GCE

Chemistry B

H033/02: Chemistry in depth

Advanced Subsidiary GCE

2021 Mark Scheme (DRAFT)

This is a DRAFT mark scheme. It has not been used for marking as this paper did not receive any entries in the series it was scheduled for. It is therefore possible that not all valid approaches to a question may be captured in this version. You should give credit to such responses when marking learner's work.

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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.

1. **Annotations**

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

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

Annotation	Meaning
/	alternative and acceptable answers for the same marking point
✓	Separates marking points
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

3. **Subject-specific Marking Instructions**

INTRODUCTION

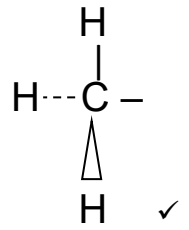
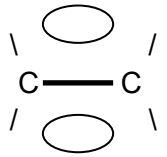
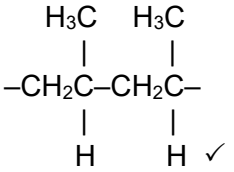
Your first task as an Examiner is to become thoroughly familiar with the material on which the examination depends. This material includes:

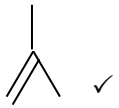
- the specification, especially the assessment objectives
- the question paper
- the mark scheme.

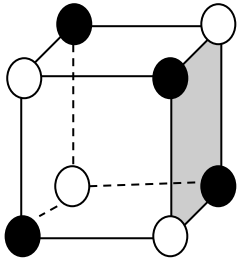
You should ensure that you have copies of these materials.

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.

Question			Answer	Marks	AO element	Guidance
1	(a)	(i)	 ✓ bond angle = 109.5 ° ✓	2	1.1(x2)	For MP1 there must be a solid wedge and a dashed line/dashed wedge in either position. **IGNORE** any connection of C- to rest of molecule. **ALLOW** 109 - 110
		(ii)	  pi (π)-bond ✓	1	1.1	**ALLOW** variations on the pi-bond, for example:  However, there must be one above and one below the sigma-bond as drawn Discuss what is acceptable at SSU.
	(b)	(i)	 ✓	1	2.5	**ALLOW** any unambiguous formula
		(ii)	add bromine water (and shake) **AND** (the bromine will) turn from orange/brown to colourless if there is (any) unreacted monomer **OR** (the bromine will) remain orange/brown if there is no unreacted monomer ✓	1	2.7	

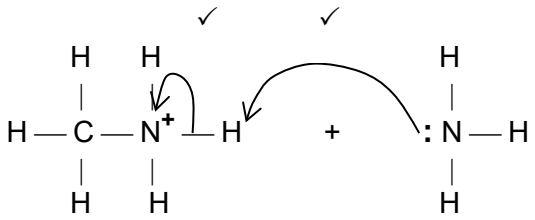
	(c)		$CH_3CH^+CH_2Cl$ ✓	**1**	**2.5**	
	(d)	**(i)**	(In but-2-ene) both groups on each C-atom (of the double bond) are different / (in propene) one of the C-atoms (of the double bond) has two atoms / groups that are the same / has two H-atoms ✓	**1**	**2.1**	
		(ii)	 ✓  ✓	**2**	**2.1(x2)**	
			Total	**9**		

Question			Answer	Marks	AO element	Guidance
2	(a)	(i)	$NaCl + H_2SO_4 \rightarrow HCl + NaHSO_4$	1	1.2	**ALLOW** equations forming Na_2SO_4 $2NaCl + H_2SO_4 \rightarrow 2HCl + Na_2SO_4$ **IGNORE** state symbols
		(ii)	phosphoric acid	1	1.1	
		(iii)	 If black are marked as positive, white must be marked as negative and vice-versa ✓	1	1.1	
	(b)	(i)	**X** is hydrogen bromide ✓ red/brown vapour is bromine ✓	2	3.1 3.2	
		(ii)	Add silver nitrate solution ✓ Off white/cream ppt (of silver bromide) ✓	2	3.3 3.4	
	(c)		Any **two** from 1.Less than 240 cm^3 of water should be used ✓ (otherwise) rinsing cannot occur ✓ 2 The glass rod should be rinsed (before removal) ✓ (otherwise) some (named) solute/solid is removed ✓ ~~6~~7 The (volumetric) flask should be inverted (several times) ✓ (in order to) thoroughly/properly mix the solution ✓	4	3.4 (x4)	the numbers 1, 2 and 6 are the numbers in the procedure in the QP and may/may not be included in an answer

2	**(d)**	**(i)**	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 0.0471 (mol dm^{-3}) award 3 marks** amount HCl = 23.55/1000 x 0.1 (= 2.355 x 10^{-3}) ✓ conc Na_2CO_3 = 0.5 x 2.355 X 10^{-3} x 1000/25 ✓ = 0.0471 (mol dm^{-3}) to 3 sf ✓	**3**	**3.1** **2.8** **3.1**	**ALLOW** ecf MP3 is scored by any calculated number to 3 sf
		(ii)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 7 award 4 marks** mass of hydrate in 1 dm^3 = 1.46 x 4 = 5.84 g ✓ mass of Na_2CO_3 in 1 dm^3 = 2.51 x 10^{-2} x106 = 2.66 g ✓ Mass of water = 5.84 – 2.66 = 3.18 g Amount of water = 3.18/18 = 0.177 mol ✓ Ratio = 0.177/0.0251 = 7 ✓	**4**	**2.8 (x4)**	**ALLOW** ecf **ONLY** award MP4 if it is given as a whole number
	(e)	**(i)**	$2I^- \rightarrow I_2 + 2e^-$ ✓	**1**	**1.2**	**ALLOW** $I^- \rightarrow \frac{1}{2}I_2 + e^-$ $2I^- - 2e \rightarrow I_2$ $I^- - e \rightarrow \frac{1}{2}I_2$ electron symbol with or without minus **IGNORE** state symbols
		(ii)	Bromine attracts electrons more (strongly) (AW) than iodine ✓	**1**	**1.1**	**ALLOW** Br has fewer electrons/less shielding than I so attracts an extra electron more (strongly)
		(iii)	(dissolved) iodine ✓	**1**	**1.2**	
			Total	**21**		

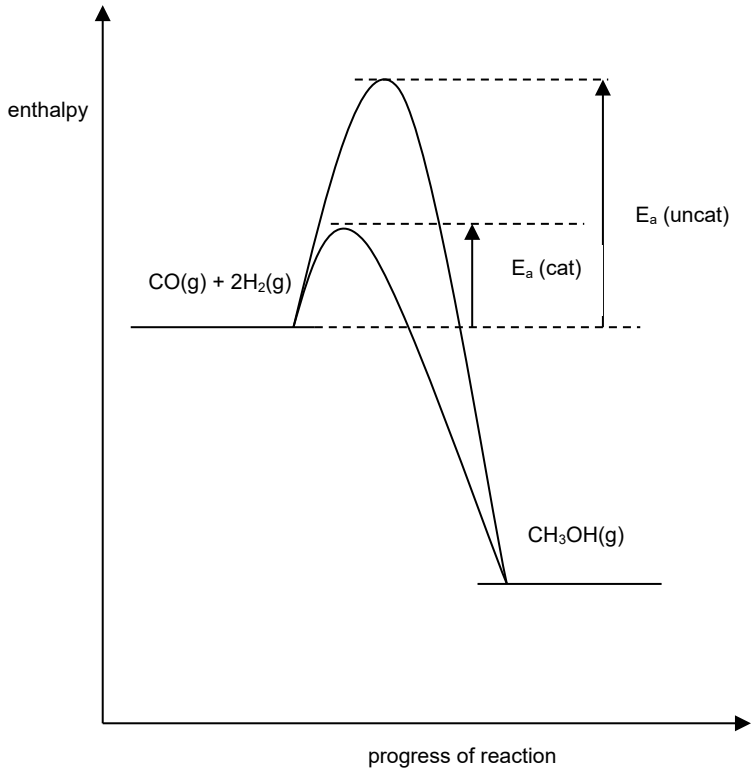
Question			Answer	Marks	AO element	Guidance
3	(a)		homolytic (fission) / homolysis ✓	1	1.2	
	(b)		**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 1.16 x 10^{15} (Hz) award 3 marks** Energy needed to break one O-H bond = (ΔH(O-H)/N_A) = 463 / 6.02 x 10^{23} = 7.69 x 10^{-22} (J) ✓ Conversion of kJ to J = 7.69 x 10^{-19} (J) ✓ υ = E/h 7.69 x 10^{-19} / 6.63 x 10^{-34} = 1.16 x 10^{15} (Hz) ✓	3	2.6 (x3)	The working for an incorrect answer **MUST** be checked in detail. Candidates may multiply/divide the numbers in a different order (or even combine steps) to that shown in the answer column so the order of/the numbers in this method of working may not necessarily be seen. However, candidates should show evidence (explicit or implicit) of using E = hυ (✓), and dividing by both the Planck constant and the Avogadro constant (✓) and converting between J and kJ (✓).
	(c)	(i)	C*l* + C*l*O **AND** C*l*O + C*l* ✓	1	1.2	
		(ii)	trichlorofluoromethane ✓	1	1.2	**IGNORE** use of hyphens

	(d)*		Please refer to the marking instructions on page 5 of this mark scheme for guidance on how to mark this question. **Level 3 (5–6 marks)** Learners give a detailed account of imb's in CH_3OH, CH_3Cl and CH_4 (*with most fine detail)* **AND** use the relationship between strength of imb and bp **AND** give correct order of bp. *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Level 2 (3–4 marks)** Learners give a detailed account of imb's in two out of three of CH_3OH, CH_3Cl and CH_4 *(with most fine detail)* **AND** give the relationship between strength of imb and bp **or** give correct order of bp **OR** a brief account of imb's in all three *(with some fine detail)* **AND** the correct order of bp *There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.* **Level 1 (1–2 marks)** Learners give a detailed account of imb's in one out of three of CH_3OH, CH_3Cl and CH_4 *(with most fine detail)* **AND** give correct order of bp **OR** a brief account of imb's in two out of three **OR** the correct order of bp *There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.* **0 marks** *No response or no response worthy of credit.*	**6**	**2.1 (x3)** **3.2 (x3)**	**Indicative scientific points include:** *(fine detail in italic)* **CH_3OH** • attraction is a very strong imb • hydrogen bond • *(contains) highly electronegative O (atom)* • *bonded to a H (atom)* • *O-H bond is highly polar* • *H atom is very small* • *H gets very close to O (on neighbouring molecule)* • *lone pair on O 'lines up' with H (on neighbouring molecule) / form directional bond between O and H* **CH_3Cl** • permanent dipole-permanent dipole/pd-pd bonds • not as strong as hydrogen bonds • *(contains) electronegative Cl (atom)* • *C-Cl bond is polar* • *permanent dipole in CH_3Cl* **CH_4** • instantaneous dipole – induced dipole bonding/ Van der Waals'/ London • weaker than pd-pd • *no electronegative atom* • *molecule is non-polar* • *unequal distribution of electron density* • *causes temporary dipole in CH_4* • *induces dipole in neighbouring CH_4* **Relationship of bond strength to bpt** • stronger the imb, the higher the bpt **Order of boiling points** • order of b.p. is $CH_3OH > CH_3Cl > CH_4$

	(e)	**(i)**	$CH_3Cl + H_2O \rightarrow CH_3OH + HCl$ ✓	**1**	**1.2**	
		(ii)	bromomethane **AND** the C-Br bond enthalpy is lower/weaker than the C-C*l* bond enthalpy ✓	**1**	**2.3**	
		(iii)	nucleophilic **AND** substitution ✓	**1**	**1.2**	
	(f)		**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 3.8 x 10^8 (dm^3) award 4 marks** M_r (CH_3Cl) = 50.5 n (CH_3Cl) = (8.0 x 10^2 x10^6 / 50.5) = 1.58 x 10^7 mol ✓ (pV = nRT) V = nRT/p ✓ V = [1.58 x 10^7 x 8.314 x (16+273) / 1.00 x 10^5] = 3.81 x 10^5 m^3 ✓ V = 3.8 x 10^8 dm^3 ✓	**4**	**2.2 (x4)**	**ALLOW** ecf
	(g)	**(i)**		**2**	**2.5 (x2)**	Curly arrows should start (when projected back if necessary) on the relevant bond or lone pair of N in NH_3 and end (when projected forward if necessary) on the atom concerned or the bond about to be formed.
		(ii)	~~Ammonia reacts with methylamine~~ methylamine (also) reacts with chloromethane ✓	**1**	**2.5**	**ALLOW** answer shown as a drawn mechanism
			Total	**22**		

Question			Answer	Marks	AO element	Guidance
4	(a)		(In a position of dynamic equilibrium, the) concentrations of reactants and products do remain constant ✓ (The) forward and reverse reactions have not stopped ✓ (but) occur at equal rates ✓	3	3.2 (x3)	
	(b)	(i)	$K_c = [CH_3OH] / [CO][H_2]^2$ ✓	1	1.1	
		(ii)	**CHECK ANSWER ON ANSWER LINE** **If answer = 0.113 (mol dm^{-3}) award 2 marks** $[H_2] = \sqrt{([CH_3OH]/ K_c [CO])}$ ✓ $[H_2] = 0.113$ (mol dm^{-3}) ✓	2	2.4	**ALLOW** ecf

	(c)*		Please refer to the marking instructions on page 5 of this mark scheme for guidance on how to mark this question. **Level 3 (5–6 marks)** Learners give an account of **BOTH** yield and rate for **BOTH** pressure and temperature *(with some explanatory points)* and draw a conclusion *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Level 2 (3–4 marks)** Learners give an outline account of **BOTH** yield and rate for **BOTH** pressure and temperature **OR** Learners give a detailed account of **EITHER** yield **OR** rate for **BOTH** pressure and temperature **OR** yield and rate for one of temp/pressure *(with some explanatory points)* *There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.* **Level 1 (1–2 marks)** Learners give an outline account of **EITHER** yield **OR** rate for **EITHER** pressure **OR** temperature *There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.* **0 marks** *No response or no response worthy of credit.*	**6**	**2.1(x3)** **3.2(x3)**	**Indicative scientific points include:** *(explanatory points in italic)* **High pressure - yield** • increase yield of methanol / shifts to rhs • poe shifts to side with fewer moles (of gas) • *if change made to system in equilibrium the poe shifts to oppose change (LCP (statement included either here and/or for 'low temp – yield')* • *as this will reduce the pressure* **High pressure - rate** • increase rate of reaction • *reacting particles are closer together* • *collide more frequently* **Low temperature - yield** • increase yield of methanol • poe shifts in direction of exothermic reaction • *forward reaction is exothermic / gives out heat* • *this will increase the temperature* **Low temperature - rate** • decrease rate of reaction • *reacting particles have less energy* • *fewer collisions have required act. en.* **Conclusions** • temperature is compromise rate/yield • high pressure is good (AW) • limited by cost/safety

	(d)		 labelled energy level of CH_3OH below that of reactants ✓ enthalpy profile **AND** E_a label for uncatalysed reaction ✓ enthalpy profile **AND** E_a label for catalysed reaction lower than that for uncatalysed reaction ✓	**3**	**1.1 (x3)**	**DO NOT ALLOW** double-ended arrows for E_a **IGNORE** an arrow for ΔH
		(ii)	heterogeneous ✓	**1**	**1.1**	
		(iii)	bond fission/breaking in reactants ✓ (bond) fusion/making in product ✓	**2**	**1.1 (x2)**	
			Total	**18**		

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