

**GCE**

**Chemistry B (Salters)**

Unit **H033/01**: Foundations of chemistry

Advanced Subsidiary GCE

**Mark Scheme for June 2016**

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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
	Benefit of doubt not given
	Noted but no credit given
	Ignore
	Blank page

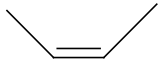
Abbreviations, annotations and conventions used in the detailed Mark Scheme (to include abbreviations and subject-specific conventions).

<b>Annotation</b>	<b>Meaning</b>
/	alternative and acceptable answers for the same marking point
✓	Separates marking points
<b>DO NOT ALLOW</b>	Answers which are not worthy of credit
<b>IGNORE</b>	Statements which are irrelevant
<b>ALLOW</b>	Answers that can be accepted
( )	Words which are not essential to gain credit
—	Underlined words must be present in answer to score a mark
<b>ECF</b>	Error carried forward
<b>AW</b>	Alternative wording
<b>ORA</b>	Or reverse argument

## SECTION A

Question	Answer	Marks	AO element
1	C	1	1.1
2	B	1	1.1
3	C	1	1.2
4	B	1	2.5
5	C	1	1.1
6	A	1	1.1
7	B	1	1.1
8	D	1	1.2
9	B	1	1.2
10	D	1	2.5
11	A	1	2.4
12	D	1	2.5
13	C	1	2.1
14	D	1	2.4
15	D	1	2.1
16	C	1	1.2
17	D	1	2.7
18	D	1	2.2
19	C	1	2.4
20	B	1	1.1

Question		Answer	Marks	AO element	Guidance
21	(a)	mass number 56 protons 28 neutrons 28	1	2.2	
	(b)	$(28 \times 92.17) + (29 \times 4.71) + (30 \times 3.12)$ /100 = 28.1(095) ✓ 28.11 (2dp) ✓	2	1.2 1.2	<b>NO</b> ecf 28.11 alone on the answer line scores 1 mark without some evidence of working. Answers to other dp without working score zero.
	(c) (i)	1. (Add NiCO <sub>3</sub> to H <sub>2</sub> SO <sub>4</sub> ) until fizzing/reaction stops/all sulfuric acid has reacted ✓ 2. filter (prior to crystallisation) ✓ 3. (partially) <u>evaporate</u> ✓ 4. Filter the crystals/pick out the crystals/leave crystals to dry/fully evaporate to produce crystals ✓	4	1.2 1.2 1.2 1.2	2. <b>IGNORE</b> what is being filtered but <b>NOT</b> nickel sulfate 3. <b>ALLOW</b> a word derived from evaporate e.g. evaporation 4. boiling to dryness <b>CON</b> pt 4, <b>ALLOW</b> products/NiSO <sub>4</sub> .6H <sub>2</sub> O for "crystals" fully evaporate to produce crystals scores pts 3 & 4
	(ii)	<b>A</b> no – this would have resulted in a higher mass/yield ✓ <b>B</b> no – nickel carbonate is added in <u>excess</u> AW/ moles of sulphuric acid are the limiting factor/(excess)nickel carbonate is removed ✓ <b>C</b> yes – loss of water would reduce <u>mass</u> (AW) ✓	3	3.1 3.1 3.1	for each mark, 'yes' or 'no' (or 'correct'/'incorrect') must be stated (or implied) and the reason given. <b>ALLOW</b> weight for mass
			10		

Question		Answer	Marks	AO element	Guidance
22	(a)	(2-)methylpropene	1	1.2	<b>IGNORE</b> dashes, commas and gaps <b>ALLOW</b> .....prop-1-ene <b>ALLOW</b> minor spelling errors
	(b)		1	2.5	<b>ALLOW</b> any unambiguous representation of the structure but <b>NOT</b> C for CH <sub>3</sub> <b>IGNORE</b> name
	(c) (i)	water/steam <b>AND</b> phosphoric/ concentrated sulfuric acid	1	1.2	<b>ALLOW</b> names of acids (including oxidation states) or formulae (c.H <sub>2</sub> SO <sub>4</sub> , H <sub>2</sub> SO <sub>4</sub> (l), H <sub>3</sub> PO <sub>4</sub> ) but if name <b>AND</b> formula present both must be correct. <b>IGNORE</b> isobutylene/2-methylpropene
	(c) (ii)	tertiary <b>AND</b> OH/functional group attached/bonded to C that has... no H atoms <b>or</b> 3 C/methyl/alkyl/R (groups)	1	1.1	<b>IGNORE</b> 'it' for 'OH' <b>ALLOW</b> Alcohol/hydroxyl group attached to C..... <b>NOT</b> hydroxide
	(iii)	(heat with) acidified dichromate(VI) ✓  A/tertiary has no reaction/stays orange /doesn't change colour. Others/primary/secondary go green/change colour ✓	2	3.4  3.4	<b>Mark separately</b> <b>ALLOW</b> correct formulae <b>ALLOW</b> sulfuric acid or sulfuric(VI) acid as replacement for acidified. <b>IGNORE</b> formulae if names correct <b>ALLOW</b> dichromate without 'VI' as long as no other number is there
	(iv)	forms the weakest/smallest/ fewest instantaneous (dipole) – induced dipole bonds/forces ✓  smallest surface area <b>OR</b> non-linear molecules are unable to get closer together/align AW ✓	2	2.1  1.2	<b>Mark separately</b> <b>IGNORE</b> references to other intermolecular bonding <b>ALLOW</b> weaker/smaller/fewer <b>ALLOW</b> Van der Waal's forces or London forces <b>DO NOT ALLOW</b> id-id in first instance <b>ALLOW</b> minor spelling errors  <b>ALLOW</b> 'less contact between molecules'
	(d) (i)	Ether/alkoxy/methoxy	1	1.2	
	(ii)	C <sub>4</sub> H <sub>8</sub> + CH <sub>4</sub> O → C <sub>5</sub> H <sub>12</sub> O	1	2.6	must be molecular formulae as shown <b>ALLOW</b> element symbols in any order <b>IGNORE</b> state symbols
			10		

Question			Answer	Marks	AO element	Guidance
23	(a)	(i)	$\text{Cl}_2 + 2\text{Br}^- \rightarrow 2\text{Cl}^- + \text{Br}_2$	1	1.2	<b>IGNORE</b> state symbols
		(ii)	chlorine is more reactive ..... and gains electrons more readily (than bromine) <i>ora</i> <b>OR</b> ..... and removes electrons from bromide/bromine (ions)	1	1.1	<b>IGNORE</b> other references to halides <b>IGNORE</b> references to electronegativity <b>IGNORE</b> "attract" <b>ALLOW</b> "accept"
	(b)	(i)	move through: $\text{Na}^+ \checkmark$ not through: $\text{Cl}^-$ <b>and</b> $\text{OH}^- \checkmark$	2	3.1 3.1	<b>IGNORE</b> $\text{H}^+$ any other ions are <b>CON</b> in each case <b>ALLOW</b> names of ions
		(ii)	$2\text{NaCl} + 2\text{H}_2\text{O} \rightarrow \text{Cl}_2 + \text{H}_2 + 2\text{NaOH}$	1	2.6	<b>ALLOW</b> multiples or halves <b>IGNORE</b> state symbols
		(iii)	100% since... no waste <b>or</b> all useful/desired products	1	3.2	<b>IGNORE</b> by-products
		(iv)	1. 37000/40 <b>OR</b> 925 $\checkmark$ 2. 925x24/2 <b>OR</b> 11100 $\checkmark$ 3. $1.1 \times 10^4 \text{ (dm}^3\text{)} \checkmark$ (2 sf and standard form)	3	2.2 2.2 2.2	Allow ecf from 1. and 2. No ecf from (b)(ii)  <b>without reference to working:</b> 1.1 x 10 <sup>4</sup> scores 3 marks 2.2 x 10 <sup>4</sup> scores 2 marks 11100 or 11000 score 2 marks 22000 or 22200 score 1 mark 11 or 1.1 x 10 <sup>1</sup> scores 2 marks 22 or 2.2 x 10 <sup>1</sup> scores 1 mark 9.3 x 10 <sup>2</sup> scores 2 marks 0.93 scores 1 mark
	(c)	(i)	-1, +5, 0	1	2.4	<b>NOT</b> signs after numbers <b>ALLOW</b> roman numerals (-I; +V)
		(ii)	(Br in) $\text{BrO}_3^-$ because oxidation state (of Br) goes down (+5 to 0)	1	1.2	<b>ALLOW</b> 'bromate' or 'bromate(V)' for $\text{BrO}_3^-$ <b>ALLOW</b> 'bromine reduced' <b>IF</b> correct oxidation states given <b>ALLOW</b> ecf on oxidation states from (c)(i)
				11		



Question			Answer	Marks	AO element	Guidance
24	(a)	(i)	atom/molecule/species/ ion with <u>unpaired</u> electron(s) ✓ formed from chloroalkanes/ R-Cl/ haloalkanes/ chlorine compounds/ CFCs/ C-Cl ✓ by high-energy/ high frequency ✓ uv ✓ homolytic (fission)✓	5	1.1 1.1 1.1 1.1 1.1	<b>IGNORE</b> 'single' 'lone' <b>ALLOW</b> 'it' for 'atom/molecule/species/ ion' <b>ALLOW</b> equation showing formation of radicals Mention of breakdown of Cl <sub>2</sub> <b>CONS</b> 2nd marking point <b>IGNORE</b> UVA for third marking point UVB and/or C covers both 3rd and 4th marking points. <b>ALLOW</b> homolysis
		(ii)	Cl + O <sub>3</sub> ----> ClO + O <sub>2</sub> ClO + O ----> Cl + O <sub>2</sub> ✓ O <sub>3</sub> + O ----> 2O <sub>2</sub> ✓	2	1.2 1.2	<b>Mark separately</b> <b>IGNORE</b> dots Cl + O <sub>3</sub> ----> ClO + O <sub>2</sub> ClO + O <sub>3</sub> ----> Cl + 2 O <sub>2</sub> and hence 2O <sub>3</sub> ----> 3O <sub>2</sub> scores 2 <sup>nd</sup> marking point only
	(b)	(i)	Y axis (concentration) correctly labelled with units and standard form ✓ X axis (time) correctly labelled with units ✓ Points plotted utilising over half of each axis ✓	3	2.6 2.6 2.6	Linear scale labelled with conc(entration) of ozone/O <sub>3</sub> <b>NOT</b> [O <sub>3</sub> ] <b>AND</b> units (molecules cm <sup>-3</sup> ). 10 <sup>12</sup> or 10 <sup>-12</sup> mentioned somewhere. Linear scale labelled with "Time" <b>AND</b> units. X and y axes swapped but otherwise correct scores only one of the first two marks. Exact position of points does not need checking. Line of best fit not essential but point to point or curved line is <b>CON</b>
		(ii)	4.979 – 4.983 x 10 <sup>12</sup> molecules cm <sup>-3</sup>	1	2.6	Minimum of 4 sf required
		(iii)	it remains constant (AW) <b>AND</b> the gradient is constant/straight line graph (AW)	1	2.7	<b>NOT</b> almost/fairly/nearly constant <b>IGNORE</b> references to negative rate

Question		Answer	Marks	AO element	Guidance
(c)		Rearrangement of gas equation to: $n = PV/RT$ ✓	4	2.5	can be implied by later working
		Conversion of volume units to $m^3$ ✓		2.6	can be implied from working
		$n = P \times \text{evaluated volume} / 8.314 \times 300$ ✓		2.6	ALLOW ecf if gas equation has been incorrectly rearranged wrong evaluation of this expression is <b>CON</b>
		Conversion of moles to molecules and evaluate to 2 or more sf. (correct answer is $2.4(1) \times 10^{17}$ ) ✓		2.6	<b>Correct answer alone scores 4 marks</b> <i>with no working:</i> $2.4 \times 10^{23}$ or $2.4 \times 10^{20}$ (incorrect conversion of v) scores 3 marks $4.0 \times 10^{-7}$ (no $N_A$ ) scores 3 marks 0.4..... (incorrect v and no $N_A$ ) scores 2 marks

Question	Answer	Marks	AO element	Guidance
(d)	<p>Choice of method:</p> <p><b>EITHER</b> Calculate the energy of 1 mole of photons and compare with bond enthalpy.            Calculate energy of one photon (<math>9.5 \times 10^{14} \times 6.63 \times 10^{-34}</math> OR <math>6.30 \times 10^{-19}</math>) ✓            Multiply up for 1 mole and convert to kJ (photon energy x <math>6.02 \times 10^{23}/1000</math>) ✓            Evaluate (379) and state whether bond will be broken. ✓</p> <p><b>OR</b> Compare the energy of one photon with one bond            Calculate energy of one photon (<math>9.5 \times 10^{14} \times 6.63 \times 10^{-34}</math> OR <math>6.30 \times 10^{-19}</math>) ✓            Calculate energy of one bond (<math>302 \times 1000/6.02 \times 10^{23}</math>) ✓            Evaluate both (<math>6.30 \times 10^{-19}</math> and <math>5.02 \times 10^{-19}</math>) and state whether bond will be broken. ✓</p> <p><b>OR</b> Calculate minimum frequency needed to break bond            Calculate energy required per molecule (<math>302000/6.02 \times 10^{23}</math>) ✓            Calculate required frequency of radiation (energy/<math>6.63 \times 10^{-34}</math>) ✓            Evaluate (<math>7.57 \times 10^{14}</math>) and state whether bond will be broken. ✓</p>	3		The 3 <sup>rd</sup> marking point can only be scored if the first 2 marks are scored OR if the only error is in conversion between J and kJ i.e. failure to convert or incorrect conversion
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