

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.

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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 <u>not</u> 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:

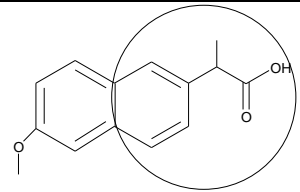
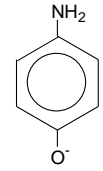
- the specification, especially the assessment objectives
- the question paper
- the mark scheme.

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 ... <u>active site</u> ✓ 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 <u>structural formula</u> 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 |

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|-------|---|-----------|--|
| 1fiii |  | 1 | Must include all 6 carbons of right hand ring |
| 1g |  \checkmark CH_3COO^- \checkmark | 2 | ALLOW 1 mark if both structures correct except show OH group IGNORE cations |
| | | 18 | |
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|-----|--|---|---|
| 2a | <p>1. (trend because) instantaneous (dipole) induced dipole (bonds/forces) get stronger down the group \checkmark</p> <p>2. (trend because) more electrons (down the group)/molecules are larger AW (down the group) \checkmark</p> <p>3. water has H-bonds \checkmark</p> <p>4. H_2S has pd-pd/id-id/ weaker H bonds \checkmark</p> <p>5. imb in water (are stronger, so ...) need more energy to break (AW) ORA \checkmark</p> | 5 | <p>DO NOT ALLOW abbreviations e.g. id-id</p> <p>DO NOT ALLOW 'more' id-id down group</p> <p>Mark independently</p> <p>QWC only allow marking point 4 if 3 scored</p> <p>IGNORE overcome</p> |
| 2b | ice (molecules are) held in (more) open structure/held further apart (AW) \checkmark by hydrogen bonds (in ice) \checkmark | 2 | Air spaces negates mp1 |
| 2ci | <p>O is more electronegative than C (ora) so C=O bonds polarised \checkmark</p> <p>Bond polarities cancel / charges balance / the dipoles balance / dipoles cancel out/ centre of +/- charge coincide \checkmark</p> | 2 | <p>ALLOW O is more electronegative than C (ora) with bond polarities shown on C=O</p> <p>Must be a comparison (of electronegativity)</p> <p>Mark independently</p> |

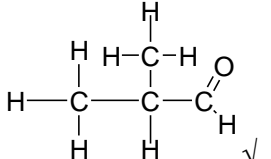
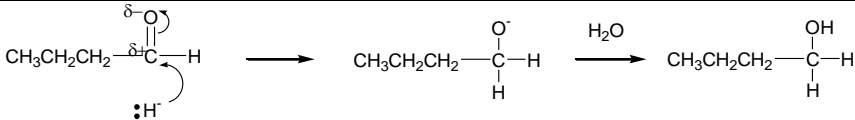
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|------|--|-----------|---|
| 2cii | H-bonds broken in water ✓ H-bonds formed between CO ₂ and water ✓ id-id bonds broken in CO ₂ ✓ (there is) little <u>energy</u> change when imb are made/broken AW ✓ | 4 | IGNORE pd pd bonds |
| 2di | $\underline{\text{Na}^+(\text{g}) + \text{Cl}^-(\text{g})}$ ✓ $\underline{\text{NaCl}(\text{s})}$ ✓ NaCl(aq)/ $\underline{\text{Na}^+(\text{aq}) + \text{Cl}^-(\text{aq})}$ ✓ 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 | $\text{Mg}_3\text{N}_2 + 6\text{H}_2\text{O} \rightarrow 3\text{Mg}(\text{OH})_2 + 2\text{NH}_3$ NH ₃ formed ✓ completely correct ✓ | 2 | IGNORE state symbols |
| | | 20 | |

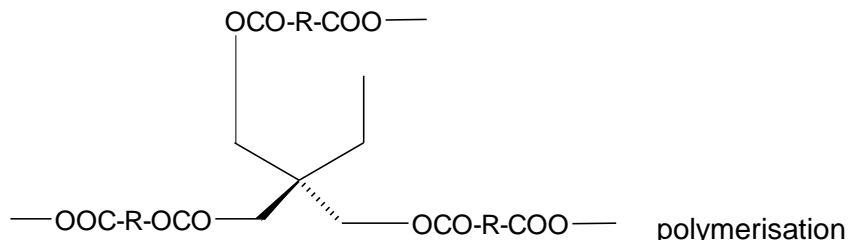
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| 3ai | to prevent equilibrium position moving \checkmark rates (of back +fwd) slower/stops reaction \checkmark | 2 | ALLOW 'prevents conc of I ₂ changing' IGNORE quench |
| 3aii | $[I_2] = 26.3 \times 0.5 \times 0.0687 / 100 \checkmark$ $= 9.03 \times 10^{-3} \checkmark$ | 2 | ALLOW 2 or more sf Correct answer on answer line scores 2 without reference to working. 1.80...x 10 ⁻² (no factor of 2) scores 1 without reference to working. 9.03 x 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) \checkmark (Initial conc of HI) = 0.004 x 10 or 0.04 (mol dm ⁻³) AND 0.04 – 0.01726 = 0.0227 \checkmark | 2 | Method must be shown to score either mark ALLOW alternative methods |
| 3bii | $[H_2] = [I_2]$ OR $[H_2] = 0.00863 \checkmark$ $K_c = [H_2] [I_2] / [HI]^2$ OR $[I_2]^2 / [HI]^2$ OR $[H_2]^2 / [HI]^2$ OR numbers substituted \checkmark $= 0.14453.... \checkmark$ $= 0.145$ (3 sf) \checkmark | 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 \checkmark S/sulfur has been reduced from +6 to -2 \checkmark | 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 \checkmark (because) <u>iodine</u> is formed so equilibrium (position) must have moved to right \checkmark | 2 | IGNORE favouring |
| 3ei | $N_2H_4 + 2I_2 \rightarrow N_2 + 4HI$ | 1 | IGNORE state symbols ALLOW $N_2H_4 + I_2 \rightarrow N_2 + 2HI + H_2$ |

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| 3eii | $\begin{array}{c} \text{H} \cdot \cdot \text{N} \cdot \cdot \text{N} \cdot \cdot \text{H} \\ \quad \quad \\ \text{H} \quad \text{H} \end{array}$ <p>5 electrons around each N ✓ completely correct ✓</p> | 2 | |
| 3eiii | <p>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 ✓</p> <p>pyramidal ✓</p> | 4 | <p>ALLOW 104 – 110</p> <p>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</p> |
| 3eiv | <p>$\text{N}_2\text{H}_5^+\text{HSO}_4^- / \text{H}_2\text{NNH}_3^+ \text{HSO}_4^- / \text{H}_3\text{NNH}_3^{2+} \text{SO}_4^{2-}$</p> <p>Formula ✓ All correct ✓</p> | 2 | <p>ALLOW one mark for $\text{N}_2\text{H}_5\text{HSO}_4$ or $\text{N}_2\text{H}_6\text{SO}_4$ (with or without correct/incorrect charges)</p> |
| 3f | <p>$([\text{HI}] =) 26.25 \times 0.110/25$ or 0.1155 ✓ $V \times 0.1155 = 1000 \times 0.1$ or $V = 1000 \times 0.1/0.1155$ ✓</p> <p>$V = 866/ 865.8$ (cm³) ✓</p> | 3 | <p>ALLOW 0.116 for 0.1155</p> <p>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)</p> <p>Correct answer on answer line scores 3 without reference to working.</p> |
| | | 26 | |

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|-------|--|---|---|
| 4a | ester | 1 | |
| 4bi | <u>acid anhydride</u> | 1 | |
| 4bii | mol phenol = $85000/94 = 904(.255\dots)$ ✓ mol cpd A = $690000/148 = 466(.216\dots)$ ✓ 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 | $0.81 \times 904/2 \times 318 = 120/116 \text{ kg}$ ✓✓ | 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 <u>carbon</u> atoms ✓ (rings are) one above and one below ✓ | 3 | IGNORE 'clouds' 'rings above and below carbon (atoms)' scores mp2 and 3 |
| 4cii | 1. <u>electrons</u> raised to higher <u>energy level</u> ✓ 2. radiation/light/photon/frequencies in electromagnetic spectrum absorbed AND $\Delta E = hv/f$ ✓ 3. more delocalisation in ion / larger chromophore ✓ 4. reduces ΔE so light/visible radiation absorbed/lower frequency radiation absorbed OR ✓ 5. (for ion) complementary colour <u>reflected/ transmitted</u> OR <u>molecule</u> 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 |

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|-------|--|----|---|
| 4d | $pK_a = pH/9.3 \checkmark$ $K_a = 5.0 \times 10^{-10} \checkmark$ | 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 $NH_4Cl \checkmark$ double volume so $0.05 \text{ mol dm}^3 \checkmark$ | 2 | 2 nd 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 $5.3 (5.29\dots) \times 10^{-6} \checkmark$ $pH = 5.3 (5.276\dots) \checkmark$ | 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 \checkmark indicator needs to change colour around a pH of 5 for this titration. \checkmark | 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/ $H_2SO_4 \checkmark$ heat/reflux \checkmark | 2 | |
| 4fiii | electrophilic substitution \checkmark | 1 | |
| 4fiv | no reaction \checkmark pink/purple colour \checkmark | 2 | If starting colour given, must be orange/yellow or colourless. |
| | | 30 | |

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|-------|---|---|--|
| 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) <u>collisions</u> with energy greater than E_a /activation enthalpy /more frequent <u>successful collisions</u> ✓ | 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 ₃ CH ₂ CH ₂ COOH AND butanoic acid | 1 | ALLOW any unambiguous structure ALLOW molecular formula C ₄ H ₈ O 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 |

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|------|---|----|--|
| 5cii | $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}=\text{NH}$ / $\text{CH}_3\text{CH}_2\text{CH}=\text{CHNH}_2$ ✓✓ | 2 | ALLOW any unambiguous representation. <i>for one mark, allow:</i> any structure that shows attack by NH_3 on the right-hand carbon and the correct molecular formula eg $\text{C}_3\text{H}_7\text{CHNH}$ or $\text{CH}_3\text{CH}=\text{CHCH}_2\text{NH}_2$ |
| 5di | heat/reflux with conc/c sulfuric acid/ H_2SO_4 | 1 | ALLOW conc HCl |
| 5dii | $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH} + \text{CH}_3\text{COOH} \rightarrow \text{CH}_3\text{COOCH}_2\text{CH}_2\text{CH}_2\text{CH}_3 + \text{H}_2\text{O}$ correct formula of ester ✓ completely correct equation ✓ | 2 | ALLOW any unambiguous structures ALLOW 1 mark for use of C_4H_9 for $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2$ |
| 5e | IR – ester (not acid), as no O–H > 3000 / has C=O ester at 1750 ✓ ester: $\text{CH}_3\text{COOCH}_2\text{CH}(\text{CH}_3)_2$ $(\text{CH}_3)_2\text{CH} -$ ✓ Remainder correct ✓ <i>two from</i> ✓✓ • 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 |  occurs at these bonds 3 ester links to TMP ✓ indication where polymerisation can continue ✓ | 2 | 2 nd mark depends on first being correct ALLOW indication of further polymerisation from COOH |
| | | 26 | |

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