

GCE

Chemistry A

H032/01: Breadth in chemistry

Advanced Subsidiary GCE

Mark Scheme for November 2020

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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.

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Annotations

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

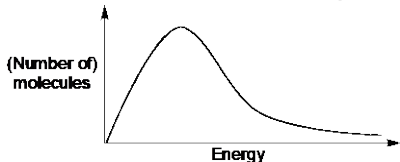
SECTION A

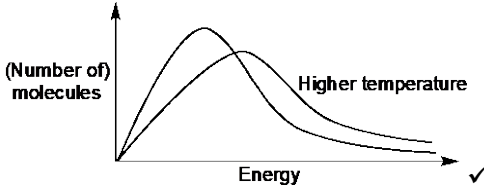
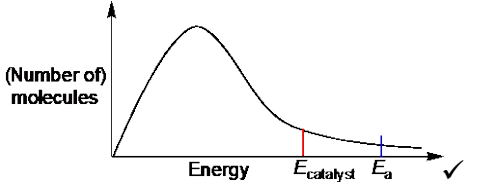
Question	Answer	Marks	AO element	Guidance
1	C	1	1.2	
2	C	1	1.2	
3	B	1	1.1	
4	A	1	1.1	
5	A	1	2.1	
6	A	1	1.2	
7	B	1	1.2	
8	C	1	1.2	ALLOW 4
9	A	1	2.2	
10	B	1	2.6	
11	C	1	2.6	
12	D	1	1.1	
13	B	1	1.2	ALLOW 0.054(0)
14	A	1	1.2	
15	C	1	1.1	
16	C	1	1.1	
17	A	1	1.2	
18	C	1	2.8	ALLOW 36.7
19	B	1	1.2	
20	C	1	2.6	
	Total	20		

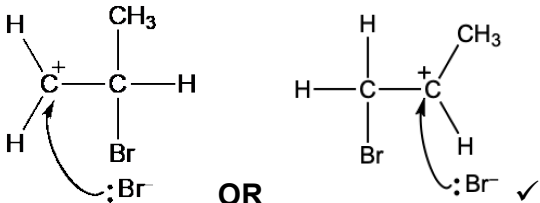
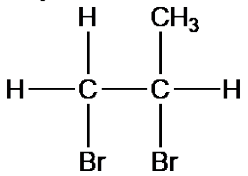
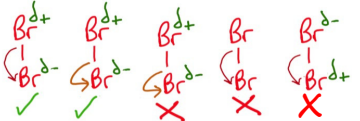
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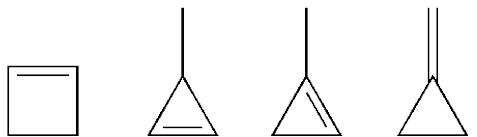
Question		Answer	Marks	AO element	Guidance
(c)		FIRST CHECK ANSWER LINES If molecular formula = BrF₅ AND 174.6/175 AND working showing use of ideal gas equation Award 5 marks for calculation ----- Rearranging ideal gas equation $n = \frac{pV}{RT}$ ✓ Unit conversion AND substitution into $n = \frac{pV}{RT}$: • $R = 8.314$ OR 8.31 • $V = 76(.0) \times 10^{-6} \text{ (m}^3\text{)}$ • $T \text{ in K: } 373 \text{ K}$ e.g. $\frac{1.00 \times 10^5 \times 76.0 \times 10^{-6}}{8.314 \times 373}$ ✓ Calculation of n using p, V, R AND T $n = 2.45 \times 10^{-3} \text{ (mol)}$ ✓ Calculation of M $M = \frac{0.428}{2.45 \times 10^{-3}} = 174.6$ ✓ Molecular formula BrF₅ OR F₅Br ✓	5	2.2×4	ALLOW ECF throughout IF $n = \frac{pV}{RT}$ is omitted, ALLOW when values are substituted into rearranged ideal gas equation. ALLOW conversion of V into dm³ AND p in kPa <i>Gives same answer in powers of 10</i> Calculator value: from 8.314 = 2.450725899 × 10⁻³ from 8.31 = 2.45190555 × 10⁻³ IGNORE figures after 5 in 2.45 ALLOW ECF from a value of n that has been derived from $pV = nRT$ e.g. 0.174.6 OR 0.175 from 2.45 ALLOW ECF matching ECF M from $pV = nRT$
	Use of 24 dm ³	Final 2 marks possible for use of 76.0 cm³ OR 0.760 dm³ by ECF e.g. $n = \frac{76.0}{24000} = 3.17 \times 10^{-3}$ No mark (calculation much simpler) $M = \frac{0.428}{3.17 \times 10^{-3}} = 135$ ✓ ECF BrF₃ ✓ ECF			

Question			Answer	Marks	AO element	Guidance
	(b)	(ii)	FIRST CHECK ANSWER ON THE ANSWER LINE If answer = 0.0856 (mol dm⁻³) award 3 marks $n(\text{HNO}_3) = 0.160 \times \frac{26.75}{1000} = 4.28 \times 10^{-3} \text{ (mol) } \checkmark$ $n(\text{Ba(OH)}_2) \text{ in } 25.0 \text{ cm}^3 = \frac{4.28 \times 10^{-3}}{2} = 2.14 \times 10^{-3} \text{ (mol) } \checkmark$ Concentration = $2.14 \times 10^{-3} \times \frac{1000}{25} = 0.0856 \text{ (mol dm}^{-3}\text{) } \checkmark$	3	2.8×2 2.4	Use ECF throughout DO NOT ALLOW 4.3×10^{-3} BUT remaining marks available by ECF e.g. $4.3 \times 10^{-3} \div 2 = 2.15 \times 10^{-3} \checkmark$ ECF $2.15 \times 10^{-3} \times \frac{1000}{25} = 0.086 \checkmark$ ECF
	(c)		Route 1 <i>Reactant:</i> Add water (to Ba) OR H₂O in equation $\checkmark$ <i>Balanced equation:</i> $\text{Ba} + 2\text{H}_2\text{O} \rightarrow \text{Ba(OH)}_2 + \text{H}_2 \checkmark$ Route 2 <i>Balanced equation with O₂</i> $2\text{Ba} + \text{O}_2 \rightarrow 2\text{BaO} \checkmark$ <i>Balanced equation with H₂O</i> $\text{BaO} + \text{H}_2\text{O} \rightarrow \text{Ba(OH)}_2 \checkmark$	4	3.3 2.6 3.3 3.3	ALLOW multiples in equations Balanced equation automatically collects 2 marks for Route 1 ALLOW 1 mark for BOTH reactants in route 2: i.e. React with O₂ AND then with H₂O NOTE 3 correct balanced equations → 4 marks

Question		Answer	Marks	AO element	Guidance
24	(a)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = -46 (kJ mol^{-1}) award 3 marks Use of $\Delta_c H$ values and balancing numbers $\pm (+180 + (3 \times -286))$ OR ± 678 AND $\pm (2 \times -293)$ OR ± 586 seen anywhere ✓ Correct subtraction using ΔH $(-678) - (-586)$ $= -92$ (kJ mol^{-1}) ✓ Calculation of $\Delta_f H(\text{NH}_3)$ formation $\Delta_f H(\text{NH}_3) = \frac{-92}{2} = -46$ (kJ mol^{-1}) ✓	3	2.6×3	FULL ANNOTATIONS MUST BE USED ALLOW ECF throughout COMMON ERRORS -92 omission of $\div 2$ for $\Delta_f H(\text{NH}_3)$ 2 marks $(+)$46 Incorrect subtraction 2 marks $(+)$92 Incorrect subtraction & no $\div 2$ 1 mark -385 no $\times 2$ for -293 and no $\div 2$ 1 mark -192.5 no $\times 2$ for -293 2 marks $(+)$480 no $\times 3$ for -286 and no $\div 2$ 1 mark $(+)$240 no $\times 3$ for -286 2 marks $(+)$187 no $\times 3$ for -286 AND no $\times 2$ for -293 AND no $\div 2$ 1 mark $(+)$93.5 no $\times 3$ for -286 AND no $\times 2$ for -293 2 marks
	(b)	Boltzmann distribution (seen anywhere) 2 marks  Curve Curve starts close to origin (ALLOW flexibility) AND curve does not touch x axis at high energy ✓ Labels (NumberOf) molecules/particles AND Energy ✓	5	1.1×2	FULL ANNOTATIONS THROUGHOUT NOTE: Look for marking criteria within annotations on Boltzmann distribution diagram IGNORE slight inflexion on the curve IGNORE small increase at end of curve For labels, ALLOW kinetic energy IGNORE number of atoms IGNORE enthalpy for energy

Question	Answer	Marks	AO element	Guidance
	Curves for two temperatures 1 mark  Catalyst and activation energy 1 mark  Molecules and activation energy, E_a 1 mark Explanation At higher temperature OR in presence of catalyst More molecules/particles/collisions • have energy above activation energy OR have enough energy to overcome E_a ✓ <i>Could be shown on diagram(s) using shaded area with annotations</i>		1.2×3	Temperature Drawing of two labelled curves AND higher temperature peak at higher energy AND lower on molecules IGNORE curves meeting at higher energy Higher temperature curve must cross over ASSUME that T_2 is higher temperature than T_1 Catalyst E_c shown at lower energy than E_a on Boltzmann distribution IGNORE catalyst provides a lower activation energy <i>Boltzmann distribution not used</i> ALLOW more molecules have energy to react ALLOW E_a for activation energy ALLOW E_c for activation energy with catalyst IGNORE more successful collisions OR collide more frequently

Question	Answer	Marks	AO element	Guidance
	3rd curly arrow Correct carbocation with + charge on C with 3 bonds AND curly arrow from Br⁻ to C⁺ of carbocation DO NOT ALLOW δ+ on C of carbocation  <i>i.e. ALLOW carbonium + on either C atom</i> Correct product to match mechanism ✓  DO NOT ALLOW half headed or double headed arrows but allow ECF if seen more than once		2.5 2.5	 3rd curly arrow must - go to the C⁺ of carbocation AND start from, OR be traced back to any point across width of lone pair on :Br⁻ OR start from – charge on Br⁻ ion  (Lone pair NOT needed if curly arrow shown from – charge on Br⁻) ALLOW bromonium ion ALLOW any combination of skeletal OR structural OR displayed formula as long as unambiguous NOTE: For a mechanism with HBr, ALLOW all marks EXCEPT for final product
(c)	(i) (series of organic compounds with the) same functional group OR same/similar reactions / chemical properties ✓ each successive member differs by CH₂ ✓	2	1.1×2	IGNORE reference to physical properties IGNORE same general formula DO NOT ALLOW same empirical OR molecular formula Differs by CH₂ is not sufficient (<i>no successive</i>) ALLOW differs by CH₂ each time AW

Question			Answer	Marks	AO element	Guidance
	(c)	(ii)	C_nH_{2n-2} ✓	1	3.2	ALLOW $C_nH_{2(n-1)}$
	(c)	(iii)	$H_3C-C \equiv C-H + 2Br_2 \longrightarrow \begin{array}{c} Br & Br \\ & \\ H_3C-C & -C-H \\ & \\ Br & Br \end{array}$ Left-hand side, i.e. Reactants, balanced with $2Br_2$ ✓ Right-hand side, i.e. Product ✓	2	2.5 2.6	ALLOW any combination of skeletal OR structural OR displayed formula as long as unambiguous ALLOW C_3H_4 for $H_3CC \equiv CH$ <i>Questions asks only for structure of product</i> ALLOW $H_3CCBr_2CHBr_2$ OR $H_3CCBr_2CBr_2H$
	(c)	(iv)	Any 2 structures from: $H_3C-C \equiv C-CH_3$ $H_2C=C(H)-C(H)=CH_2$ $H_2C=C=C(H)-CH_3$ 	2	3.2×2	ALLOW any combination of skeletal OR structural OR displayed formula as long as unambiguous
	(c)	(v)	$H_3C-\overset{\overset{CH_3}{ }}{C}-C \equiv C-\overset{\overset{CH_3}{ }}{C}-CH_2-CH_3$ ✓	1	2.5	ALLOW any combination of skeletal OR structural OR displayed formula as long as unambiguous

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