OCR
Oxford Cambridge and RSA

GCE

Chemistry B

Unit **H433A/02:** Scientific literacy in chemistry

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 available in RM Assessor

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

12. 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

Annotation	Meaning
	Correct response
	Incorrect response
	Omission mark
	Benefit of doubt given
	Contradiction
	Rounding error
	Error in number of significant figures
	Error carried forward
	Level 1
	Level 2
	Level 3
	Benefit of doubt not given
	Noted but no credit given
	Ignore

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:

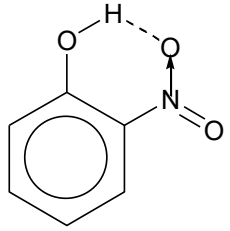
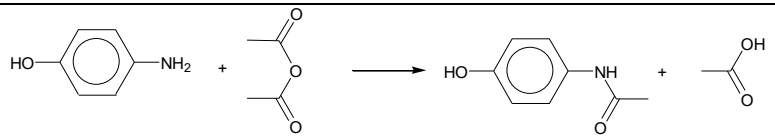
- the specification, especially the assessment objectives
- the question paper
- the mark scheme.

You should ensure that you have copies of these materials.

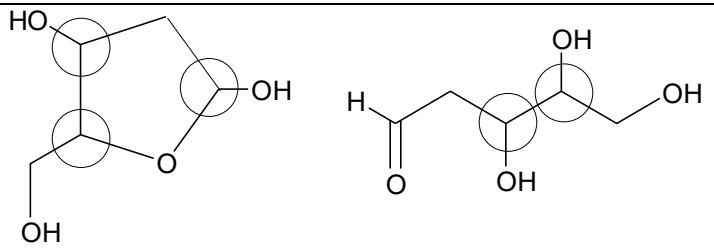
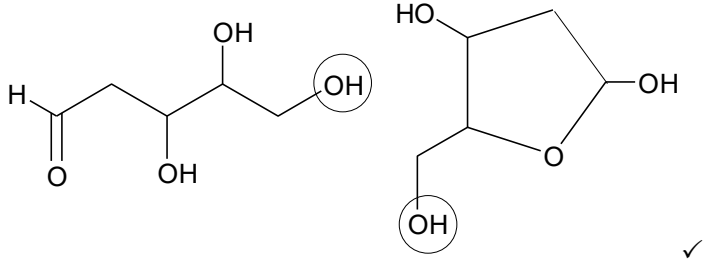
You should ensure also that you are familiar with the administrative procedures related to the marking process. These are set out in the OCR booklet **Instructions for Examiners**. If you are examining for the first time, please read carefully **Appendix 5 Introduction to Script Marking: Notes for New Examiners**.

Question			Answer	Marks	Guidance
1	(a)	(i)	$2CH_3COOH + Na_2CO_3 \rightarrow 2CH_3COONa + CO_2 + H_2O$ formulae ✓ balancing of correct formulae✓	2	**ALLOW** any unambiguous formulae (including molecular formulae) **ALLOW** H_2CO_3 as a product in a balanced equation for 1 mark **IGNORE** state symbols
		(ii)	**FIRST CHECK ANSWER LINE** **If answer =** 11.25 or 11.3 (cm^3) award 2 marks amount CH_3COOH = 25 x 0.450/1000 **OR** 0.01125(mol) ✓ volume Na_2CO_3 (= 0.5 x 0.01125 x 1000/0.500) = 11.25 (cm^3) ✓	2	**ALLOW** ecf from 1:1 ratio in a(i) **ALLOW** 3 or more sf
	(b)		$CH_3COO^- + H_2O \rightleftharpoons CH_3COOH + OH^-$	1	**IGNORE** state symbols **ALLOW** arrow for equilibrium sign
	(c)	(i)	$CH_3COOH \rightleftharpoons CH_3COO^- + H^+$	1	**ALLOW**: $CH_3COOH + H_2O \rightleftharpoons CH_3COO^- + H_3O^+$ **Equilibrium sign required** **IGNORE** state symbols
		(ii)	**FIRST CHECK ANSWER LINE** **If answer =** 3.1(462**)** award 2 marks $[H^+] = \sqrt{(1.7 \times 10^{-5} \times 0.030)}$ **OR** 7.14(....) x 10^{-4} ✓ pH (= -log 7.14 x 10^{-4}) = 3.1(462) ✓	2	**ALLOW** 'H^+' for '$[H^+]$' **ALLOW** ecf for second mark provided value for $[H^+]$ is quoted and it is smaller than 3 x 10^{-2} and greater than 1.1 x 10^{-7}.
	(d)		acid/ H^+ moves equilibrium to left / reactants✓ idea of restoring/maintaining pH ✓ large concentrations/ amounts/excess of salt/CH_3COO^- ✓	3	Equilibrium **must** be written out (either for ethanoic acid or HA) to score first mark (or they could refer back to (c)(i)) **ALLOW** idea of "ethanoate ions react with H^+ ions to restore equilibrium" to score first mark
	(e)	(i)	($[H^+] = K_a \times [CH_3COOH]/[CH_3COO^-]$) gives pH = 4.77/4.8 ✓	1	

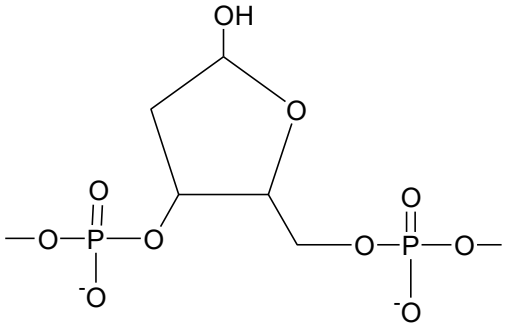
Question			Answer	Marks	Guidance
		(ii)	**FIRST CHECK ANSWER LINE** **If answer =** 0.35(g) award 4 marks $[CH_3COO^-] = K_a \times [CH_3COOH]/ [H^+]$ ✓ $= 1.7 \times 10^{-5} \times 0.1/10^{-5}$ **OR** 0.17 (mol dm^{-3}) ✓ mass CH_3COONa per $dm^3 = 82 \times 0.17$ **OR** 13.94 g ✓ mass per 25 $cm^3 = 13.94/40 = 0.35$ g ✓ **OR** moles in 25$cm^3 = 0.17/40 = 4.25 \times 10^{-3}$ ✓ mass per 25 $cm^3 = 4.25 \times 10^{-3} \times 82 = 0.35$g ✓	4	**Accept** 0.349g / 0.3485g **ALLOW** 2 or more sf **ALLOW** ecf throughout **ALLOW** correct expression for K_a
			Total	16	

Question			Answer	Marks	Guidance
2	(a)		Phenol/hydroxy(l) ✓ <u>secondary</u> amide ✓	2	**NOT** alcohol
	(b)	(i)	**FIRST CHECK ANSWER LINE** **If answer =** 13.5 **/** 14(g) award 2 marks amount 4-nitrophenol = 5.0/139 **OR** 0.03597 (mol) **AND** mass phenol to give 100% = 5.0 x 94/139 **OR** 3.381 (g) ✓ scaling by 100/25 to get 13.5 / 14 (g) ✓	2	**ALLOW** ecf Any number scaled by 100/25 and to 2 or 3 sf scores second mark (if first mark not scored)
		(ii)	 ✓ ✓	2	**ALLOW** on NO_2 group: • double bond to either oxygen with a single or dative bond to the other • 'one and a half' bonds to each oxygen One mark for correct bonding within NO_2 group One mark for hydrogen bond between correct H and O (even if bonding wrong)
		(iii)	reduction **AND** amine	1	
		(iv)	 reactants ✓products ✓	2	**IGNORE** non-skeletal formulae **/**ambiguous attachments **Allow** correct use of Ethanoyl chloride for 1 mark
		(v)	dissolve in minimum volume of <u>hot</u> water / solvent ✓ filter (hot solution) removing insoluble impurities ✓ allow to crystallise /AW✓ filter, soluble impurities removed/remain in solution ✓	4	**ALLOW** wash (and dry) crystals - soluble impurities are washed away ✓

Question			Answer	Marks	Guidance
		(c)(i)	(AM404) has a similar shape to andanamide AW ✓ (AM404) fits/ binds/bonds to active site ✓ (AM404 in active site) not broken down/ stays on (active site)/ blocks site to/ competes with andanamide AW✓	3	
		(ii)	(all) cis/*Z* ✓	1	
		(iii)	lack of rotation/twisting ✓	1	
			Total	18	

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>3</td><td>(a)</td><td>(i)</td><td> 
</td><td>1</td><td>All 5 Carbon atoms must be circled</td></tr>
<tr><td></td><td></td><td>(ii)</td><td>aldehyde ✓</td><td>1</td><td>NOT carbonyl here</td></tr>
<tr><td></td><td></td><td>(iii)</td><td>one from
<table><tr><td>test 1 mark ✓</td><td>result linked to appropriate test 1 mark ✓</td></tr><tr><td>heat with Fehling’s/ Benedicts solution</td><td>(brick) red ppt</td></tr><tr><td>add Tollens’ reagent and warm</td><td>silver mirror /AW</td></tr><tr><td>heat with acid dichromate</td><td>goes green</td></tr></table></td><td>2</td><td>Reagents may be specified (eg ‘silver nitrate and ammonia’ for Tollens’)</td></tr>
<tr><td></td><td></td><td>(iv)</td><td> 

✓
OH/it is attached to a C with 2H/ one C-C bond /attached to a carbon that is only bonded to one other carbon / R group✓</td><td>2</td><td>Both OH groups must be circled</td></tr>
</table>

Question			Answer	Marks	Guidance
		(v)	Water / a small molecule is not produced/ both have same molecular formula	1	
		(vi)	–CHO + HO– → **–CH(OH)–O–**	1	**ALLOW** any unambiguous representation
	(b)		 correct bonding in phosphates ✓ correct connection of phosphates **AND** correct ring structure ✓	2	
	(c)	(i)	Base(s) ✓ Condense/react with(remaining) OH on deoxyribose ✓	2	
		(ii)	GAC	1	
		(iii)	leucine ✓	1	
		(iv)	mRNA sequence /(triplet) codon ✓ codes for/fits with tRNA (anti-codon) on amino acid ✓	2	

	(d)		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)** Structure correct and at least one piece of evidence related to the structure is provided from each spectrum. *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)** Structure correct but does not use evidence from each spectrum OR structure not given or incorrect but at least four correct pieces of evidence given from a minimum of two spectra *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)** Structure correct with no evidence **OR** Structure not given or incorrect but at least two correct pieces of evidence given *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**	**indicative scientific points include:** **structure** $CH_3OOCCH(OCH_3)_2$ **Allow** $(CH_3O)_2CHOCOCH_3$ **infrared spectrum** • C=O for ester (at 1750cm^{-1}) • C—O for ester/ether (at 1000 - 1300cm^{-1}) • no O-H/COOH (at 2500 - 3000cm^{-1}) **ignore** idea of C—H stretch/O—H stretch at approx. 3000cm^{-1} **^{1}H NMR** • 3 proton environments • no splitting • 2 CH_3 groups in the same environment • all O-CH (AW) **^{13}C NMR** • four C environments • C=O at δ = 160ppm • C—O at δ = 50ppm • no C—C present If incorrect bond or environment identified consider whether or not the line of reasoning has been impeded and if so, then award lower mark within a level
			Total	**22**	

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>4</td><td>(a)</td><td>(i)</td><td>
<table>
<tr><th>Equation no.</th><th>Oxidation state of Cr in reactant</th><th>Oxidation state of Cr in product</th><th>Has Cr been oxidised, reduced or neither?</th><th></th></tr>
<tr><td>4.1</td><td>+3</td><td>+6</td><td>oxidised</td><td>✓</td></tr>
<tr><td>4.2</td><td>+6</td><td>+6</td><td>neither</td><td>✓</td></tr>
<tr><td>4.3</td><td>+6</td><td>+3</td><td>reduced</td><td>✓</td></tr>
<tr><td>4.4</td><td>+3</td><td>0</td><td>reduced</td><td>✓</td></tr>
</table>
</td><td>4</td><td>Mark each row separately
Penalise (+) omitted /3+ etc once only</td></tr>
<tr><td></td><td></td><td>(ii)</td><td>FIRST CHECK ANSWER LINE
If answer = 0.46 or rounding to 0.465 (kg) award 2 marks

amount chromite = 1000/223.8 OR 4.468 (mol) ✓
mass Cr = 2 x 4.468 x 52/1000 = 0.46467 (kg) ✓</td><td>2</td><td>ALLOW 2 or more sf

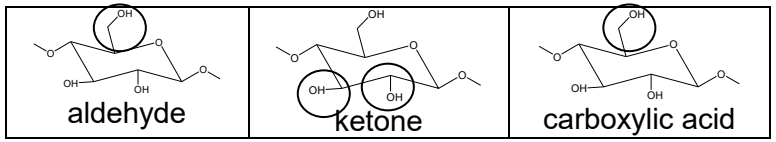
ALLOW 0.232kg for 1 mark</td></tr>
<tr><td></td><td>(b)</td><td>(i)</td><td>$1s^2 2s^2 2p^6 3s^2 3p^6 3d^3$</td><td>1</td><td>ALLOW any sized letters but numbers must be superscripts
Accept [Ar] $3d^3$
ALLOW $4s^0$</td></tr>
<tr><td></td><td></td><td>(ii)</td><td>beaker (etc) with solution and two electrodes with battery/power supply connected ✓

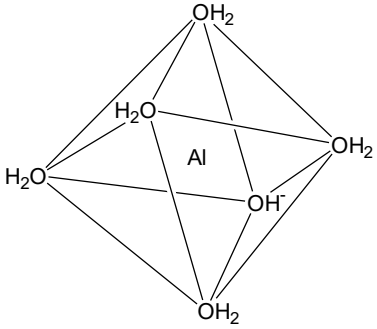
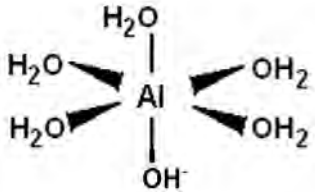
solution labelled chromium(III) chloride / $CrCl_3$/ Cr^{3+} ✓

+ve electrode/anode labelled ‘graphite’ AND
–ve electrode/cathode labelled ‘steel (object)’. ✓</td><td>3</td><td>If two beaker diagram drawn, allow 1 mark for a steel electrode inserted into a chromium(III)chloride solution

Ignore battery convention UNLESS polarity of electrodes not otherwise indicated</td></tr>
<tr><td></td><td></td><td>(iii)</td><td>$Cr^{3+} + 3e^{(-)} \rightarrow Cr$ ✓</td><td>1</td><td>IGNORE state symbols
ALLOW ecf from labelled cathode half cell if present in b(ii)</td></tr>
</table>

		(iv)	**FIRST CHECK ANSWER LINE** **If answer =** 8 (hours) award 3 marks moles of electrons = 3 x 26/52 **OR** 1.5 ✓ time = 1.5 x 96500/5 **OR** 28950 **(**sec) ✓ time in hours = 28950/3600 = 8(.04) (hours) ✓	**3**	**ALLOW** ecf **ALLOW** any sf If final answer rounds to 2.7 hours scores 2
	(c)	**(i)**	chloride (ions) **AND** water (molecules)	**1**	**IGNORE formulae** **NOT** chlorine **ALLOW** chloro and aqua
		(ii)	Add a named ionic chloride (solution) **or** hydrochloric acid/HCl ✓ to move equilibrium to the left/reactants ✓	**2**	Mark independently
	(d)	**(i)**	**FIRST CHECK ANSWER LINE** **If answer =** 0.977 (g/100cm^3) on second answer line award 6 marks **If answer =** 0.21 (mol dm^{-3}) on first answer line award 5 marks amount $Cr_2O_7^{2-}$ init. = 20 x 0.2/1000 **OR** 4 x 10^{-3} (mol) ✓ amount $Na_2S_2O_3$ = 27.6 x 0.1/1000 **OR** 2.76 x 10^{-3} (mol) ✓ amount $Cr_2O_7^{2-}$ left = 2.76 x 10^{-3}/6 **OR** 4.6 x 10^{-4} (mol) ✓ amount $Cr_2O_7^{2-}$ used = 3.54 x 10^{-3} (mol) ✓ conc ethanol = (1.5 x 3.54 x 10^{-3} x 40) **=** 0.212(4) (mol dm^{-3}) ✓ % (= 0.0212 x 46) = 0.975/0.977 (g/100cm^3) ✓	**6**	**ALLOW** two or more sf **ALLOW** ecf throughout.
	(d)	**(ii)**	no other oxidising agents/ reducing agents in the beer	**1**	
			Total	**24**	

Question			Answer	Marks	Guidance
5	(a)		 aldehyde ketone carboxylic acid	3	**ALLOW** just OH circled or C as well (as shown) **Both** circles must be shown for the ketones. If only carbon atoms have been identified, mark incorrect once and apply ecf
	(b)	(i)	*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) Shows a good understanding of all three areas *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) Shows a sound understanding of at least two areas. **OR** Discusses all three areas, demonstrating a sound understanding of one area *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) Shows some understanding of one area. *There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.* **Level 0** (0 marks) *No response or response has no merit.*	6	**Indicative scientific points include** **Why radiation absorbed** • electrons move to higher energy levels/shells • absorbing light/radiation • frequency absorbed $\Delta E = hv$ (allow E = hv if clear reference to energy *gap*) **Affect of structure on frequency of radiation** • amount of delocalisation affects ΔE/ frequency • smaller delocalisation, larger ΔE/frequency • lignin has smaller chromophore/ less delocalisation than decomposition prods **Source of yellow colour** • uv higher frequency/ larger ΔE than visible • look yellow because they absorb the complementary colour/ blue/violet For answers that talk about electrons falling and releasing radiation/ light/colour impedes the line of reasoning and should result in the lower mark within a level being awarded.

Question			Answer	Marks	Guidance
		(ii)	***FIRST CHECK ANSWER LINE*** ***If answer** = 342 (kJ mol–1) award 3 marks* Rearrangement of E = hv and c = vλ to E = hc/λ ✓ E = 6.63 x 10^{-34} x 3 x 10^{8} / 3.5 x 10^{-7} (J per atom) **OR** E = 6.63 x 10^{-34} x 8.57 x 10^{14} ✓ multiply by N_A and divide by 1000 and evaluate (6.63 x 10^{-34} x 3 x 10^{8} x 6.02 x 10^{23} / 3.5 x 10^{-7} x 1000) = 342 kJ mol^{-1} ✓	3	**ALLOW** ecf MP2 subsumes MP1 and scores 2 marks
	(c)	(i)	$[Al(H_2O)_6]^{3+}$/ H_2O <u>ligand</u>/ <u>in complex</u> ✓	1	Allow water/aqua for H_2O.
		(ii)	 *OR*  ✓ *octahedral* ✓	2	**IGNORE** charges Allow diagrams that are unambiguous in showing adjacent equatorial ligands with two coming out of the plane, and two going into the plane of the paper Do Not allow bonds to H atoms, must be to O as bonding is to the lone pair of electrons Mark independently

	(d)		$2Fe^{2+} + O_2 + 2H^+ \rightarrow 2Fe^{3+} + H_2O_2$ ✓ Idea that Fe^{2+} is not recycled ✓	**2**	
	(e)		Use of diethyl zinc/ $(C_2H_5)_2Zn$ ✓ Adding nanoparticles/ microparticles of $MgO/Mg(OH)_2/Ca(OH)_2$/metal hydroxides ✓ $(C_2H_5)_2Zn + 2H^+ \rightarrow Zn^{2+} + 2C_2H_6$ **OR** $Ca(OH)_2 + 2H^+ \rightarrow Ca^{2+} + H_2O$ **OR** $Mg(OH)_2 + 2H^+ \rightarrow Mg^{2+} + H_2O$ ✓	**3**	
			Total	**20**	

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