Published Mark Schemes for GCE A2 Chemistry

Summer 2010

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NORTHERN IRELAND GENERAL CERTIFICATE OF SECONDARY EDUCATION (GCSE)
AND NORTHERN IRELAND GENERAL CERTIFICATE OF EDUCATION (GCE)

MARK SCHEMES (2010)

Foreword

Introduction

Mark Schemes are published to assist teachers and students in their preparation for examinations. Through the mark schemes teachers and students will be able to see what examiners are looking for in response to questions and exactly where the marks have been awarded. The publishing of the mark schemes may help to show that examiners are not concerned about finding out what a student does not know but rather with rewarding students for what they do know.

The Purpose of Mark Schemes

Examination papers are set and revised by teams of examiners and revisers appointed by the Council. The teams of examiners and revisers include experienced teachers who are familiar with the level and standards expected of 16- and 18-year-old students in schools and colleges. The job of the examiners is to set the questions and the mark schemes; and the job of the revisers is to review the questions and mark schemes commenting on a large range of issues about which they must be satisfied before the question papers and mark schemes are finalised.

The questions and the mark schemes are developed in association with each other so that the issues of differentiation and positive achievement can be addressed right from the start. Mark schemes therefore are regarded as a part of an integral process which begins with the setting of questions and ends with the marking of the examination.

The main purpose of the mark scheme is to provide a uniform basis for the marking process so that all the markers are following exactly the same instructions and making the same judgements in so far as this is possible. Before marking begins a standardising meeting is held where all the markers are briefed using the mark scheme and samples of the students' work in the form of scripts. Consideration is also given at this stage to any comments on the operational papers received from teachers and their organisations. During this meeting, and up to and including the end of the marking, there is provision for amendments to be made to the mark scheme. What is published represents this final form of the mark scheme.

It is important to recognise that in some cases there may well be other correct responses which are equally acceptable to those published: the mark scheme can only cover those responses which emerged in the examination. There may also be instances where certain judgements may have to be left to the experience of the examiner, for example, where there is no absolute correct response – all teachers will be familiar with making such judgements.

The Council hopes that the mark schemes will be viewed and used in a constructive way as a further support to the teaching and learning processes.

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Rewarding Learning

ADVANCED
General Certificate of Education
2010

Chemistry

Assessment Unit A2 1

assessing

Periodic Trends and Further Organic, Physical and Inorganic Chemistry

[AC212]

FRIDAY 21 MAY, AFTERNOON

MARK SCHEME

Section A

1 C

2 B

3 C

4 C

5 A

6 B

7 D

8 C

9 C

10 B

[2] for each correct answer [20] 20

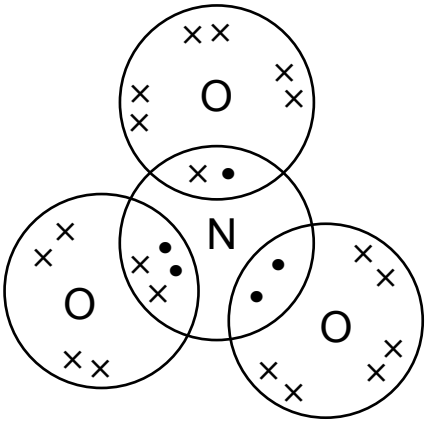
Section A **20**

Section B

11 (a) (i) $NH_3 + HNO_3 \rightarrow NH_4NO_3$ [1]

(ii) acid [1]
salt of strong acid and weak base [1] [2]

(iii)



each error [–1] [2]

(b) (i) $NH_4NO_3 \rightarrow N_2O + 2H_2O$ [1]

(ii) ΔG always negative [1]

(c) (i) volume / smell / storage / composition [1]

(ii) mass $NH_4NO_3 = 80$

%N = $(2 \times 14 / 80) \times 100$

= 35%

award [2] directly for correct answer, each error [–1] [2]

(d) (i) leaching of fertilisers / detergents [1]

(ii) = 0.05×10^{-3}g per cm^3

= 0.05 g per dm^3

= 0.05/62

= 8.06×10^{-4} M

each error [–1], carry error through [3]

(iii) iron +2 to +3 oxidation [1]
nitrogen reduction +3 to +2 [1] [2] 16

12 **(a)** $pK_a = 4.87$

$K_a = 1.35 \times 10^{-5}$ mol dm^{-3}

$K_a = [CH_3CH_2COO^-][H^+] / [CH_3CH_2COOH]$

$1.35 \times 10^{-5} = [H^+]^2 / 0.05$

$[H^+]^2 = 6.74 \times 10^{-7}$

$[H^+] = 8.2 \times 10^{-4}$

$pH = -\log(8.2 \times 10^{-4})$

pH = 3.09 **or** 3.085 **or** 3.1

each error [–1], carry error through [4]

(b) $CH_3CH_2COOH \rightleftharpoons CH_3CH_2COO^- + H^+$ eqn 1 [1]

$CH_3CH_2COONa \rightarrow CH_3CH_2COO^- + Na^+$ eqn 2 [1]

add acid

pushes equilibrium 1 to lhs / H^+ react with $CH_3CH_2COO^-$ [1]

salt acts as a source of $CH_3CH_2COO^-$ [1]

to a maximum of 4 [4]

(c) **(i)** $CH_3CH_2COOH + CH_3OH \rightleftharpoons CH_3CH_2COOCH_3 + H_2O$ [1]

(ii) catalyst / increases yield / pushes eqn to rhs / absorbs water [1] [1]

(iii) propanoic acid has hydrogen bonding (between O–H)
the ester has no hydrogen bonding [1]
comment on relative strengths of bonding [1] [2]

(iv) higher yield / not reversible [1]
faster [1]
other product gaseous [1]
any **two** [2]

(d) $NH_3 \rightarrow C_2H_5COONH_4$ [1]

$Na_2CO_3 \rightarrow CH_3CH_2COONa$ [1]

$LiAlH_4 \rightarrow CH_3CH_2CH_2OH$ [1] [3] 17

13 **(a)** **(i)** sulphur [1]

(ii) magnesium oxide [1]

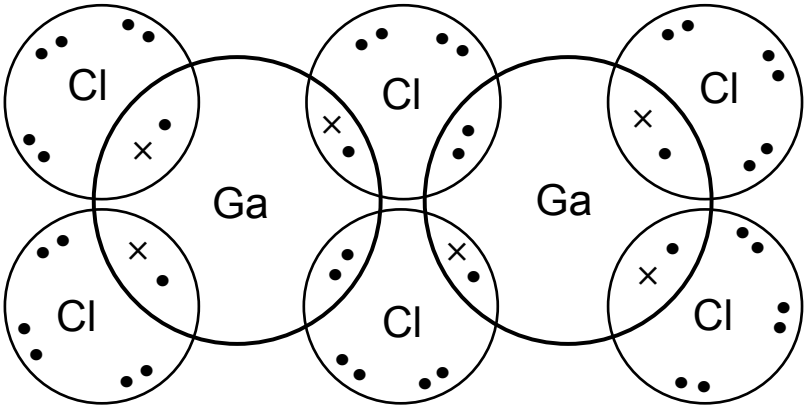
(iii) PCl_5 or $PCl_4^+PCl_6^-$ [1]

(iv) basic [1]
acidic [1]
acidic [1] [3]

(b) **(i)** $Ga_2O_3 + 6HCl \rightarrow 2GaCl_3 + 3H_2O$ [2]

unbalanced [–1]

(ii)



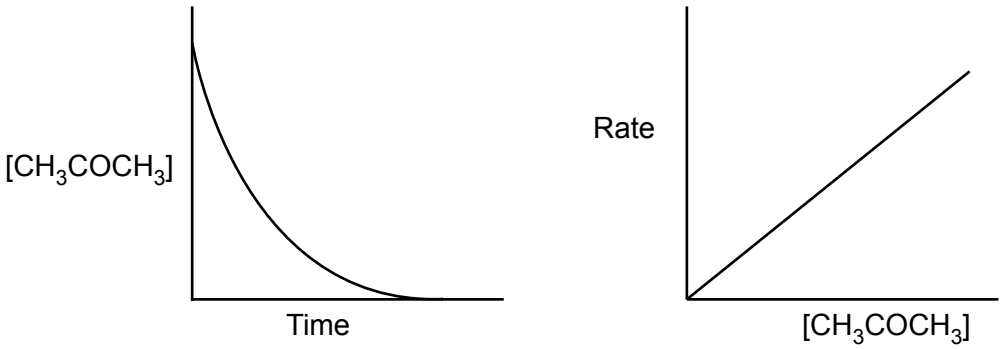
[2] 10

14 **(a)** $2KI + 3H_2SO_4 + MnO_2 \rightarrow I_2 + 2KHSO_4 + MnSO_4 + 2H_2O$ [2]
unbalanced [–1]

(b) **(i)** colorimeter [1] [1]

(ii) rate constant [1]
$dm^3mol^{-1}s^{-1}$ [1] [2]

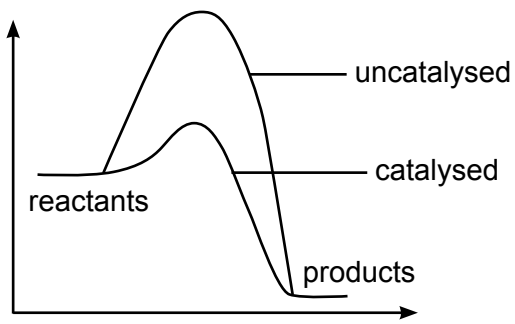
(iii)



[2]

(iv) × 4 [1]

(v)



missing label [–1] [2]

(vi) increases k (as Eact is smaller) [1]

(c) **(i)** known mass of oil [1]
add Wij's solution and place in dark and add KI(aq) [1]
prepare blank [1]
titrate with standard sodium thiosulphate [1]
starch indicator [1] [5]

Quality of written communication: [2]

2 marks The candidate expresses ideas clearly and fluently through well-linked sentences and paragraphs. Arguments are generally relevant and well-structured. There are few errors of grammar, punctuation and spelling.

1 mark The candidate expresses ideas clearly, if not always fluently. Arguments may sometimes stray from the point. There may be some errors of grammar, punctuation and spelling, but not such as to suggest a weakness in these areas.

0 marks The candidate expresses ideas satisfactorily, but without precision. Arguments may be of doubtful relevance or obscurely presented. Errors in grammar, punctuation and spelling are sufficiently intrusive to disrupt the understanding of the passage.

(ii) saturated / few C═C double bonds [1]

(d) **(i)** $H_2 + I_2 \rightarrow 2HI$

1 1 0

0.25 0.25 1.5

$K_c = [HI]^2 / [H_2][I_2]$

$= 1.5^2 / 0.25 \times 0.25$

$= 36$ [2]

no units [1] [3]

(ii) volumes would cancel [1]

(iii) 0.0277 or $\frac{1}{36}$ (carry error through from part **(i)**) [1]

(e) $Pb(NO_3)_2 + 2KI \rightarrow PbI_2 + 2KNO_3$

moles KI = $50 \times 0.4 / 1000 = 0.02$ gives 0.01 mol PbI_2

moles PbI_2 formed = $3.8 / 461 = 0.00824$

% yield = $(0.00824 / 0.01) \times 100$

= 82.4%

award [3] for correct answer

each error [–1], carry error through [3] 27

15 **(a)** +7 [1]
+3 [1] [2]

(b) **(i)** $1s^2 2s^2 2p^6$ [1]
$1s^2 2s^2 2p^6 3s^2 3p^6$ [1] [2]

(ii) X = first ionisation energy of Mg [1]
Y = (twice) electron affinity for chlorine [1]
Z = (standard) enthalpy of formation of $MgCl_2$ [1] [3]

(iii) $+148 \; +738 \; +1451 + 242 \; -696 = -642 + \Delta H_{latt}$
$\Delta H_{latt} = +2525 \; (kJmol^{-1})$
each error [–1] [2]

(c) **(i)** $CH_3CH_2CH_2COOH + SOCl_2 \rightarrow CH_3CH_2CH_2COCl + SO_2 + HCl$ [1]

$CH_3CH_2CH_2COOH + PCl_5 \rightarrow CH_3CH_2CH_2COCl + POCl_3 + HCl$ [1] [2]

(ii) more pure [1]
other products are gaseous [1] [2]

(d) **(i)** (increase dissociation)
increase temperature moves eqn to rhs [1]
to absorb thermal energy / endothermic direction [1] [2]

(ii) (decreased dissociation)
eqn moves to lhs [1]
to side with fewer molecules / reduce pressure [1] [2]

(iii)

SO_2Cl_2	$\rightarrow$	SO_2	+	Cl_2
2		0		0
0.5		1.5		1.5

partial pressure $SO_2 = 1.5 / 3.5 \times 150 = 64.285$
partial pressure $Cl_2 = 64.285$
partial pressure $SO_2Cl_2 = 0.5 / 3.5 \times 150 = 21.43$
$K_p = PP(SO_2) \times PP(Cl_2) / PP(SO_2Cl_2)$
$= (64.285)^2 / 21.43$
$= 192.85$ [3] kPa [1]
each error [–1], carry error through [4]

(e) $SO_2Cl_2 + 2H_2O \rightarrow H_2SO_4 + 2HCl$

1 mole $SO_2Cl_2 \rightarrow$ 4 moles H^+

135 g = 1 mole

$[H^+] = 4M$

pH = –log 4

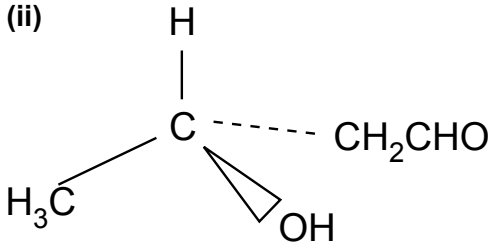
= –0.6

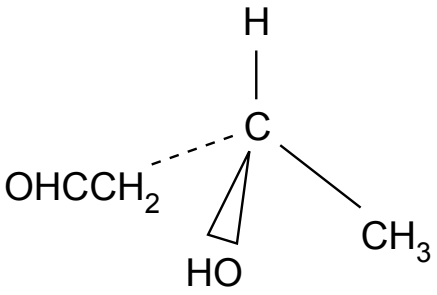
each error [–1], carry error through [3] 24

16 **(a)** $C_2H_5OH \rightarrow CH_3CHO + H_2$ [1]

(b) **(i)** rotate (the plane) [1]
of plane polarised light [1]
(plane must be mentioned at least once) [2]

(ii)





[2]

(iii) $CH_3—CH=CH—CHO$ [1] 6

Section B **100**

Total **120**

Rewarding Learning

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Chemistry

Assessment Unit A2 2

assessing

Analytical, Transition Metals, Electrochemistry and Further Organic Chemistry

[AC222]

TUESDAY 1 JUNE, AFTERNOON

MARK SCHEME

Section A

1 C

2 A

3 D

4 C

5 B

6 C

7 D

8 D

9 C

10 B

[2] for each correct answer [20] 20

Section A **20**

Section B

11 (a)

Titration	Indicator	Colour change	
		from	to
Magnesium/Edta	Eriochrome black T	Red	Blue
Iodine/Thiosulphate	Starch	Blue/Black	Colourless

[1] for the correct indicator
[1] for the correct colour change [6]

(b) (i) $MnO_4^- + 8H^+ + 5Fe^{2+} \rightarrow Mn^{2+} + 4H_2O + 5Fe^{3+}$
Formulae [1], balancing [1] [2]

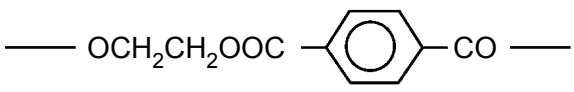
(ii) Colourless [1] to pink [1] [2]

(iii) Moles of MnO_4^- = (18.7 × 0.01)/1000 = 1.87×10^{-4}
Moles of $FeC_4H_2O_4$ in 25 cm^3 = $(1.87 \times 10^{-4}) \times 5 = 9.35 \times 10^{-4}$
Moles of $FeC_4H_2O_4$ in 250 cm^3 = 9.35×10^{-3}
Mass of $FeC_4H_2O_4$ = $(9.35 \times 10^{-3}) \times 170 = 1.59$ g
Mass of $FeC_4H_2O_4$ in 1 tablet = 1.59/5 = 0.318 g
(4 marks, [–1] for each mistake) [4] 14

12 (a) (i) Temperature: 20–75 °C [1]
Pressure: 1–25 atmospheres [1]
Catalyst: Ziegler/titanium(IV) chloride and triethylaluminium [1] [3]

(ii) High density: (little branching/high crystallinity)/low flexibility
or
Low density: (high branching/low crystallinity)/high flexibility [2]

(b) (i)



2 marks ([–1] for each mistake) [2]

(ii) e.g. clothing/plastic bottles [1] 8

13 **(a)** Polydentate ligand: a ligand with more than one lone pair of electrons which forms more than one central bond (with a coordinate/dative metal) [2]

(b) **(i)** 4 [1]

(ii) Square planar [1]

(iii) —— : Covalent bond [1]
----- : Hydrogen bond [1]
⟶ : Dative/Co-ordinate bond [1] [3]

(c) (dimethylglyoxime) replaces 6 water molecules/
or 3 molecules → 7 molecules. [1]
This increases the overall entropy [1] [2] 9

14 **(a)** methyl –2, 4, 6 – trinitrobenzene [1]

(b) $2C_7H_5N_3O_6 + 10\frac{1}{2}\text{or}\frac{21}{2}O_2 \rightarrow 14CO_2 + 3N_2 + 5H_2O$
Formulae [1], balancing [1] [2]

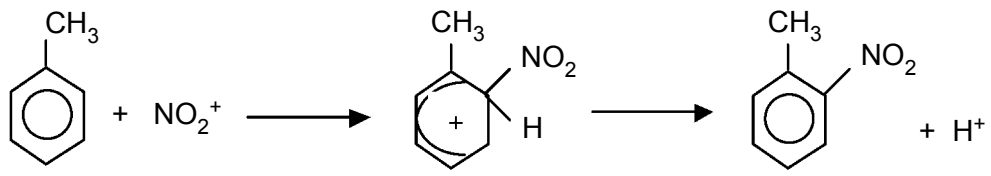
(c) **(i)** Concentrated nitric acid [1] and
concentrated sulphuric acid [1] [2]

(ii) $HNO_3 + 2H_2SO_4 \rightarrow NO_2^+ + 2HSO_4^- + H_3O^+$
Formulae [1], balancing [1] [2]

(iii) Nitronium ion [1]

(d) **(i)** Electrophilic [1] substitution [1] [2]

(ii)



([–1] for each mistake) [2]

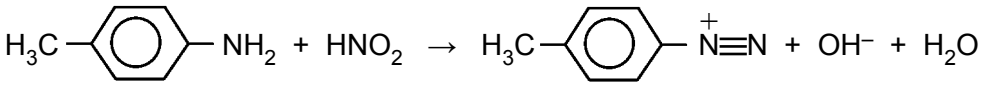
(e) **(i)** Tin [1] in (concentrated) hydrochloric acid [1] [2]

(ii) Addition of alkali to the salt [1]
([–1] for each mistake)

(f) **(i)** $NaNO_2 + HCl \rightarrow HNO_2 + HCl$ [1]

(ii) Below 10°C [1]

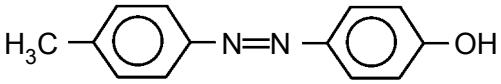
(iii)



([–1] for each mistake) [2]

(g) **(i)** Coupling [1]

(ii)



([–1] for each mistake) [2]

(iii) Conjugated (double bonds)/Delocalised/Energy levels close together [1]
Hence electron excited/move to higher energy level [1]
Removes a colour from light [1] [3] 25

15 **(a)** Transition metal atoms/ions have an incomplete d-subshell. [1]

(b) **(i)** $2SO_2 + O_2 \rightarrow 2SO_3$ [1]

(ii) It is in a different physical state from the reactants. [1]

(iii) Reactants adsorb onto the surface [1]
Bonds weakened in the reactants [1]
Bonds form in products and products are desorbed from the surface [1]
Orientation/closer together/lower activation energy [1]
Any 3 from 4 [3]

(c) **(i)**

Ion	Colour
VO_2^+ (aq)	
VO^{2+} (aq)	**Blue**
V^{3+} (aq)	**Green**
V^{2+} (aq)	

([1] each) [2]

(ii) $3VO_2^+(aq) + 6H^+(aq) + Cr(s) \rightarrow 3VO^{2+}(aq) + 3H_2O(l) + Cr^{3+}(aq)$

Formulae [1], balancing [1]

e.m.f. +1.74 V [1] [3]

(d) **(i)** Hydrogen peroxide [1]

(ii) Green [1] to yellow [1] [2]

(iii) Colour change from orange to yellow [1]
H^+ ions will be removed [1]
Equilibrium moves to the left [1] [3] 17

16 **(a)** **(i)** $C_{18}H_{27}O_3N$ [1]

(ii) 100 cm^3 contain 5 g
1000 cm^3 contain 50 g

$\frac{50}{305} = 0.164$ mol dm^{-3} [3]

(b) Place sample at the corner of a chromatogram [1]
Run the chromatogram in a suitable solvent [1]
(Dry chromatogram and) run at right angles in a different solvent [1]
Development + Compare R_f values or chromatogram run with capsaicin [1]
Quality of written communication [2] [6] 10

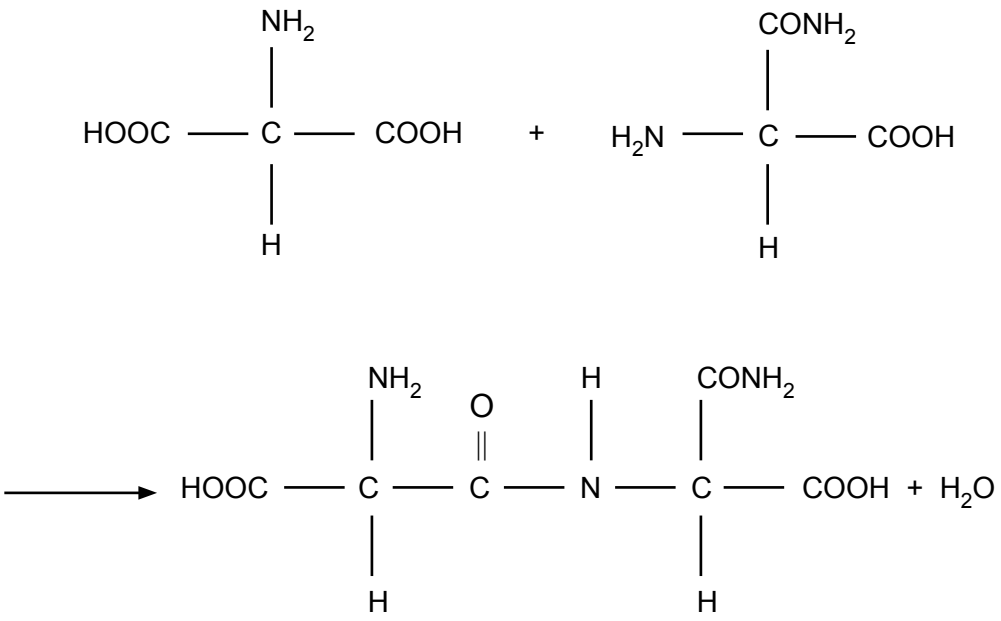
17 **(a)** **(i)** **Primary**: sequence of amino acids [1]
Secondary: alpha helix/beta pleated sheet [1] due to the formation of a hydrogen bond between the nitrogen of one peptide bond and the oxygen of another further along the chain [1]
Tertiary: cross links between amino acids [1] due to H-bonds between amino acids/electrostatic attractions between polar groups/ dipole–dipole interactions/Van der Waals forces between non-polar groups/disulphide bridges [1] [5]

(ii) The enzyme provides an active site [1]/lock and key mechanism [1] [2]

(iii) High temperature denatures the enzyme [1]
the structure and the active site is no longer functional [1]
(disrupts the secondary and tertiary structures by breaking bonds [1])
Any **two** [2]

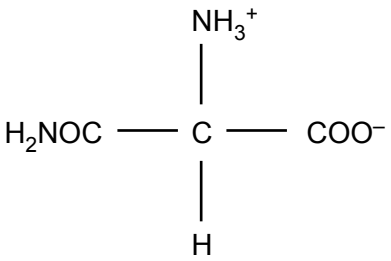
(b) (i) React with ammonia and heat the ammonium salt [1]

(ii)



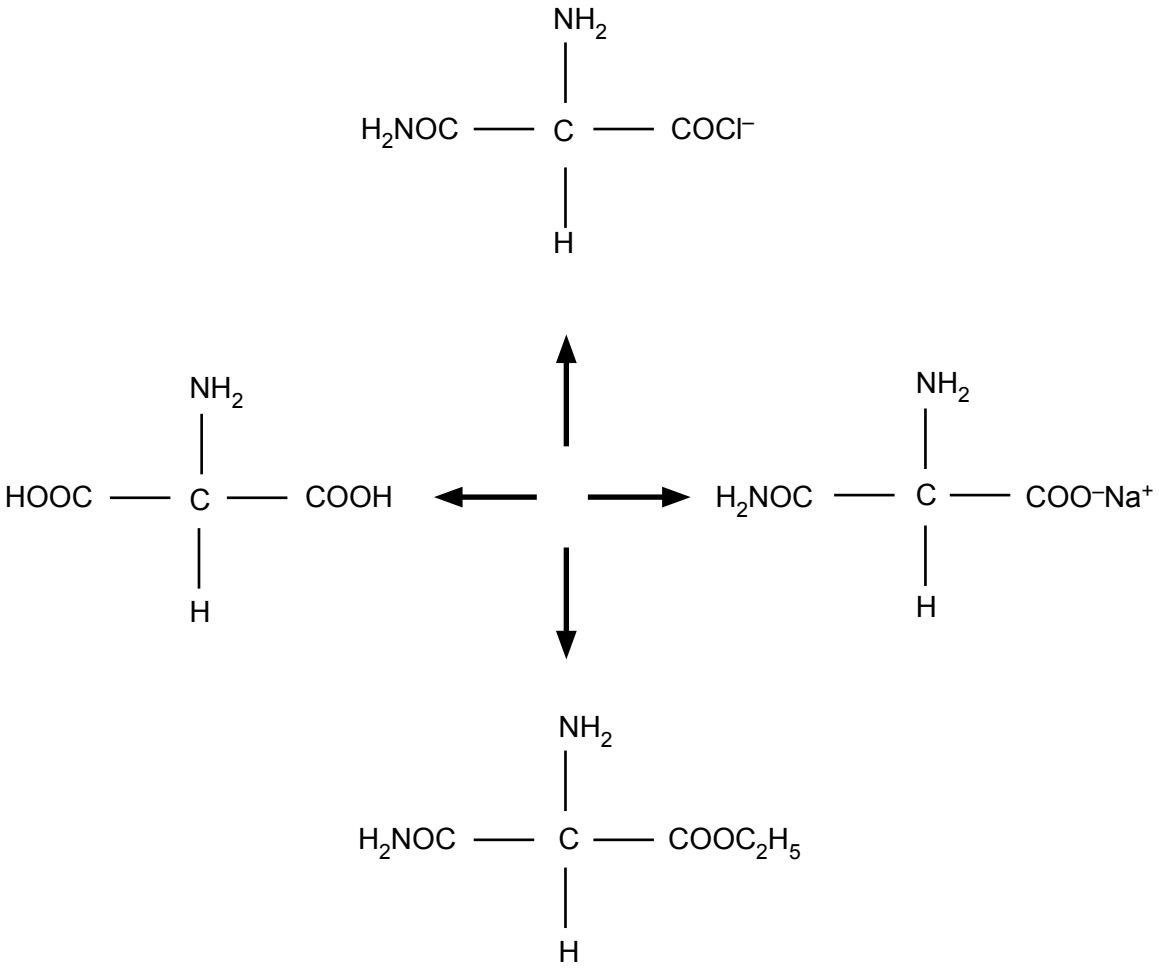
([–1] for each mistake) [2]

(iii)

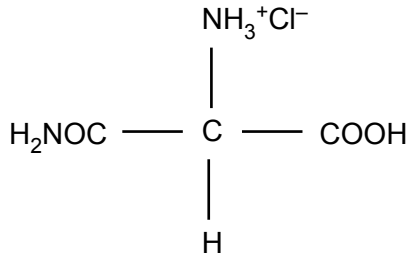


[1]

(iv)



or



([1] each) [4] 17

Section B **100**

Total **120**

Rewarding Learning

ADVANCED
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2010

Chemistry

Assessment Unit A2 3

Internal Assessment
Practical Examination 1

[AC231]

THURSDAY 20 MAY

MARK SCHEME

Annotation

1. Please do all marking in red ink.
2. All scripts are checked for mathematical errors. Please adopt the system of one tick (✓) equals [1] mark e.g. if you have awarded 4 marks for part of a question then 4 ticks (✓) should be on this candidate's answer.
3. As candidates have access to scripts please do not write any inappropriate comments on their scripts.

1 Titration exercise

(a) **Rinse** out a pipette with the solution of potassium iodate (V) and **transfer** a known volume of the solution into a (conical) flask [1]
Add a portion of sulphuric acid and a sample of potassium iodide [1]
Rinse out the burette with the solution of sodium thiosulphate and **fill** the burette [1]
Add the solution from the burette until the solution turns a straw yellow colour [1]
Add starch indicator [1]
Continue to add the solution from the burette one drop at a time until the solution changes from blue/black to colourless [1]
Repeat for reliability [1]

To a maximum of [6]

Mark denied if:
(i) there is no mention of rinsing pipette
(ii) there is no mention of rinsing burette

(b) Table [1]
Significant figures [2]
Calculation of average titre [2]
Titration consistency [2]
Agreement with supervisor's titre [3] [10]

NOTES:

Table:

Table should include initial burette reading, final burette reading, and volume delivered. Units should be included for volume delivered (may be omitted in the other readings). Mark denied if no indication of units.

Significant figures:

All burette readings should be to at least one decimal place – each mistake is penalised by 1 mark.
(However, initial burette readings of 0 are penalised once only)
If used, the second decimal position should be 0 or 5 only – other values are penalised by 1 mark for each.

Average titre:

Values for accurate titrations only should be used.
The use of the rough value is [−1].

The average value can be two decimal places, e.g. 25.37
An incorrect calculation is 0. Units must be included.
Mark denied if:
(i) only one accurate titration done or if the titre is not calculated correctly
(ii) units not included loses one mark

Titration consistency:

This is the difference between the first and second accurate readings

Difference	Mark
±0.1	[2]
±0.2	[1]
±0.3	[0]

Titration agreement with supervisor:

This is the difference between the average titre and the supervisor's value

Difference	Marks
±0.1	[3]
±0.2	[2]
±0.3	[1]
±0.4	[0]

Please note that the supervisor's titre should be recorded at the bottom of page 3 in the candidate's script in RED INK.
The marks for table, significant figures etc should be recorded on the left-hand side of the candidate's table of results.

(c) Correct calculation of moles of sodium thiosulphate [1]
Number of moles of sodium thiosulphate divided by two [1]

(d) (i) **2** IO_3^- + **12** H^+ + **10** e^- $\longrightarrow$ I_2 + **6** H_2O

2 **12** and **6** [1]

10 e^- [1]

(ii) $2\ IO_3^- + 12\ H^+ + 10\ I^- \longrightarrow 6\ I_2 + 6\ H_2O$

or $IO_3^- + 6\ H^+ + 5\ I^- \longrightarrow 3\ I_2 + 3\ H_2O$ [2]

(e) Moles of iodine from **(c)** divided by 3 [1]
then multiplied by 40 (1000/25) [1]
then multiplied by RFM of KIO_3 which is 214 [1] 25

Consequential marking/carry error through (CET) to be applied in calculations e.g. incorrect ratio in (d)(ii) can be carried through into part (e).

2 Observation/deduction

There are 28 scoring points available in question 2.
However the maximum marks for this question is 25.

In Tests 3 and 5 candidates can score additional marks to those indicated – see below.

If the candidate scores more than 25 then MAX 25 should be written at beginning of question in the teacher mark column.

(a) Test 1 *Blue [1] solid*

Test 2 *Blue solution [1]*

Test 3 *White [1] precipitate [1] blue solution remains [1]*
Candidates can score all three marks

Test 4 *Blue [1] precipitate [1]*

Test 5 *Blue [1] precipitate [1]*
precipitate dissolves [1]
deep blue solution [1]
Candidates can score all four marks

Test 6 *Green [1] solution [1]*
or yellow-green

Test 2 *$[Cu(H_2O)_6]^{2+}$ [1] – square bracket essential*

Test 5 *$[Cu(NH_3)_4(H_2O)_2]^{2+}$ [1] – square bracket essential*

Test 6 *$[CuCl_4]^{2-}$ [1] – square bracket essential*

Hydrated [1]
Copper (II) sulphate [1] (Accept copper sulphate.)

(b) *2 layers* [1]
red/red-brown [1]
solid [1]

structure of propanal [1]
structure of propanone [1]

(c) *solid disappears/dissolves* [1]
bubbles/fizzes/effervescence [1]
colourless gas/solution [1]
becomes warm [1]
Max 3

structure of propanoic acid [1]
structure of ethyl methanoate [1] 25

3 Planning exercise

(a) $Sn + 2\,I_2 \longrightarrow SnI_4$ [2]
(unbalanced [–1])

(b) Want actual yield of 6.0 g (0.00957 moles)

∴ theoretical yield is 6.67g [1] (or 0.0106 moles)

moles of iodine needed 0.0212 moles [1]

mass of iodine 5.40 [1] g [1]

Correct answer gets 4 marks. Units missing from final answer [–1] [4]

(c) **(i)** gloves since iodine is corrosive or DCM is toxic [1]
no naked flame/use electrical heater since DCM is flammable [1] [2]

(ii) repeated [1] boiling and condensing [1] of a reaction mixture
(without loss of material) [2]

(d) **(i)** colour (of iodine) [1] disappears [1] [2]

(ii) filter [1] [1]

(iii) evaporate the solvent until crystals begin to appear [1]
allow to cool and then filter [1] [2]

or

distil off the solvent [1]
using a water bath/fume cupboard / crystals in flask [1]

(iv) dissolve in minimum of the hot DCM [1]
filter while hot [1]
allow filtrate to cool [1]
filter again [1] to a maximum of [3]

Quality of written communication:

2 marks	The candidate expresses ideas clearly and fluently through well-linked sentences and paragraphs. Arguments are generally relevant and well-structured. There are few errors of grammar, punctuation and spelling.	
1 mark	The candidate expresses ideas clearly, if not always fluently. Arguments may sometimes stray from the point. There may be some errors of grammar, punctuation and spelling, but not such as to suggest a weakness in these areas.	
0 marks	The candidate expresses ideas satisfactorily, but without precision. Arguments may be of doubtful relevance or obscurely presented. Errors in grammar, punctuation and spelling are sufficiently intrusive to disrupt the understanding of the passage. [2]	20
	Total	**70**

Rewarding Learning

ADVANCED
General Certificate of Education
2010

Chemistry

Assessment Unit A2 3

Internal Assessment
Practical Examination 2

[AC232]

FRIDAY 21 MAY

MARK SCHEME

Annotation

1. Please do all marking in red ink.
2. All scripts are checked for mathematical errors. Please adopt the system of one tick (✓) equals [1] mark e.g. if you have awarded 4 marks for part of a question then 4 ticks (✓) should be on this candidate's answer.
3. As candidates have access to scripts please do not write any inappropriate comments on their scripts.

1 Titration exercise

(a) **Rinse** out a pipette with the solution of sodium iodate (V) and **transfer** a known volume of the solution into a (conical) flask [1]
Add a portion of sulphuric acid and a sample of potassium iodide [1]
Rinse out the burette with the solution of sodium thiosulphate and **fill** the burette [1]
Add the solution from the burette until the solution turns a straw yellow colour [1]
Add starch indicator [1]
Continue to add the solution from the burette one drop at a time until the solution changes from blue/black to colourless [1]
Repeat for reliability [1]

To a maximum of [6]

Mark denied if:
(i) there is no mention of rinsing pipette
(ii) there is no mention of rinsing burette

(b) Table [1]
Significant figures [2]
Calculation of average titre [2]
Titration consistency [2]
Agreement with supervisor's titre [3] [10]

NOTES:

Table:

Table should include initial burette reading, final burette reading, and volume delivered. Units should be included for volume delivered (may be omitted in the other readings). Mark denied if no indication of units.

Significant figures:

All burette readings should be to at least one decimal place – each mistake is penalised by 1 mark.
(However, initial burette readings of 0 are penalised once only)
If used, the second decimal position should be 0 or 5 only – other values are penalised by 1 mark for each.

Average titre:

Values for accurate titrations only should be used.
The use of the rough value is [−1].
The average value can be two decimal places, e.g. 25.37
An incorrect calculation is 0. Units must be included.
Mark denied if only one accurate titration done or if the titre is not calculated correctly.
Units not included loses one mark.

Titration consistency:

This is the difference between the first and second accurate readings

Difference	Mark
±0.1	[2]
±0.2	[1]
±0.3	[0]

Titration agreement with supervisor:

This is the difference between the average titre and the supervisor's value

Difference	Marks
±0.1	[3]
±0.2	[2]
±0.3	[1]
±0.4	[0]

Please note that the supervisor's titre should be recorded at the bottom of page 3 in the candidate's script in RED INK.
The marks for table, significant figures etc should be recorded on the left-hand side of the candidate's table of results.

(c) Correct calculation of moles of sodium thiosulphate [1]
Number of moles of sodium thiosulphate divided by two [1]

(d) (i) **2** IO_3^- + **12** H^+ + **10** e^- $\longrightarrow$ I_2 + **6** H_2O

2 **12** and **6** [1]

10 e^- [1]

(ii) 2 IO_3^- + 12 H^+ + 10 I^- $\longrightarrow$ 6 I_2 + 6 H_2O

or IO_3^- + 6 H^+ + 5 I^- $\longrightarrow$ 3 I_2 + 3 H_2O [2]

(e) Moles of iodine from **(c)** divided by 3 [1]
then multiplied by 40 (1000/25) [1]
then multiplied by RFM of $NaIO_3$ which is 198 [1] 25

Consequential marking/carry error through (CET) to be applied in calculations e.g. incorrect ratio in (d)(ii) can be carried through into part (e).

2 Observation/deduction

There are 28 scoring points available in question 2.
However the maximum marks for this question is 25.

In Tests 3 and 5 candidates can score additional marks to those indicated – see below.

If the candidate scores more than 25 then MAX 25 should be written at beginning of question in the teacher mark column.

(a) Test 1 *Pink [1] solid – accept red or red-brown*

Test 2 *Pink solution[1]*

Test 3 *White [1] precipitate [1] pink solution remains [1]*
Candidates can score all three marks

Test 4 *Blue [1] precipitate [1]*

Test 5 *Blue [1] precipitate [1]*
precipitate dissolves [1]
yellow-brown solution [1]
Candidates can score all four marks

Test 6 *Blue [1] solution [1]*

Test 2 $[Co(H_2O)_6]^{2+}$ *[1] – square bracket essential*

Test 5 $[Co(NH_3)_6]^{2+}$ *[1] – square bracket essential*

Test 6 $[CoCl_4]^{2-}$ *[1] – square bracket essential*

Hydrated [1]
Cobalt (II) sulphate [1] (Accept cobalt sulphate.)

(b) *2 layers* [1]
red/red-brown [1]
solid [1]

structure of propanal [1]
structure of propanone [1]

(c) *solid disappears/dissolves* [1]
bubbles/fizzes/effervescence [1]
colourless gas/solution [1]
becomes warm [1]
Max 3

structure of propanoic acid [1]
structure of ethyl methanoate [1] 25

3 Planning exercise

(a) $C_3H_7COOH + C_4H_9OH \rightleftharpoons C_3H_7COOC_4H_9 + H_2O$

(equilibrium arrows missing [–1]) [2]

(b) Want actual yield of 0.181 moles/26.1 g [1]

∴ theoretical yield is 0.259 moles/37.3 g [1]

moles of butanoic acid needed 0.259 moles [1]

mass of butanoic acid 22.8 [1] g [1]

Correct answer gets 4 marks. Units missing from final answer [–1] [4]

(c) Procedure:

Add (excess) butan-1-ol, butanoic acid and concentrated sulphuric acid to a (round-bottomed or pear-shaped) flask [1]
Reflux the mixture [1]
distil [1]
collect at 163–167°C [1]

Safety:

Either: gloves since concentrated sulphuric acid is corrosive
Or: add concentrated sulphuric acid slowly since exothermic
Or: add anti-bump granules to promote smooth boiling [1] [5]

(d) **(i)** shake with solution of sodium carbonate / hydrogencarbonate [1]
using a separating funnel [1]
separate the two layers/release pressure [1] [3]

(ii) (shake with) suitable named anhydrous solid [1]
filter/decant [1] [2]

(iii) distillation [1]
collect at 165°C (164°–166°) [1] [2]

Quality of written communication:

2 marks	The candidate expresses ideas clearly and fluently through well-linked sentences and paragraphs. Arguments are generally relevant and well-structured. There are few errors of grammar, punctuation and spelling.	
1 mark	The candidate expresses ideas clearly, if not always fluently. Arguments may sometimes stray from the point. There may be some errors of grammar, punctuation and spelling, but not such as to suggest a weakness in these areas.	
0 marks	The candidate expresses ideas satisfactorily, but without precision. Arguments may be of doubtful relevance or obscurely presented. Errors in grammar, punctuation and spelling are sufficiently intrusive to disrupt the understanding of the passage. [2]	20
	Total	**70**