) \rightarrow (CH_3COO)_3Al(aq)$ + **1½**$H_2(g)$
		(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 *(treat as rough working)*

Question			Answer	Marks	Guidance
	(c)	(i)	**FIRST CHECK THE ANSWER ON THE ANSWER LINE** **If answer = 2.21 (mol dm^{-3}) award 4 marks** -- **TITRATION** **M1** $n(Ba(OH)_2)$ in 25.0 cm^3 = = $\mathbf{1.125 \times 10^{-3}}$ (mol) ✓ **M2** $n(CH_3COOH)$ in 25.45 cm^3 **diluted** vinegar = $\mathbf{2} \times 1.125 \times 10^{-3}$ = $\mathbf{2.25 \times 10^{-3}}$ (mol) ✓ -- **SCALING** **ALLOW ECF** from $n(CH_3COOH)$ **M3** $[CH_3COOH]$ in **diluted** vinegar $= \frac{2.25 \times 10^{-3} \times 1000}{25.45}$ = **0.0884** (mol dm^{-3}) ✓ Calculator: 0.0884086 **M4** $[CH_3COOH]$ in **original** vinegar $= \frac{0.0884 \times 250}{10.0}$ = **2.21** (mol dm^{-3}) ✓	4	**FULL ANNOTATIONS MUST BE USED** -- **ALLOW 3 SF** or more correctly rounded throughout Apply **ECF** where appropriate **ALLOW ECF** from $n(Ba(OH)_2)$ -- **ALTERNATIVE APPROACHES FOR M3 AND M4:** -- **M3** $n(CH_3COOH)$ in 25.45 cm^3 **original** vinegar $= \frac{2.25 \times 10^{-3} \times 250}{10.0}$ = 0.05625 (mol) ✓ **M4** $[CH_3COOH]$ in **original** vinegar $= \frac{0.05625 \times 1000}{25.45}$ = 2.21 (mol dm^{-3}) ✓ -- **M3** $n(CH_3COOH)$ in 250 cm^3 **diluted** vinegar $= \frac{2.25 \times 10^{-3} \times 250}{25.45}$ = 0.0221 (mol) ✓ **M4** $[CH_3COOH]$ in **original** vinegar $= 0.0221 \times \frac{1000}{250} \times \frac{250}{10.0}$ = 2.21 (mol dm^{-3}) ✓
	(c)	(ii)	***Assumption*:** Vinegar contains (ethanoic acid and) **no other acids** ✓ ***Prediction*:** Expermental result is greater than conc of CH_3COOH **OR** conc of CH_3COOH is less than experimental result ✓	2	For credit, the response **must** refer to other **acids** **IGNORE** impurities, solution is pure, etc **ONLY award the 'prediction' mark if 'assumption' mark is correct**
			Total	**10**	

Question			Answer	Marks	Guidance
25	(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** *Energy for bonds made (4 × C=O + 4 × O–H)* 4 × 805 + 4 × 464 **OR** 3220 + 1856 **OR** 5076 (kJ) ✓ *Energy for bonds broken (4 × C–H + 3 × O=O)* 4 × 413 + 3 × 498 **OR** 1652 + 1494 **OR** 3146 (kJ) ✓ *C=C bond enthalpy correctly calculated* C=C bond enthalpy = –1318 – 3146 + 5076 = (+)612 kJ mol^{-1} ✓ *Mark is for answer*	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
			-- *Rearranging ideal gas equation to make n subject* $n = \frac{pV}{RT}$ ✓ *Substituting all values including conversion to Pa and m*^{3} $n = \frac{(101 \times 10^3) \times (82.5 \times 10^{-6})}{8.314 \times 373}$ ✓ $n = 2.68693073 \times 10^{-3} \rightarrow 2.69 \times 10^{-3}$ (mol) ✓ unrounded rounded to 3 SF *Calculation of molar mass, M* $M = \frac{m}{n} = \frac{0.1881}{2.68693073 \times 10^{-3}}$ = 70(.0) (g mol^{-1}) $\rightarrow \frac{0.1881}{2.69 \times 10^{-3}}$ = 69.9 (g mol^{-1}) ✓ *Molecular formula of* **D** C_5H_{10} ✓ -- **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.**		**below** 1st mark may be implicit by direct substitution of correct values below into rearranged equation. **ONLY award this mark if *n* has been derived from correct rearranged ideal gas equation** **ALLOW 3 SF up to calculator value, correctly rounded** **NOTE: ALLOW** 69.9 → 70.0 **AND** 70 (**2 SF**) *Calculator from unrounded: 70.00552634* **ALLOW** any unambiguous structure **ALLOW ECF** provided that formula given is an alkene and matches *M* calculated from 0.1881 **AND** *pV = nRT* -- **M =** $\frac{0.1881}{82.5/24000}$ **OR** $\frac{0.1881}{3.4375 \times 10^{-3}}$ = 54.72 **OR** 54.7 **OR** 55 ✓ **ALLOW** 54.68 from use of 3.44×10^{-3} From **54.72, ONLY ALLOW** = C_4H_8 ✓
			Total	**9**	

OCR (Oxford Cambridge and RSA Examinations)
1 Hills Road
Cambridge
CB1 2EU

OCR Customer Contact Centre

Education and Learning
Telephone: 01223 553998
Facsimile: 01223 552627
Email: general.qualifications@ocr.org.uk

www.ocr.org.uk

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