Oxford Cambridge and RSA

GCE

Chemistry B (Salters)

H433/03: Practical skills in chemistry

Advanced 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.

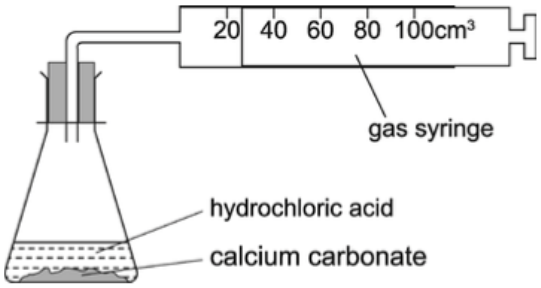
Mark schemes should be read in conjunction with the published question papers and the report on the examination.

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

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

Question			Answer	Mark	AO element	Guidance
1	(a)		sodium $2s^2\ 2p^6\ 3s^1$ ✓ magnesium ion $2s^2\ 2p^6$ ✓	2	1.1 x2	must be correct order and lower case
1	(b)		*Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question.* **Give some credit for thermal decomposition/stability but only to level 1 (1 – 2 marks)** **Level 3 (5 – 6 marks)** Describes full procedure (words or diagram) with most fine detail. **AND** Describes in full how the results should be interpreted, with most fine detail. *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)** Describes full procedure (words or diagram) with most fine detail. **OR** Describes the procedure with some fine detail omitted. **AND** Describes in how the results should be interpreted, with some fine detail omitted. *There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.*	6	3.1 3.2 x2 3.3 3.4 x2	**indicative scientific points may include:**  **Procedure AO3.3/4 (could all be from diagram and labels)** • apparatus as above (or collection over water) • Use of at least three named Group 2 carbonates • Add (hydrochloric) acid to carbonate flask or vice versa *Fine detail:* • rapid stoppering of flask after adding acid. • same concentration of acid • same volume of acid • same amount and particle size of carbonate • accept mass **Results and interpretation: AO3.1/2** **either** • measure time to collect a certain volume of gas • shorter time means faster rate *fine detail* • volume to collect is specified

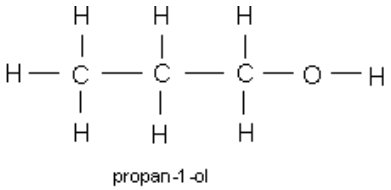
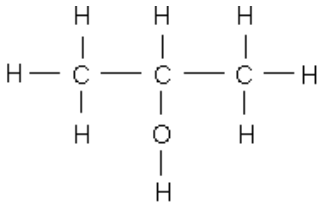
Question			Answer	Mark	AO element	Guidance
			Level 1 (1 – 2 marks) Describes procedure and interpretation of results with no fine detail. **OR** Describes the procedure with some fine detail omitted. **OR** Describes in how the results should be interpreted, with some fine detail omitted. *There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant and correct.* **Level 0** (no marks) No response or no response worthy of credit			• rate is proportional to 1/time (subsumes second point) • relating times/rates to trend down group **or** • plot graph of volume against time • gradient shows rate *fine detail* • sketch of graph • gradient at origin • relating rates to trend down group
1	**(c)**	**i**	heating until there is no further change to mass ✓	1	1.1	Ideas around mass doesn't change/remains constant/to constant mass
		ii	mass of CO_2 lost = 2.09 g so moles of CO_2 = 2.09/44 = 0.0475 ✓ 4.00g of MCO_3 = 0.0475 moles mass of 1 mole = 4.00/0.0477 = 84.2(105..) **OR** ✓ 1.91 g of MgO = .0475 mol Mass of 1 mol = 40.2 g mass of M = 84.2 – 60 (or 40.2 – 16) = 24.2 so M is magnesium/Mg ✓	3	3.1 3.1 3.2	Some CORRECT working must be shown to score marks It is possible to answer this question using an algebraic method…… as mols of carbonate and oxide formed are the same $\frac{4.00}{(x + 60)} = \frac{1.91}{(x + 16)}$ giving 2.09x = 50.6 x =24/Mg ALSO if Mg assumed only the use of 24 gives same number of moles of oxide as carbonate **Only scores last mark if method correct**

Question			Answer	Mark	AO element	Guidance
1	d		$\Delta_x H$ Lattice enthalpy ✓ $\Delta_y H$ hydration enthalpies of cation + anion/ions in the solvent ✓	2	1.2 x2	**ALLOW** LE and Hyd as abbreviations **ALLOW** solvation energy must be for both cation and anion **OR** ions
	e		More reactive is correct but not reason/ reactivities have nothing to do with it✓ (Student B is correct): barium has lower charge density(ora) / Ba^{2+} is larger than Ca^{2+}✓ attracts water molecules less (ora) ✓ less energy released (AW) (ora)✓	4	3.1 3.2 3.2 2.1	Look for "it isn't the reason / not reason"
			Total	**18**		

Question			Answer	Mark	AO element	Guidance
2	(a)	(i)	unsaturated…C=C / CC double bonds ✓ cis ....adjacent parts of chain next to each other around double bond (AW) ✓	2	1.1 x 2	i.e. avoids giving mark for C=O **ALLOW** π bonds in chains **NOT** just double bonds **ALLOW** H's/groups on same side/AW **NOT in same 'plane'**
2	(a)	ii	instantaneous dipole – induced dipole between (non-polar) chains ✓ permanent dipole-permanent dipole between C=O/C–O bonds (AW) ✓	2	2.1 x2	**ALLOW** both types of bond with inadequate locations for 1 mark **NOT** id-id? **NOT** pd-pd, unless correct term has to be used once; then allow pd .
		(iii)	(Chains in) Structure **A** pack better/closer together/more;points of contact ✓ Stronger imb / id-id✓ More energy/ higher temperature required to break bonds ✓	3	2.5 x 3	**ORA** throughout. **AW** close enough No need to specify but for example H bonding would be a **CON.** A**LLOW** id-id. **NOT** fewer bonds
2	(b)	i	solvent for ester/(organic) product formed ✓	**1**	2.3	
		ii	Removes/neutralises acid (impurity) ✓	**1**	1.2	**ALLOW** reacts with acid
		iii	removes water/dries/dehydrates the mixture ✓	**1**	1.2	
		iv	(about) boiling point of ester / cyclohexane boils off before ester ✓	**1**	2.7	So methyl benzoate is the only product/substance collected.. **ALLOW** only pure product.

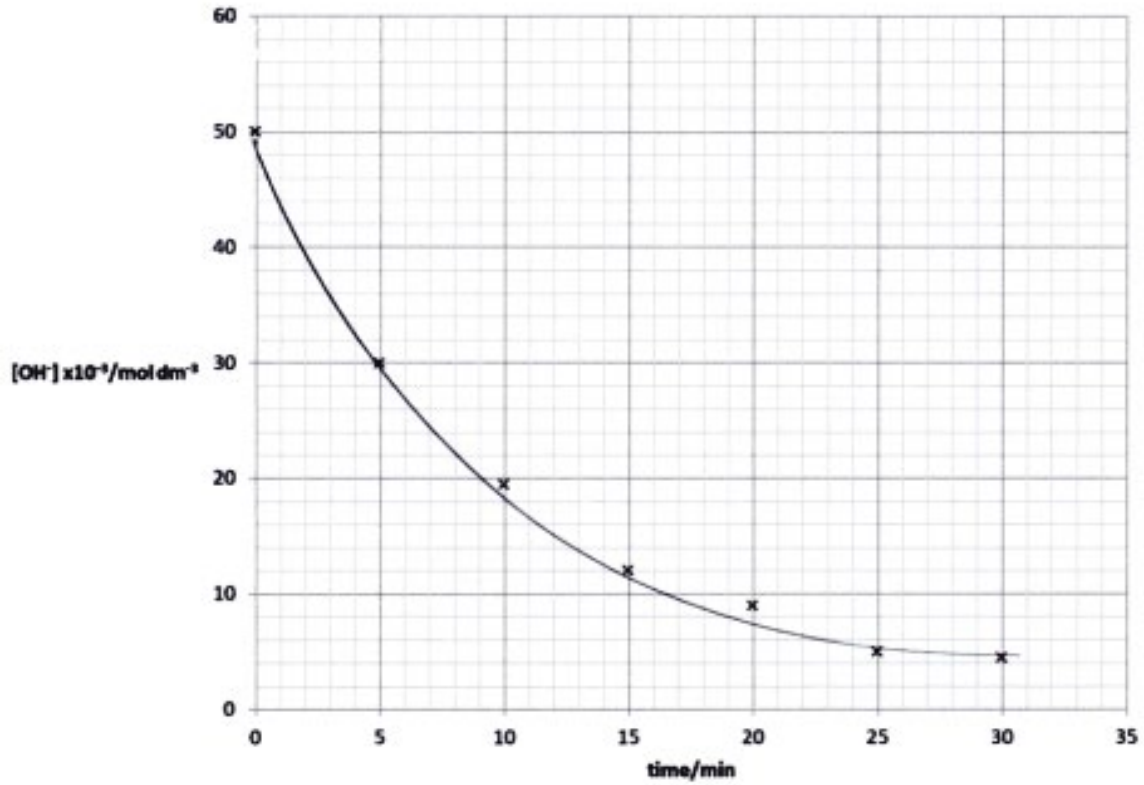
Question			Answer	Mark	AO element	Guidance
	(c)		**FIRST CHECK ANSWER ON THE ANSWER LINE** **If answer = 61(%) award 4 marks** 8.0g of benzoic acid is 8.00/122 = 0.066moles ✓ 100% conversion gives 0.066 x 136 =8.976g ✓ % yield is 5.46/8.92 x 100 = 61.2 / 60.8 ✓ two sf = **61**(%) ✓	4 2.6 x2 2.8 x2		ecf on values actual values depend on when rounding done **OR** mol ester = 5.46/136 = 0.04 **OR** % = 0.04 x 100 / 0.066 = 60.6
			Total	**15**		

Question			Answer	Mark	AO element	Guidance
3	(a)		**FIRST CHECK ANSWER ON THE ANSWER LINE** **If answer = –1520 / -1518 (kJmol^{-1}) award 3 marks** q =mc∆T = 100 x 4.18 x 11.5 = 4807 (J) ✓ moles of fuel burnt = 0.19/60 = 0.00317 / 0.00316 ✓ enthalpy change per mole=4807/0.00317= –1520 /-1518 (kJmol$^{-1)}$ ✓	3	2.8x3	**ALLOW** 2 or more sf, rounding in different steps **ALLOW** 4.2 negative sign needed for final mark
	(b)	i	**Any two from:** incomplete combustion ✓ evaporation of fuel ✓ evaporation of water ✓ non-standard condition ✓	2	3.3 x 2	
		ii	**Any one from:** a top for spirit burner when flame out ✓ Insulate(d) container ✓ draft shields ✓ lid on metal can ✓	1	3.4	**ALLOW** minimising distance between flame and can “lid” alone is enough

Question			Answer	Mark	AO element	Guidance
	(c)	i	 propan-1-ol  propan-2-ol ✓	1	1.2	
		ii	(average) bond enthalpies give energy required/given out to break/form a particular bond ✓ same number <u>and</u> type of bonds (broken and formed) ✓ energy given out when new bonds form greater than energy taken in to break old bonds ✓	3	1.2 2.1 2.1	**ALLOW** listing of all the bonds (broken and made)
			Total	**10**		

Question			Answer	Mark	AO element	Guidance
4	(a)		*Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question.* **Level 3 (5 – 6 marks)** Detailed procedure given on how to sample, quench and titrate. **AND** A detailed method for how to calculate the data in Table 4.1. *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)** Outline procedure given on how to sample, quench and titrate. **OR** Detailed procedure given for either sample OR quench OR titrate, with a second procedure given in outline. **OR** Detailed procedure given for either sample OR quench OR titrate. **AND** A detailed method for how to calculate the data in Table 4.1. *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)** Outline procedure given on how to sample OR quench OR titrate. **OR** An outline method for how to calculate the data in Table 4.1. *There is some attempt at a logical structure with a line of reasoning. The information present is in the most part relevant.*	6	3.3 x2 3.4 x3 2.8 x2	**indicative scientific points may include:** **Sampling and quenching reaction** • extract fixed volume of reaction mixture at regular time intervals • use a graduated/ volumetric pipette • one method of quenching reaction, eg: o rapid cool by adding to ice o add to large volume of water o adding to a fixed volume of excess acid of known concentration **Titration** either: • titrate sample with acid e.g hydrochloric acid • standard solution of acid **OR** • back titrate using standard solution of sodium hydroxide • standard solution of NaOH

Question	Answer	Mark	AO element	Guidance
	Level 0 (no marks) *No response or no response worthy of credit*			• In both cases a suitable acid base indictor must be used • colour change at end-point • drop by drop near end point **Calculation (2.8)** • $c_1V_1 = c_2V_2$ • c_1 is conc of acid and c_2 is unknown [OH^-] • V_1 is titre and V_2 is pipette volume

Question			Answer	Mark	AO element	Guidance
	(b)	i	 points✓ best fit✓	2	2.8 x2	**points** Allow +/- half squares **best fit** **ALLOW** Any sensible curve even those hand drawn!
		ii	7min and 7.5min / readings based on student graph ✓ working on graph ✓	2	2.4 x 2	**ALLOW** ecf on <u>student graph</u>
		iii	must be overall order because both concentrations are decreasing with time ✓ first order because half-lives / $t_{1/2}$ are same ✓	2	2.7 1.2	Mark separately from (b)(ii)

Question			Answer	Mark	AO element	Guidance
		iv	rds is slowest step in mechanism ✓ mechanism B has only one 'species' in the first step / If second step were rds, kinetics would be second order ✓	2	3.1 3.2	
	(c)	i	first order wrt each ✓ quintupling OH^- conc. (with haloalkane constant) quintuples rate and when haloalkane conc. doubled rate doubles (with OH^- constant)✓	2	2.8 x 2	
		ii	Rate = k[1-bromobutane][OH^-] ✓	1	2.4	**ALLOW** ecf from (c)(i) **ALLOW** a formula instead of '1-bromobutane' **ALLOW** bromobutane
			Total	**17**		

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