OCR
Oxford Cambridge and RSA

GCE

Chemistry B (Salters)

Unit **F335:** Chemistry by Design

Advanced 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

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

Annotation	Meaning
✓	correct response – there must be one tick for every one mark awarded
×	incorrect response – These should not be used for every mark lost; just use them in places where it makes your marking clearer.
bod	benefit of the doubt given. Please give a tick as well
nbod	benefit of the doubt **not** given
ECF	error carried forward
^	information omitted
I	Ignored
SEEN	to be used on any other page where there is a response but no other annotation
BP	indicates a blank page that has been checked.
CON	contradicts a correct response and negates the mark
SF	to draw attention to the significant figures

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:

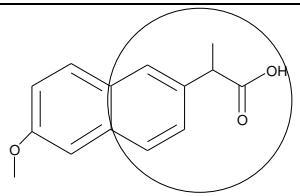
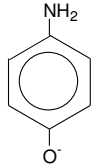
- the specification, especially the assessment objectives
- the question paper
- the mark scheme.

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.

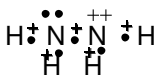
Question	Answer	Marks	Guidance
1a	$C_{13}H_{18}O_2$	1	**ALLOW** any order of the elements
1bi	$CH_3CH(CH_3)CH_2Cl$ √ 1-chloro-2-methylpropane √	2	**ALLOW** any unambiguous structural formula
1bii	$AlCl_3$ (catalyst) **AND** anhydrous √	1	**IGNORE** reaction conditions **DO NOT ALLOW** other reagents
1ci	arachidonic acid	1	**IGNORE minor spelling errors**
1cii	binds with/bonds with/fits into ...active site √ stops (some) substrate binding/fitting/bonding OR competes with substrate/prevents enzyme-substrate complexes forming/blocks active site AW √ (is reversible/unbinds because) does not bond covalently/forms temporary / weak bonds with active site/can be reversed by increasing substrate concentration (AW) √	3	
1d	aqueous bromine/bromine solution/ bromine in (named) organic solvent √ turns colourless from yellow/orange /brown **OR** decolourised √	2	Not just 'bromine' for mp1 but **ALLOW** for 2 marks Bromine changing from red/red brown to colourless If aqueous bromine/bromine solution **ALLOW** any colour combinations of orange/yellow/brown If bromine in solvent **ALLOW** any combination of brown, red or orange. **ALLOW** decolourises bromine for 1 mark
1ei	(isomers that have) same structural formula AND different arrangements in space	1	**DO NOT ALLOW** atoms bonded in different order **DO NOT ALLOW** 'same molecular formula'
1eii	cis **AND** *Z*	1	
1fi	ether	1	**ALLOW** alkoxy
1fii	part of molecule (AW) √ where pharmaceutical (AW) action occurs/(that) causes pharmacological effect AW/that causes biological action (AW) √	2	**DO NOT ALLOW** medicinal action

1fiii		**1**	Must include all 6 carbons of right hand ring
1g	 √ CH_3COO^- √	**2**	**ALLOW** 1 mark if both structures correct except show OH group **IGNORE** cations
		18	

2a	**1.** (trend because) instantaneous (dipole) induced dipole (bonds/forces) get stronger down the group √ **2.** (trend because) more electrons (down the group)/molecules are larger **AW** (down the group) √ **3.** water has H-bonds √ **4.** H_2S has pd-pd/id-id/ weaker H bonds √ **5.** imb in water (are stronger, so …) need more energy to break (AW) **ORA**√	**5**	**DO NOT ALLOW** abbreviations *e.g.* id-id **DO NOT ALLOW** 'more' id-id down group Mark independently **QWC** only allow marking point 4 if 3 scored **IGNORE** overcome
2b	ice (molecules are) held in (more) open structure/held further apart (AW) √ by hydrogen bonds (in ice)√	**2**	Air spaces negates mp1
2ci	O is more electronegative than C (ora) so C=O bonds polarised √ Bond polarities cancel / charges balance / the dipoles balance / dipoles cancel out/ centre of +/- charge coincide √	**2**	**ALLOW** O is more electronegative than C (ora) with bond polarities shown on C=O Must be a comparison (of electronegativity) Mark independently

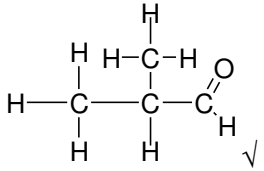
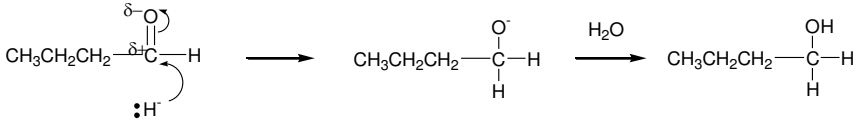
2cii	H-bonds broken in water √ H-bonds formed between CO_2 and water √ id-id bonds broken in CO_2 √ (there is) little <u>energy</u> change when imb are made/broken AW √	**4**	**IGNORE** pd pd bonds
2di	$\underline{Na^+(g) + Cl^-(g)}$ √ $NaCl(aq)/\underline{Na^+(aq) + Cl^-(aq)}$ √ $\underline{NaCl(s)}$ √ sum of enthalpy changes of hydration (of ions) = -775 kJ mol^{-1} √	**4**	For mp2, energy levels must be in sequence shown/ **IGNORE** arrows
2dii	Ion (-)dipole √	**1**	
2e	$Mg_3N_2 + 6H_2O \longrightarrow 3Mg(OH)_2 + 2NH_3$ NH_3 formed √ completely correct √	**2**	**IGNORE** state symbols
		20	

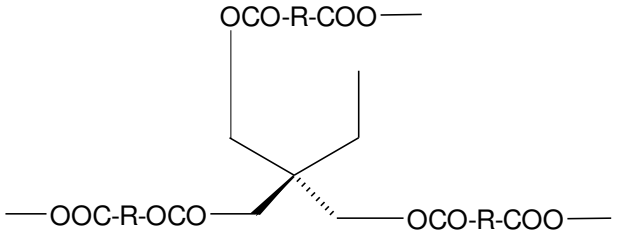
3ai	to prevent equilibrium position moving √ rates (of back +fwd) slower/stops reaction √	**2**	**ALLOW** 'prevents conc of I_2 changing' **IGNORE** quench
3aii	$[I_2]$ = 26.3 x 0.5 x 0.0687/ 100 √ = 9.03×10^{-3} √	**2**	**ALLOW** 2 or more sf Correct answer on answer line scores 2 without reference to working. $1.80... \times 10^{-2}$ (no factor of 2) scores 1 without reference to working. 9.03×10^{-4} (divides by 1000 not 100) scores 1 without reference to working mp 2 ecf only for a transcription error
3bi	2 x 0.00863/0.01726 (mol dm^{-3}) of HI react (to give 0.00863 mol dm^{-3} I_2) √ (Initial conc of HI) = 0.004 x 10 **or** 0.04 (mol dm^{-3}) **AND** 0.04 – 0.01726 = 0.0227 √	**2**	Method must be shown to score either mark **ALLOW** alternative methods
3bii	$[H_2] = [I_2]$ **OR** $[H_2]$ = 0.00863 √ $K_c = [H_2]\,[I_2]/[HI]^2$ **OR** $[I_2]^2/[HI]^2$ **OR** $[H_2]^2/[HI]^2$ **OR** numbers substituted √ = 0.14453.... √ = 0.145 (3 sf) √	**4**	First marking point can be inferred from later working 0.14453....or 0.144 score 3 without working 0.145 scores 4 without working **ALLOW** mp4 for any calculation correctly evaluated and shown to 3sf
3c	I/iodine has been oxidised from -1 to 0 √ S/sulfur has been reduced from +6 to -2 √	**2**	Give one mark for correct identification of iodine (oxidised) and sulfur (reduced) without/with wrong oxidation states. **DO NOT ALLOW** I_2 for 'iodine'
3d	Endothermic √ (because) <u>Iodine</u> is formed so equilibrium (position) must have moved to right √	**2**	**IGNORE** favouring
3ei	$N_2H_4 + 2I_2 \longrightarrow N_2 + 4HI$	**1**	**IGNORE** state symbols **ALLOW** $N_2H_4 + I_2 \longrightarrow N_2 + 2HI + H_2$

3eii	 5 electrons around each N √ completely correct √	**2**	
3eiii	109 √ 4 pairs/ groups of electrons/ 4 areas of electron density/ 4 regions of <u>negative</u> charge √ repel **AND** get as far away from each other as possible √ pyramidal √	**4**	**ALLOW** 104 – 110 mp3 **ALLOW** 'minimise repulsion' **IGNORE** 'repel as much as possible' **QWC** 'pyramidal' must be spelled correctly to score **IGNORE** tetrahedral/triangular **ALLOW** trigonal pyramid spelled correctly no ecf
3eiv	$N_2H_5^+HSO_4^-$ / $H_2NNH_3^+$ HSO_4^- /$H_3NNH_3^{2+}$ SO_4^{2-} Formula √ All correct √	**2**	**ALLOW** one mark for $N_2H_5HSO_4$ or $N_2H_6SO_4$ (with or without correct/incorrect charges)
3f	([HI] =) 26.25 x 0.110/25 **or** 0.1155 √ V x 0.1155 = 1000 x 0.1 **or** V = 1000 x 0.1/0.1155√ V = 866/ 865.8 (cm^3) √	**3**	**ALLOW** 0.116 for 0.1155 **ALLOW** 862.068..... if 0.116 used **ALLOW** answer to 2 or more sf (870) **ALLOW** ecf from first marking point. **ALLOW** 865.1 for 3 marks (early rounding mp1) Correct answer on answer line scores 3 without reference to working.
		26	

4a	ester	**1**	
4bi	acid anhydride	**1**	
4bii	mol phenol = 85000/94 = 904(.255...) √ mol cpd A = 690000/148 = 466(.216...) √ cpd A in excess AND because reacting mols is 2:1 ratio √	**3**	**ALLOW** calculations in kilomoles but maximum 1 mark for mp1 and mp2 if units omitted and 0.904 AND 0.466 2:1 ratio can be shown from calculation **ALLOW** ecf
4biii	0.81 x 904/2 x 318 = 120/116 kg √√	**2**	**ALLOW** ecf from numbers (but not wrong conclusion) in **ii** **ALLOW** one mark for incorrect evaluation of correct expression **ALLOW** for 1 mark correct evaluation of expression with 0.81 **or** 2 missing. ie 143.76 scores 1 (missing x 0.81); 232.85 scores 1 (missing /2) **ALLOW** answers to 2 or more sf
4ci	1 electron from each carbon √ in ring(s) over all carbon atoms √ (rings are) one above and one below √	**3**	**IGNORE** 'clouds' 'rings above and below carbon (atoms)' scores mp2 and 3
4cii	1. electrons raised to higher energy level √ 2. radiation/light/photon/frequencies in electromagnetic spectrum absorbed **AND** ΔE=hv/f √ 3. more delocalisation in ion / larger chromophore √ 4. reduces ΔE so light/visible radiation absorbed/lower frequency radiation absorbed ORA√ 5. (for ion) complementary colour reflected/ transmitted **OR** molecule absorbs in uv √	**5**	mp2 **ALLOW** E= hv/f if 'energy gap' clearly indicated **QWC** only award 4. if 3. scored mp5 **ALLOW** 'complimentary' or 'colour(s)/frequency(ies) not absorbed' for 'complementary'. **DO NOT ALLOW** mention of 'dropping back down' or 'emit' in mp5

4d	pK_a = pH/9.3 √ $K_a = 5.0 \times 10^{-10}$ √	**2**	**ALLOW** 1sf Correct answer on answer line scores 2 without reference to working.
4ei	0.1 mol of HCl and NH_3 react to form 0.1 mol NH_4Cl √ double volume so 0.05 mol dm^3 √	**2**	2nd mark dependent on first
4eii	$[NH_3]$ $[H^+]/[NH_4^+]$	**1**	Must be square brackets
4eiii	$[H^+] = \sqrt{(5.6 \times 10^{-10} \times 0.05)}$ **or** 5.3 (5.29...) $\times 10^{-6}$ √ pH = 5.3 (5.276....) √	**2**	**ALLOW** first mark if 'H^+ =' stated. **ALLOW** ecf for second mark if $[H^+]$ or 'H^+' quoted incorrectly as 10^{-3} or smaller and correctly evaluated.
4eiv	pink colour of phth only develops after/around pH 9.3 √ indicator needs to change colour around a pH of 5 for this titration.√	**2**	**ALLOW** ecf from 4eiii provided an acidic pH **ALLOW** +/- 0.5 pH units
4fi	benzene sulfonic acid	**1**	**ALLOW** 'sulphonic'
4fii	conc/c sulfuric acid/H_2SO_4 √ heat/reflux √	**2**	
4fiii	electrophilic substitution √	**1**	
4fiv	no reaction √ pink/purple colour √	**2**	If starting colour given, must be orange/yellow or colourless.
		30	

5ai	increasing pressure increases yield (**ORA**) √ fewer/less moles/molecules/particles on right/products **ORA** √	**2**	Mark independently **IGNORE** 'fewer/less products'
5aii	increasing temperature increases rate √ more frequent (AW) collisions with energy greater than E_a/activation enthalpy /more frequent successful collisions√	**2**	
5aiii	disorder **or** number of ways of arranging particles/molecules/quanta of energy √ –/negative since fewer/less moles/molecules/particles on right/products √	**2**	**IGNORE** 'fewer/less products'
5bi	butanal	**1**	
5bii	 √ (2-)methylpropanal √	**2**	
5biii	$CH_3CH_2CH_2COOH$ **AND** butanoic acid	**1**	**ALLOW** any unambiguous structure **ALLOW** molecular formula $C_4H_8O_2$
5ci	 attack of H^- and curly arrow on aldehyde √ intermediate √ attack by water to give product √ partial charges correct on C=O **AND** lone pair on H^- √	**4**	Mark independently Curly arrow should start either from lone pair or negative charge on H^- and end pointing at the C atom or the bond about to form between C and H **IGNORE** curly arrows and lone pairs on water

5cii	$CH_3CH_2CH_2CH=NH$ / $CH_3CH_2CH=CHNH_2$ √√	**2**	**ALLOW** any unambiguous representation. ***for one mark**, allow:* any structure that shows attack by NH_3 on the right-hand carbon and the correct molecular formula eg C_3H_7CHNH or $CH_3CH=CHCH_2NH_2$
5di	heat/reflux with conc/c sulfuric acid/H_2SO_4	**1**	**ALLOW** conc HCl
5dii	$CH_3CH_2CH_2CH_2OH + CH_3COOH \rightarrow CH_3COOCH_2CH_2CH_2CH_3 + H_2O$ correct formula of ester √ completely correct equation √	**2**	**ALLOW** any unambiguous structures **ALLOW** 1 mark for use of C_4H_9 for $CH_3CH_2CH_2CH_2$
5e	IR – ester (not acid), as no O–H > 3000 / has C=O ester at 1750 √ ester: $CH_3COOCH_2CH(CH_3)_2$ $(CH_3)_2CH$ – √ Remainder correct √ *two from* √√ • Peak at 2.0* indicates CHCO • 6 protons at 0.9* indicates 2 CH_3 **or** 4 proton environments • 2 proton doublet at 3.9* indicates CH_2O next to CH * allow ±0.1	**5**	**ALLOW** range 2500 to 3200 for O-H **DO NOT ALLOW** ranges for chemical shift
5f	 polymerisation occurs at these bonds 3 ester links to TMP √ indication where polymerisation can continue √	**2**	2nd mark depends on first being correct **ALLOW** indication of further polymerisation from COOH
		26	

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