Rewarding Learning

ADVANCED
General Certificate of Education

Chemistry

Assessment Unit A2 3

assessing

Further Practical Chemistry
Practical Booklet B (Theory)

[ACH32]

Assessment

MARK SCHEME

General Marking Instructions

Introduction

The main purpose of the mark scheme is to ensure that examinations are marked accurately, consistently and fairly. The mark scheme provides examiners with an indication of the nature and range of candidates' responses likely to be worthy of credit. It also sets out the criteria which they should apply in allocating marks to candidates' responses.

Assessment objectives

Below are the assessment objectives for **GCE Chemistry**:

Candidates should be able to:

AO1	Demonstrate knowledge and understanding of scientific ideas, processes, techniques and procedures.
AO2	Apply knowledge and understanding of scientific ideas, processes, techniques and procedures: • in a theoretical context • in a practical context • when handling quantitative and qualitative data
AO3	Analyse, interpret and evaluate scientific information, ideas and evidence (in relation to particular issues) • make judgements and reach conclusions • develop and refine practical design and procedures

Quality of candidates' responses

In marking the examination papers, examiners should be looking for a quality of response reflecting the level of maturity which may reasonably be expected of a 17- or 18-year-old which is the age at which the majority of candidates sit their GCE examinations.

Flexibility in marking

Mark schemes are not intended to be totally prescriptive. No mark scheme can cover all the responses which candidates may produce. In the event of unanticipated answers, examiners are expected to use their professional judgement to assess the validity of answers. If an answer is particularly problematic, then examiners should seek the guidance of the Supervising Examiner.

Positive marking

Examiners are encouraged to be positive in their marking, giving appropriate credit for what candidates know, understand and can do rather than penalising candidates for errors or omissions. The exception to this, for GCE Chemistry, is when examiners are marking complex calculations and mechanisms when the examiners are briefed to mark by error or omission. Examiners should make use of the whole of the available mark range for any particular question and be prepared to award full marks for a response which is as good as might reasonably be expected of a 17- or 18-year-old GCE candidate.

Awarding zero marks

Marks should only be awarded for valid responses and no marks should be awarded for an answer which is completely incorrect or inappropriate.

Marking Calculations

In marking answers involving calculations, examiners should apply the 'carry error through' rule so that candidates are not penalised more than once for a computational error. To avoid a candidate being penalised, marks can be awarded where correct conclusions or inferences are made from their incorrect calculations.

Types of mark schemes
Mark schemes for tasks or questions which require candidates to respond in extended written form are marked on the basis of levels of response which take account of the quality of written communication.

Other questions which require only short answers are marked on a point for point basis with marks awarded for each valid piece of information provided.

Levels of response
In deciding which level of response to award, examiners should look for the number of indicative content points in candidate responses to ensure that the answer has been written to coincide with the question. In deciding which mark within a particular level to award to any response, quality of communication will be assessed and examiners are expected to use their professional judgement.

The following guidance is provided to assist examiners.

- ***Threshold performance:*** Response which just merits inclusion in the level but the quality of communication is basic should be awarded a mark at the bottom of the range.
- ***High performance:*** Response which fully satisfies the level description for both content and quality of communication should be awarded a mark at the top of the range.

Quality of written communication
Quality of written communication is taken into account in assessing candidates' responses to all tasks and questions on theory examination papers that require them to respond in extended written form. These tasks and questions are marked on the basis of levels of response. The description for each level of response includes reference to the quality of written communication.

For conciseness, quality of written communication is distinguished within levels of response as follows:

Level C: Quality of written communication is basic.
Level B: Quality of written communication is good.
Level A: Quality of written communication is excellent.

In interpreting these level descriptions, examiners should refer to the more detailed guidance provided below:

Level C (Basic): Basic reference to scientific terminology. The candidate makes only a limited selection and use of an appropriate form and style of writing. The organisation of material may lack clarity and coherence. There is little use of specialist vocabulary. Presentation, spelling, punctuation and grammar may be such that intended meaning is not clear.

Level B (Good): Good reference to scientific terminology. The candidate makes a reasonable selection and use of an appropriate form and style of writing. Relevant material is organised with some clarity and coherence. There is some use of appropriate specialist vocabulary. Presentation, spelling, punctuation and grammar are sufficiently competent to make meaning clear.

Level A (Excellent): Excellent reference to scientific terminology. The candidate successfully selects and uses the most appropriate form and style of writing. Relevant material is organised with a high degree of clarity and coherence. There is widespread and accurate use of appropriate specialist vocabulary. Presentation, spelling, punctuation and grammar are of a sufficiently high standard to make meaning clear.

General marking guidance for GCE Chemistry

1. Alternative responses

In general, a solidus (/) used between responses indicates alternative answers or parts of an answer.

When a solidus may be confused with part of the answer (for example as a division sign or with units) "or" may be used to show alternatives.

Example: What is observed when propanone is warmed with Tollens' reagent? [1]
MS: remains colourless/no change [1]

2. Acceptable colours and observations

For the use of a solidus with the colours supplied in the ***acceptable colour changes and observations*** document, the solidus indicates that one of the responses should be given.

Example: What colour is the flame observed when a flame test is carried out on a sample of sodium chloride? [1]
MS: yellow/orange [1]

Response	Candidate Response	Marks awarded	Notes
1	yellow	1	Correct response
2	orange	1	Correct response
3	yellow-orange	0	Both responses with a hyphen not credited

In the acceptable colour changes and observations document, where two colours are given with a hyphen between them, this indicates that both colours are required in a response with the hyphen between them.

Example: What is observed when a few drops of sodium hydroxide solution are added to a solution containing Cr^{3+} ions? [1]
MS: green-blue ppt [1]

Response	Candidate Response	Marks awarded	Notes
1	green-blue ppt	1	Correct response
2	blue-green ppt	1	Correct response
3	blue/green ppt	0	Hyphen is required between the colours
4	blue ppt	0	Both colours required with a hyphen
5	green ppt	0	Both colours required with a hyphen

Note that in Booklet A of AS3 and A23, more flexibility is allowed on the marking of colours. A range of colours and shades of those colours will be accepted.

3. Brackets in a response

Normal parentheses used in a mark scheme response means that a term is **not required** for the response to be marked correct. However, an incorrect term would lose the mark.

Example: Describe how you would make a salt bridge using paper in the laboratory. [1]
MS: Soak a strip of filter paper in a (saturated/concentrated) solution of potassium chloride/potassium nitrate [1]

Response	Candidate Response	Marks awarded	Notes
1	soak filter paper in potassium chloride solution	1	Correct response
2	soak a piece of filter paper in dilute potassium nitrate solution	0	Not accepted as dilute is incorrect

4. Marking of lists

Where candidates give extra responses, additional correct responses can be ignored.

Additional neutral responses can also be ignored. A neutral response is one which does not have a bearing on the question but is not incorrect.

Additional incorrect responses **cancel out** a correct response to the marking point to which they pertain.

Example: Describe how the presence of chloride ions could be confirmed in a sample of solid sodium chloride. [4]
MS: dissolve the solid in water/nitric acid [1]
add silver nitrate solution [1]
white [1] precipitate [1] [4]

Response	Candidate Response	Marks awarded	Notes
1	Dissolve the solid in nitric acid and add silver nitrate solution and you will get a white precipitate/solution	3	The last mark is not awarded as solution is an incorrect response cancelling out the correct response.
2	Put the solid in water and add silver nitrate and ammonia. You will get a white precipitate.	3	No mention of **solution** with silver nitrate and ammonia is not completely incorrect but in context of this response it cancels out the second mark as well if they had written solution
3	Add silver nitrate solution and you get a white precipitate/solution	2	First mark not awarded and precipitate mark not awarded as solution would cancel this out

5. Marking values where a range is given

Where a numerical range is given, correct responses are any value in the range, the range itself or any other range given which falls within the MS range.

Example: Name the reagents and conditions under which they are used to form the benzenediazonium ion from phenylamine. [2]

MS: sodium nitrite and (dil/conc) hydrochloric acid [1]
temperature 0 – 10 °C/in ice [1]

Focussing on the range awarded for the second mark.

Response	Candidate Response	Marks awarded	Notes
1	0	1	A single value within the accepted range
2	1	1	A single value within the accepted range
3	5	1	A single value within the accepted range
4	10	1	A single value within the accepted range
5	2.5	1	A single value within the accepted range
6	0–10	1	The accepted range
7	5–10	1	A range given within the accepted range
8	5–15	0	Range given outside the accepted range

6. Names of compounds

- Any question which asks you to "name" a chemical expects a correct chemical name and any errors in the name given by a candidate will be a –1 error.
- Where a question asks for an IUPAC name for an organic compound, the answer will require, where appropriate, correct locant numbers, dashes, commas and spaces. Each error is –1.
- The term systematic name is often used in inorganic nomenclature where oxidation states are required, e.g. sodium sulfate(IV). An incorrect oxidation state would be a –1 error.

7. Marking equations

Some general points about formulae and equations:

- Equations are usually worth 1 mark if they do not require balancing, however very familiar equations with balancing may only be worth 1 mark and in that case all formulae and balancing must be correct.
- Equations worth 2 marks are marked as [1] for all formulae being correct and [1] for correct balancing. The balancing mark is dependent on the formulae mark and is only considered if all the formulae are correct. If any formula incorrect, no marks are awarded.
- Some more complex structural equations are worth 3 marks. Details of how to mark these questions will be provided in the mark scheme.

8. QWC

Quality of written communication is marked using indicative content and a banded mark scheme.

The initial marking is for the indicative content points. The number of indicative content points places a candidate in a specific band. The overall marks awarded should be in that band based on the standard of the written communication.

A typical banded grid from a mark scheme where there would be 8 indicative content points is shown below:

Band	Response	Mark
A	Candidates must use appropriate specialist terms including a minimum of 7 points of indicative content. They use good spelling, punctuation and grammar and the form and style are of a high standard.	[5]–[6]
B	Candidates must use appropriate specialist terms including a minimum of 5 points of indicative content. They use satisfactory spelling, punctuation and grammar and the form and style are of a satisfactory standard.	[3]–[4]
C	Candidates provide a brief and partial response including a minimum of 2 points of indicative content. They use limited spelling, punctuation and grammar and they have made little use of specialist terms. The form and style are of a limited standard.	[1]–[2]
D	Response not worthy of credit.	[0]

[6]

A candidate who provides 5 indicative content points is placed in band B and can be awarded 3 or 4 overall marks (out of 6) for their response based on the spelling, punctuation and grammar.

Generally, the upper mark in a band would be awarded unless the quality of the written communication was very poor (i.e. multiple spelling, punctuation and grammar errors).

9. Marking calculations

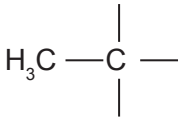
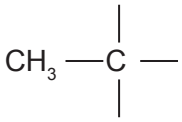
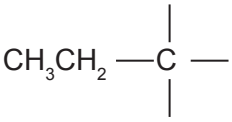
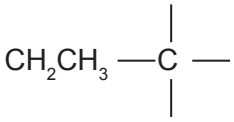
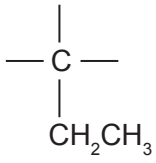
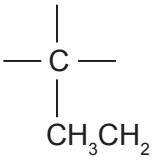
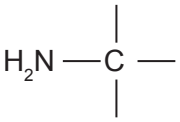
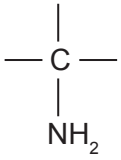
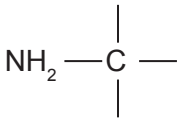
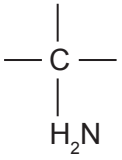
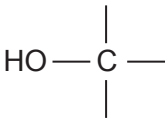
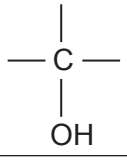
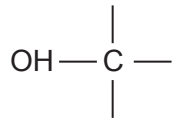
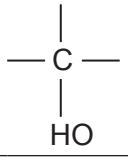
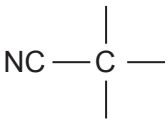
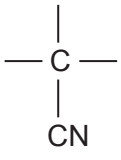
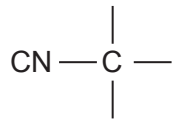
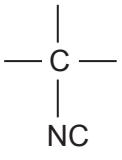
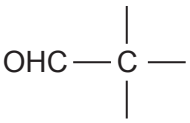
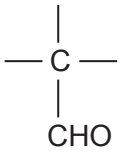
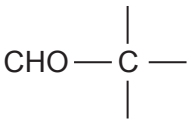
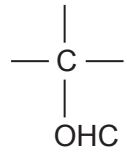
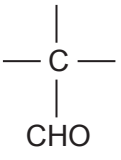
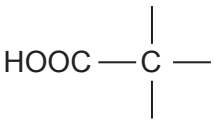
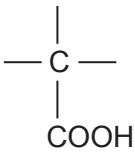
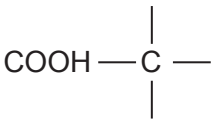
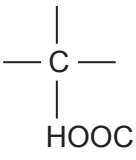
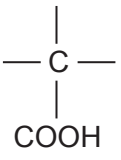
- The total marks in a calculation are given at the end of the question part on the mark scheme and each error in the calculation is –1 mark.
- Errors in a calculation may be carried forward within part of a calculation. This should be indicated using ECF.
- Where a specific number of significant figures or decimal places is asked for in the question, this should be provided and not following this instruction would be classed as an error.
- The phrase “appropriate number of significant figures” is used where a candidate must make a decision about the number of significant figures they use for their final answer. This will be the lowest number of significant figures in the data provided which is used in the calculation.
- Calculations which use the number in the calculator and arrive at the correct answer (following any instructions regarding significant figures or decimal places) can be awarded full marks.
- A correct numerical answer to a calculation (given to the specified number of significant figures or decimal places or correct appropriate number of significant figures) can be awarded full marks provided that the question does not state that working out must be shown.
- Where appropriate, units would be required with a numerical answer.

10. Definitions

- Definitions are provided in the clarification of terms document. Each error/omission in the definition is -1. Correct extra information provided by a candidate would not be penalised.
- Minor errors should not be penalised if they do not change the meaning of the answer given.

11. Organic structures

- Structural formulae should generally show the individual groups or atoms bonded to each carbon atom in the main chain or ring structure. CH_3, CH_2, CH, OH, NH_2, CN, CHO, CO, COOH, COCl, COO, $CONH_2$ etc do not need to be expanded to show all bonds except where specifically asked for in the question.
- Skeletal formulae must show the angled chain. Functional groups should be clearly shown with all atoms except for carbon atoms.
- Each organic structure is generally worth 1 mark. However more complex structures may be worth more marks.
- Connectivity of atoms in structural formulae should only be penalised based on what is presented in the table.
- Bonds to groups on the left (or right) of a structure should be connected to the correct atom apart from in the case of CH_3 groups.
- Bonds going vertically to groups should be bonded to the correct atom, however if the bond appears to be close to the required atom, this may be accepted.

Accepted	Not accepted
	N/A
	N/A
	
	
 	 
 	 
 	 
 	  
 	  

12. Mechanisms

The following features are required for electrophilic addition, electrophilic substitution, nucleophilic substitution and nucleophilic addition mechanisms:

1. Curly arrows (coming from a bond or the ring of a benzene ring or from a lone pair of electrons) When the curly arrow is showing the formation of a bond, it may go to the atom, close to the atom or in the position where the bond would form.
2. Lone pairs of electrons shown as a double dot beside the relative atom/ion.
3. Any charges on the intermediates in the mechanism.
4. Any leaving group shown in the products for substitution mechanisms.

Note that for radical substitution mechanisms the dot may be placed before or after the radical.

13. Marking diagrams

- Diagrams of apparatus are again marked in terms of the errors. Each error is -1.
- Diagrams of apparatus are expected to be two-dimensional cross-sectional diagrams of the assembled apparatus with clear labelling and recognisable pieces of apparatus.
- There should be no blockage to the flow of liquids or gases in a diagram of apparatus such as a line across the end of a delivery tube or the exit or entry from a piece of glassware unless intentional such as the valve in a separating funnel.

14. Solution/aqueous

- When describing a practical method or test and a solution of a substance is used, the term **solution** is required in the response unless it is in brackets in the mark scheme.
- The term solution is equivalent to aqueous. For example, aqueous sodium hydroxide is the same as sodium hydroxide solution.
- Solution is not required for dilute acids.

1 **(a)** calcium carbonate is insoluble in water [1]

(b) **(i)** bubbles (of gas) stop forming [1]

(ii) test for calcium ions:
dip a nichrome wire into sample solution and place in blue Bunsen (burner) flame/carry out a flame test [1]
brick red/red flame [1] [2]

test for chloride ions:
add silver nitrate solution [1]
white ppt [1] [2]

(c) transfer the solution to the 250 cm^3 volumetric flask [1]
rinse the conical flask with deionised water and add washings to the volumetric flask [1]
make up to the mark by adding deionised water until the bottom of the meniscus is on the mark (or line) [1]
stopper the flask and invert to mix [1] [4]

(d) colourless to pink [1]

(e) **(i)** moles of hydrochloric acid = 2.45×10^{-3} [1]

(ii) 2.45×10^{-2} [1]

(iii) original moles = $\frac{2.00 \times 25.0}{1000} = 0.05$
reacting moles = $0.05 - 2.45 \times 10^{-2} = 0.0255$ [1]

(iv) Mass of calcium carbonate = $\frac{0.0255}{2} \times 100 = 1.275/1.28\,g$ [2]

(v) $1.275 \div 1.76 \times 100 = 72/72.4\%$ [2]

AVAILABLE MARKS

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				AVAILABLE MARKS
2	**(a)**	100 kPa 25 °C/298 K 1 mol dm^{-3} (error [–1])	[2]	
	(b)	**(i)** $MnO_4^- + 5Fe^{2+} + 8H^+ \rightarrow Mn^{2+} + 5Fe^{3+} + 4H_2O$	[2]	
		(ii) add a few drops of aqueous sodium hydroxide/ammonia solution [1] brown ppt [1]	[2]	
	(c)	**(i)** the position of equilibrium will move to the right	[1]	
		(ii) emf becomes smaller/less positive	[1]	
	(d)	the purple colour fades/purple to colourless	[1]	
	(e)	**(i)** silver spoon and aluminium, both in contact with sodium hydrogencarbonate solution [1] connecting wire [1]	[2]	
		(ii) $Ag^+ + e^- \rightarrow Ag$ [1] $Al \rightarrow Al^{3+} + 3e^-$ [1]	[2]	
		(iii) $3Ag^+ + Al \rightarrow Al^{3+} + 3Ag$	[1]	
		(iv) 0.80 + 1.66 = + 2.46 V	[1]	
		(v) the aluminium would stop reacting	[1]	
		(vi) $3Ag_2S + 2Al \rightarrow 6Ag + Al_2S_3$	[1]	
		(vii) hydrogen sulfide	[1]	18

AVAILABLE MARKS

3 **(a)** **(i)** atom economy = $\frac{180}{240} \times 100 = 75\%$ [2]

(ii) ethanoic acid [1]
reaction does not go to completion/reaction is too slow [1]
or
ethanoyl chloride [1]
produces HCl gas/vigorous reaction/safety [1] [2]

(b) **(i)** a catalyst [1]

(ii) $(CH_3CO)_2O + H_2O \rightarrow 2CH_3COOH$ [1]

(iii) white solid/crystals [1]

(iv) dissolve in a minimum volume of hot solvent [1]
filter when hot using gravity filtration [1]
allow to cool and crystallise [1]
filter (off the crystals) using suction filtration [1]
any 3 from 4 [3]

(c) **(i)** lower spot aspirin/upper spot salicylic acid [1]

(ii) R_f of aspirin about 0.57
R_f of salicylic acid about 0.66 [1]

(d) theoretical yield of aspirin = $\frac{6}{138} \times 180 = 7.83\,g$

% yield = $\frac{7}{7.83} \times 100 = 89.4\%$ [3]

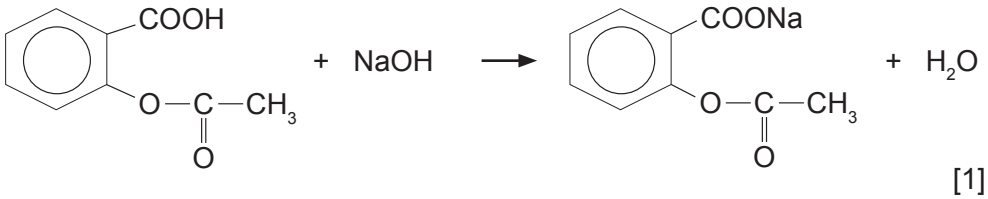
(e) **(i)** incomplete reaction/side reaction [1]

(ii) loss in transfer/loss in separation/loss in recrystallisation [1]

(f) ester (group) [1]

(g) prepare solutions of salicylic acid/Fe^{3+} complex at different concentrations [1]
plot a calibration curve of absorbance against concentration [1]
dissolve an aspirin tablet in a suitable solvent and
add excess aqueous Fe^{3+} ions [1]
place in colorimeter, record absorbance and use graph to determine concentration [1] [4]

(h) (i)



[1]

(ii) less acidic so less irritation of digestive system [1]
or
more soluble so more quickly absorbed (into bloodstream) [1] [1]

Total

AVAILABLE MARKS
24
60