

AS/ADVANCED GCE CHEMISTRY

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**TEACHER SUPPORT: COURSEWORK GUIDANCE
SECOND EDITION**

Foreword to the Second Edition

This is the Second Edition of the Teacher Support: Coursework Guidance booklet designed to accompany the OCR Advanced Subsidiary GCE and Advanced GCE in Chemistry.

This revision was carried out in Spring 2003 in the light of the moderation of coursework in January and June 2002.

It should be emphasised that there are no changes to the regulations concerning coursework. This booklet has been written to give further guidance to assist the teaching and assessing of the coursework components of the AS and A2 units of the specification.

Sidelines in Sections 1-5 indicate where passages from the previous coursework guidance booklet have been rewritten.

There are significant differences between this edition and the first edition published in September 2000:

- The exemplar materials have been extensively revised (now in Section 6).
- The Appendices have been restructured
- The AS exemplars have been more structured.
- The Organic Unknown exemplar for A2 has been extensively revised with new examples. Accompanying spectra can be found in Appendix 1.
- Three new exemplars have been added for A2.
- Marking criteria for all exemplars have been revised.

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1 General Introduction

This guide has been written to assist teachers in setting suitable coursework tasks and in assessing candidates' work. The guide should be read in conjunction with the specification itself. However, all sections of the specification relating to coursework assessment are included here.

While this guide is concerned with the assessment of coursework, it cannot be emphasised too strongly that before candidates are assessed on their experimental and investigative skills, whether by coursework or by practical examination, these skills must be taught and candidates must have opportunities to practise and to develop their abilities.

Experimental and Investigative skills may be assessed either **internally** (by coursework) or **externally** (by a combination of an externally marked task and a practical examination).

Entries are made for Unit 2813 (in AS) or 2816 (in A2). In each of these Units, candidates must take two components - a written paper (Component 01) and one of the above two assessments of experimental and investigative skills (Components 02 or 03). Both written paper and skills assessment components **must** be taken in the same examination session.

Centres may opt to enter candidates for:

- coursework in AS and in A2;
- the practical examination in AS and in A2;
- coursework in AS and the practical examination in A2;
- the practical examination in AS and coursework in A2.

In Unit 2813, Components 02 and 03, marks contribute towards Assessment Objective AO3, Experiment and Investigation.

In Unit 2816, Components 02 and 03, marks contribute equally to Assessment Objectives AO3 and AO4, Synthesis of Knowledge, Understanding and Skills. There is assessment of AO4 because:

- candidates are required to use chemical knowledge and understanding from other modules of the specification in planning their experimental and investigative work, and in analysing evidence and drawing conclusions;
- in the assessment of all four experimental skills in Components 02 and 03, taken at the end of the course of study, candidates are expected to draw on their experience of such work throughout the course, and in particular on the outcome of the assessment of these skills in Components 02 and 03.

Practical work provides many opportunities to develop key skills and to collect evidence that may contribute towards the assessment of key skills. Full details are given in Appendix A of the specification and links are identified throughout the content of the specification booklet. Teachers are advised to discuss such opportunities with colleagues and with the students concerned.

2 Coursework Assessment

Unit 2813/02 – Coursework 1 (60 Marks)

Unit 2816/02 – Coursework 2 (60 Marks)

Assessment of candidates' experimental and investigative work is made by the teacher (as coursework) and moderated externally by OCR.

Skills **P** and **A** are marked out of 8 and Skills **I** and **E** are marked out of 7. Thus, for each candidate entered for 2813 (Component 02), and for 2816 (Component 02), Centres are required to award **one** mark for each of Skills **P**, **I**, **A** and **E**. Hence the maximum raw mark available for each component is 30. These marks are then doubled so that the final marks submitted are out of 60.

Candidates' marks are recorded on a coursework assessment form, a copy of which is included in Appendix 4. Also included is a copy of the cover sheet that should be attached to each candidate's work submitted for moderation. Centres are provided with these forms according to the number of entries made, but the forms may be freely photocopied if desired.

When a skill has been assessed on more than one occasion, in Advanced Subsidiary or in A2, the better or best mark for that skill should be submitted. However, Centres are recommended **not** to assess the skills on more than two occasions in each of Advanced Subsidiary and A2 since this may take up time which might better be devoted to other aspects of the specification.

The skills may be assessed at any time during the course using suitable practical activities based on laboratory work, related to or part of the content of the teaching course. The context(s) for the assessment of the coursework for the AS Component 02 should be drawn from the content of the Advanced Subsidiary modules, 2811: Foundation Chemistry, 2812: Chains and Rings and 2813 (Component 01): How Far, How Fast? The context(s) for the assessment of the coursework for the A2 2816 (Component 02) should be drawn from the content of the A2 modules, 2814: Chains, Rings and Spectroscopy, 2815: Trends and Patterns/Options and 2816 (Component 01): Unifying Concepts in Chemistry in which the level of demand of the related scientific knowledge and understanding is higher.

In Advanced Subsidiary GCE and in A2 the skills may be assessed in the context of separate practical exercises, although more than one skill may be assessed in any one exercise. They may also be assessed all together in the context of a single 'whole investigation' in which the task is set by the teacher, or using individual investigations in which each candidate pursues his or her own choice of assignment.

A similar set of mark descriptors is used for both Advanced Subsidiary and A2. These descriptors have been written to provide clear continuity from the assessment of Sc1 in GCSE Science. The difference in standard of Advanced Subsidiary and A2 is a product of the level of demand of the related scientific knowledge and understanding expected and the complexity and level of demand of the tasks set. Also, the mark descriptors for Skills **P** and **A** at A2 include synoptic elements.

Marks submitted for coursework assessment must have been generated from candidates' individual work. Group work is not suitable for assessment unless the work of the individual candidate can be quite clearly identified both by the teacher and the moderator. In some cases it is necessary for candidates to work collectively in order to collect sufficient data for analysis; in these circumstances, planning and implementing should not be assessed but the work of candidates may be assessed in analysing and evaluating their results, when they are working independently.

The submission of proposed coursework tasks for approval by OCR is not a requirement of the scheme. However, Centres wishing to obtain guidance on whether a coursework task is suitable, should send details to the Subject Officer for Chemistry at OCR (address given in Appendix 5) on form OPF. A response will be provided within 6 weeks. Guidance may also be obtained on the

marks awarded to candidates' work prior to moderation by sending details of the task set, any background information and marked examples of candidates' work to the same address. These services are free of charge. Teachers are asked not to send large quantities of material; if unreasonable amounts are sent, only a proportion will be scrutinised.

A programme of INSET meetings is arranged to provide detailed guidance on coursework assessment. Details are circulated to Centres and a contact number for OCR Training and Customer Support is given in Appendix 5.

The length of time to be devoted to the assessment of experimental and investigative skills is entirely at the discretion of the teacher. However, it is anticipated that between 5 to 10 hours class time should be sufficient in each of AS and A2.

2.1 Standards at AS and A2

A similar set of assessment descriptors is used for the assessment of coursework in both AS and A2. (The mark schemes for the practical examinations are also based on these descriptors).

Assessments at AS and A2 are differentiated by the complexity of the tasks set and the contexts of the underlying scientific knowledge and understanding. In A2, candidates will be required to apply knowledge, understanding and skills from the AS and A2 parts of the specification in planning experimental work and in the analysis of results to reach conclusions.

At AS, experimental and investigative work is likely to be qualitative or require processing in a context that is familiar to candidates.

- **Planning** exercises, although novel, focus on apparatus and techniques which have previously been encountered, based on knowledge and understanding from a limited part of the AS specification.
- **Implementing** involves the manipulation of simple apparatus and the application of easily recognised safety procedures.
- **Analysing and concluding** involve simple data handling, reaching conclusions based on a limited part of the AS specification.
- **Evaluation** expects recognition of the main sources of error and direct methods for improving accuracy.

At A2, assessments will expect a greater level of sophistication and higher levels of skill.

- **Planning** exercises require research to provide a satisfactory solution to a problem which can be addressed in more than one way. The underlying knowledge, understanding and skills are likely to be drawn from several different parts of the AS and A2 specifications.
- **Implementing** involves a detailed risk assessment and the careful use of sophisticated techniques or apparatus to obtain results that are precise and reliable.
- **Analysing and concluding** involve sophisticated data handling and the synthesis of several strands of evidence. In developing conclusions, candidates will have the opportunity to demonstrate their skills in drawing together principles and concepts from different parts of the AS and A2 specifications.

- **Evaluation** requires recognition of the key experimental limitations and other sources of error as well as an understanding of the methods that may be used to limit their effect. The evaluation is likely to draw together principles and concepts from different parts of the specification.

2.2 Assessment and Moderation

All coursework is marked by the teacher and internally standardised by the Centre. Marks are then submitted to OCR by a specified date, after which postal moderation takes place in accordance with OCR procedures. The purpose of moderation is to ensure that the standard for the award of marks in coursework is the same for each Centre, and that each teacher has applied the standards appropriately across the range of candidates within the Centre.

Coursework submissions should be clearly annotated by the Centre to support the marks awarded to the candidates.

The sample of work that is submitted to the Moderator for moderation must show how the marks have been awarded in relation to the marking criteria.

2.3 Minimum Coursework Requirements

If a candidate submits no work for a coursework component, the candidate should be indicated as being absent from that component on the coursework mark sheets submitted to OCR. Any work submitted by a candidate should be assessed according to the mark descriptors and marking instructions and the appropriate mark awarded, which may be 0 (zero).

2.4 Authentication of Coursework

As with all coursework, the teacher must be able to verify that the work submitted for assessment is the candidate's own. Sufficient work must be carried out under direct supervision to allow the teacher to authenticate the coursework marks with confidence. The teacher is required to sign the MS1 marksheets to authenticate the marks and signatures are also required on the coursework summary forms and cover sheets (see Appendix 4).

2.5 Special Arrangements for Coursework

For candidates who submit some coursework but are unable to complete the full assessment, or whose performance may be adversely affected through no fault of their own, teachers should consult the *Inter-Board Regulations and Guidance Booklet for Special Arrangements and Special Consideration*. In such cases, advice should be sought from OCR as early as possible during the course. Applications for special consideration in coursework components should be accompanied by Coursework Assessment Forms giving the breakdown of marks for each skill.

2.6 Differentiation

In coursework, differentiation is by task and by outcome. Candidates will undertake assignments which enable them to display positive achievement.

3 Introduction to Each Skill

The experimental and investigative skills to be assessed are:

Skill P Planning

Candidates should:

- identify and define the nature of a question or problem using available information and knowledge of chemistry;
- choose effective and safe procedures, selecting appropriate apparatus and materials and deciding the measurements and observations likely to generate useful and reliable results;
- consider the environmental and safety aspects of the proposed procedures.

For candidates to be able to achieve the highest marks for this skill, tasks set must be sufficiently open-ended to allow more than one solution. The tasks must provide opportunities for candidates to gather information from a variety of sources (including perhaps text books, the Internet, preliminary experiments) to inform their plans and the scientific knowledge and understanding underpinning their work should be of a high standard.

For each task, it is suggested that candidates are asked to complete a preliminary plan which is assessed by the teacher, primarily to ensure that it is practicable and safe. The final mark awarded for planning should, however, take into account any additional work done during the implementation of the plan, i.e. to include any modifications or additions. Planning must be carried out individually and experience shows that candidates achieve higher marks if they carry out their plan. However, Skill P may be assessed as part of a 'whole investigation' or with any combination of other skills.

At A2, there are additional statements that relate to synoptic assessment to take into account in the assessment. Thus, to achieve the highest marks, the tasks set must offer opportunities for candidates to make use, in their planning, of scientific knowledge and understanding from modules in both AS and A2 parts of the specification.

Skill I Implementing

Candidates should:

- use apparatus and materials in an appropriate and safe way;
- carry out work in a methodical and organised way with due regard for safety and with appropriate consideration for the well-being of the environment;
- make and record detailed observations in a suitable way, and make measurements to an appropriate degree of precision, using ICT where appropriate.

For candidates to achieve the highest marks for this skill, the techniques used should be familiar and well understood. The tasks set should involve techniques that require precision and skill and that make sufficient demands on a candidate's ability to manipulate apparatus.

Skill I may be assessed as part of a 'whole investigation', in isolation, or in combination with any other skills.

Skill A Analysing Evidence and Drawing Conclusions

Candidates should:

- communicate information and ideas, including, where appropriate, tabulation, line graphs, histograms, continuous prose, annotated drawings and diagrams;
- recognise and comment on trends and patterns in data;
- draw valid conclusions by applying chemical knowledge and understanding.

For candidates to achieve the highest marks in this skill, the tasks set must provide sufficient data or information to make the analysis demanding, and allow them to relate their results to scientific knowledge and understanding of a high standard.

Skill A may be assessed as part of a 'whole investigation', in isolation, or in combination with other skills.

At A2, there are additional statements that relate to synoptic assessment to take into account in the assessment. Thus, to achieve the highest marks, the tasks set must offer opportunities for candidates to make use, in their analysis, of scientific knowledge and understanding from modules in both AS and A2 parts of the specification.

Skill E Evaluating Evidence and Procedures.

Candidates should:

- assess the reliability and precision of experimental data and the conclusions drawn from it;
- evaluate the techniques used in the experimental activity, recognising their limitations.

For candidates to achieve the highest marks in this skill it is advisable that they either carry out the investigation themselves or have seen the techniques demonstrated. Only in this way will they be able to evaluate experimental procedures effectively. The tasks set should be sufficiently complex to allow detailed analysis and the data or information collected should permit evaluation of error and reliability. There should also be the opportunity to suggest realistic changes to the procedures used that would improve the quality of the results.

Skill E is best assessed as part of a 'whole investigation', or together with Skill A, in which case the experimental procedure should have been carried out by the candidates themselves, or demonstrated to them. Where the experimental procedures are such that individual working is not possible, candidates could carry out the investigation working in groups but then be assessed for Skills A and E on their individual work.

4 Notes for Guidance on Coursework Submission and Assessment

These notes are intended to provide guidance for teachers in assessing experimental and investigative skills, but should not exert an undue influence on the methods of teaching or provide a constraint on the practical work undertaken by candidates. It is not expected that all of the practical work undertaken by candidates would be appropriate for assessment.

It is expected that candidates will have had opportunities to acquire experience and develop the relevant skills before assessment takes place.

4.1 The Demand of an Activity

The demand of an activity is an important feature of the assessment. From the bottom to the top of the mark range in a skill area the activity should involve increasing demands of associated scientific knowledge and understanding, manipulation, precision and accuracy and complexity.

The difference in standard of Advanced Subsidiary and A2 is a product of the level of demand of the related scientific knowledge and understanding, together with the complexity and level of demand of the tasks set. In A2, candidates will be required to apply knowledge, understanding and skills from the AS and A2 parts of the specification in planning experimental work and in the evaluation of data (synoptic assessment).

Teachers should appreciate that the choice of an activity that is comparatively undemanding (primarily in terms of the level of the scientific knowledge and understanding that can be linked to the activity, and in the range/complexity of the equipment/techniques used) may prevent access to the highest marks.

Teachers should be aware of this feature of the assessment so that, when considering the award of higher marks, the activity should require a sophisticated approach and/or complex treatment. Higher marks must not be awarded for work that is simplistic or trivial.

One of the factors that determine the demand of an activity is the level of guidance given to candidates. The use of a highly structured worksheet, for example, will reduce the number of decisions and judgements required by the candidate and will limit the range of marks available.

4.2 Marking Candidates' Work

A similar set of mark descriptors is used for Advanced Subsidiary and A2. The descriptors should be used to make a judgement as to which mark best fits a candidate's performance.

The descriptors have been written to provide clear continuity from the assessment of Sc1 for GCSE. This should ensure an effective continuation of the development of candidates' skills from GCSE to Advanced Subsidiary and A Level.

The mark descriptors within a skill area have been written to be hierarchical. Thus, in marking a piece of work, the descriptors for the lowest defined mark level should be considered first and only if there is a good match should the descriptors for the next level up be considered. Therefore, if a teacher is considering awarding a high mark for a piece of work, the work must have demonstrated a good match to all the lower mark descriptors.

For each skill, the scheme allows the award of intermediate marks (between the defined mark levels). An intermediate mark may be awarded when the work of a candidate exceeds the requirements of a defined mark level but does not meet the requirements of the next higher defined mark level sufficiently to justify its award. Thus, an intermediate mark could be awarded if the work meets only one of the two descriptors at the higher defined mark level, or provides a partial match to both descriptors, or provides a complete match to one and a partial match to the other.

In Skills **P** and **A**, a mark above the highest defined mark level should be awarded for work which meets all the requirements of the descriptors for the highest defined mark level, and is judged to be of exceptional merit in terms of originality, depth, flair, or in the use of novel or innovative methods.

A mark of zero should be awarded where there has been an attempt to address the skill but the work does not meet the requirements of the lowest defined mark level.

The marks awarded should be based on both the final written work and on the teacher's knowledge of the work carried out by the candidate. In assigning a mark, attention should be paid to the extent of any guidance needed by, or given to, the candidate.

4.3 Synoptic Assessment

Synoptic assessment involves the explicit drawing together of knowledge, understanding and skills learned in different parts of the Advanced GCE course. Assessment Objective AO4 relates specifically to synoptic assessment and marks from the A2 Experimental Skills (coursework) Unit, 2816/2, contribute to the assessment of AO4.

During experimental and investigative work, synoptic assessment:

- allows candidates to apply knowledge and understanding of principles and concepts from different parts of the specification in planning experimental work and in the analysis and evaluation of data;
- allows candidates to apply skills and techniques learned during the course.

All practical work assessed internally by Centres for the A2 Unit 2816/02 should draw on the range of experience that the candidate has acquired during the AS and A2 courses. It is particularly important that an exercise used to assess planning skills should involve an element of research which goes beyond the repetition of an experiment that simply reflects the use of ideas or techniques met within the module currently being studied. Likewise, an assessment involving analysing evidence and drawing conclusions must require a candidate to use knowledge and understanding acquired outside the confines of a standard experiment recently practised. During the process of moderation, evidence will be sought that such breadth has been achieved.

The assessment descriptors for the skills of Planning (P) and Analysing Evidence and Drawing Conclusions (A), include statements that relate specifically to synoptic assessment. These are shown in bold and should be applied only when assessing A2 work. Thus, in A2, a candidate will not be able to achieve more than 2 marks in each of Skills P and A without demonstrating aspects of synoptic assessment. Candidates will also bring to the assessment of Skill I (Implementing) their experience of practical and investigative work from throughout the course. In Skill E (Evaluating Evidence and Procedures), aspects of Skills P and A are evaluated. Overall, in A2, approximately

15 of the 30 available marks can thus be identified as contributing to an assessment of AO4 (synoptic assessment).

4.4 Quality of Written Communication

Coursework must include an assessment of candidates' quality of written communication. At Level 3, candidates are required to:

- select and use a form and style of writing that is appropriate to the purpose and complex subject matter;
- organise relevant information clearly and coherently, using specialist vocabulary when appropriate;
- ensure the text is legible and that spelling, grammar and punctuation are accurate, so that the meaning is clear.

The mark descriptors for Skills **P** and **A** have been written to include these aspects, and these skills carry an additional mark each in recognition of this.

4.5 Annotation of Candidates' Work

Each piece of assessed coursework must be annotated to show how the marks have been awarded in relation to the relevant skills.

The writing of comments on candidates' work can provide a means of dialogue and feedback between teacher and candidate, and a means of communication between teachers during internal standardisation of coursework. The main purpose of annotating candidates' coursework should be, however, to provide a means of communication between the teacher and the Moderator, showing where marks have been awarded and why. The sample of work which is submitted for moderation **must** show how the marks have been awarded in relation to the marking criteria.

Annotations should be made at appropriate points in the margins of the text. The annotations should indicate both where achievement for a particular skill has been recognised, and where the mark has been awarded. It is suggested that the minimum which is necessary is that the 'shorthand' mark descriptors (for example, **P.5a**, **I.3b**) should be written at the point in the text where it is judged that the work has met the descriptors concerned.

For Skill **I**, Implementing, more detail is necessary and the Moderator will require evidence concerning candidates' use of practical techniques and safe working practice. This evidence could take the form of checklists or written notes.

4.6 Health and Safety

In UK law, health and safety is the responsibility of the employer. For most establishments entering candidates for Advanced Subsidiary and Advanced GCE this is likely to be the education authority or the governing body. Employees, i.e. teachers and lecturers, have a duty to cooperate with their employer on health and safety matters.

Various regulations, but especially the COSHH Regulations 1996 and the Management of Health and Safety at Work Regulations 1992, require that before any activity involving a hazardous procedure or harmful micro-organisms is carried out, or hazardous chemicals are used or made, the employer must provide a risk assessment. A useful summary of the requirements for risk assessment in school or college science can be found in Chapter 4 of *Safety in Science Education* (see below). For members, the CLEAPSS guide, *Managing Risk Assessment in Science* offers detailed advice.

Most education employers have adopted a range of nationally available publications as the basis for their Model Risk Assessments. Those commonly used include:

Safety in Science Education, DfEE, 1996, HMSO, ISBN 0 11 270915 X;

Safeguards in the School Laboratory, 10th edition, 1996, ASE ISBN 0 86357 250 2;

Hazcards, 1995, CLEAPSS School Science Service*;

Laboratory Handbook, 1988-97, CLEAPSS School Science Service*;

Topics in Safety, 2nd edition, 1988, ASE ISBN 0 86357 104 2;

Safety Reprints, 1996 edition, ASE ISBN 0 86357 246 4.

Hazardous Chemicals, A Manual for Science Education, 1997, SSERC Limited ISBN 0 9531776 0 2

* Note that CLEAPSS publications are only available to members or associates.

Where an employer has adopted these or other publications as the basis of their model risk assessments, an individual school or college then has to review them, to see if there is a need to modify or adapt them in some way to suit the particular conditions of the establishment. Such adaptations might include a reduced scale of working, deciding that the fume cupboard provision was inadequate or the skills of the candidates were insufficient to attempt particular activities safely. The significant findings of such risk assessment should then be recorded, for example on schemes of work, published teachers guides, work sheets, etc. There is no specific legal requirement that detailed risk assessment forms should be completed, although a few employers require this.

Where project work or individual investigations, sometimes linked to work-related activities, are included in specifications this may well lead to the use of novel procedures, chemicals or micro-organisms, which are not covered by the employer's model risk assessments. The employer should have given guidance on how to proceed in such cases. Often, for members, it will involve contacting the CLEAPSS School Science Service (or, in Scotland, SSERC).

When candidates are planning their own practical activities, whether in project work or more routine situations, the teacher or lecturer has a duty to check the plans before practical work starts and to monitor the activity as it proceeds.

5 Mark Descriptors for Experimental and Investigative Skills

In defining the various mark descriptors, it is recognised that practical tasks vary widely, both in the experimental procedures used and in the nature of the observations and measurements which may be made by the candidate. The mark descriptors within each defined level are intended to provide guidance to teachers on how to recognise levels of achievement. It is acknowledged that the balance between the statements provided for a particular level of performance will vary with the nature of the activity. Whilst both statements for a particular level **must** be considered in awarding the marks, it is clear that teachers will need to judge for themselves the relative weightings they attach to each of the statements.

Both statements at a defined level must be satisfied in order that the mark for this level is awarded. All descriptors for lower defined levels must be satisfied before a higher mark is awarded. From the bottom to the top of the mark range the activity should involve increasing demands of related scientific knowledge and understanding, manipulation, precision, accuracy and complexity.

Skill P - Planning

Total 8

The candidate:

Mark	General strategy	Level	Choices within plan	Level
0				
1	P1.a <ul style="list-style-type: none"> develops a question or problem in simple terms and plans a fair test or an appropriate practical procedure; making a prediction where relevant. 		P1.b <ul style="list-style-type: none"> chooses appropriate equipment. 	
2				
3	P3.a <ul style="list-style-type: none"> develops a question or problem using scientific knowledge and understanding drawn from more than one area of the specification; identifies the key factors to vary, control or take account of. 		P3.b <ul style="list-style-type: none"> decides on a suitable number and range of observations and/or measurements to be made. 	
4				
5	P5.a <ul style="list-style-type: none"> uses detailed scientific knowledge and understanding drawn from more than one module of the specification; uses information from preliminary work or a secondary source to plan an appropriate strategy, taking into account the need for safe working and justifying any prediction made. 		P5.b <ul style="list-style-type: none"> describes a strategy, including choice of equipment, which takes into account the need to produce precise and reliable evidence; produces a clear account and uses specialist vocabulary appropriately. 	
6				
7	P7.a <ul style="list-style-type: none"> retrieves and evaluates information from a variety of sources, and uses it to develop a strategy which is well structured, logical and linked coherently to underlying scientific knowledge and understanding drawn from different parts of the AS and A2 specification; uses spelling, punctuation and grammar accurately. 		P7.b <ul style="list-style-type: none"> justifies the strategy developed, including the choice of equipment, in terms of the need for precision and reliability. 	
8				

The statements in bold represent additional requirements when assessing A2 work; they are not to be used at AS.

Skill I - Implementing

Total 7

The candidate:

Mark	Manipulation	Level	Recording	Level
0				
1	11.a <ul style="list-style-type: none"> demonstrates competence in simple techniques and an awareness of the need for safe working. 		11.b <ul style="list-style-type: none"> makes and records observations and/or measurements which are adequate for the activity. 	
2				
3	13.a <ul style="list-style-type: none"> demonstrates competence in practised techniques is able to manipulate materials and equipment with precision. 		13.b <ul style="list-style-type: none"> makes systematic and accurate observations and/or measurements which are recorded clearly and accurately. 	
4				
5	15.a <ul style="list-style-type: none"> demonstrates competence and confidence in the use of practical techniques; adopts safe working practices throughout. 		15.b <ul style="list-style-type: none"> makes observations and/or measurements with precision and skill; records observations and/or measurements in an appropriate format. 	
6				
7	17.a <ul style="list-style-type: none"> demonstrates skilful and proficient use of all techniques and equipment. 		17.b <ul style="list-style-type: none"> makes and records all observations and/or measurements in appropriate detail and to the degree of precision permitted by the techniques or apparatus. 	

Skill A - Analysing Evidence and Drawing Conclusions

Total 8

The candidate:

Mark	Processing evidence	Level	Drawing conclusions	Level
0				
1	A1.a <ul style="list-style-type: none"> carries out some simple processing of the evidence collected from experimental work. 		A1.b <ul style="list-style-type: none"> where appropriate, identifies trends or patterns in the evidence and draws simple conclusions. 	
2				
3	A3.a <ul style="list-style-type: none"> processes and presents evidence gathered from experimental work including, where appropriate, the use of appropriate graphical and/or numerical techniques. 		A3.b <ul style="list-style-type: none"> links conclusions drawn from processed evidence with the associated scientific knowledge and understanding drawn from more than one area of the specification. 	
4				
5	A5.a <ul style="list-style-type: none"> carries out detailed processing of evidence and analysis including, where appropriate, the use of advanced numerical techniques such as statistics, the plotting of intercepts or the calculation of gradients.. 		A5.b <ul style="list-style-type: none"> draws conclusions which are consistent with the processed evidence and links these with detailed scientific knowledge and understanding drawn from more than one module of the specification; produces a clear account which uses specialist vocabulary appropriately. 	
6				
7	A7.a <ul style="list-style-type: none"> where appropriate, uses detailed scientific knowledge and understanding drawn from different parts of the AS and A2 specification to make deductions from the processed evidence, with due regard to nomenclature, terminology and the use of significant figures (where relevant). 		A7.b <ul style="list-style-type: none"> draws conclusions which are well structured, appropriate, comprehensive, and concise and which are coherently linked to underlying scientific knowledge and understanding drawn from different parts of the AS and A2 specification; uses spelling, punctuation and grammar accurately. 	
8				

The statements in bold represent additional requirements when assessing A2 work; they are not to be used at AS.

Skill E - Evaluating Evidence and Procedures

Total 7

The candidate:

Mark	Procedures	Level	Sources of error	Level
0				
1	E1.a <ul style="list-style-type: none"> • makes relevant comments on the suitability of the experimental procedures. 		E1.b <ul style="list-style-type: none"> • recognises any anomalous results. 	
2				
3	E3.a <ul style="list-style-type: none"> • recognises how limitations in the experimental procedures and/or strategy may result in sources of error. 		E3.b <ul style="list-style-type: none"> • comments on the accuracy of the observations and/or measurements, suggesting reasons for any anomalous results. 	
4				
5	E5.a <ul style="list-style-type: none"> • indicates the significant limitations of the experimental procedures and/or strategy and suggests how they could be improved. 		E5.b <ul style="list-style-type: none"> • comments on the reliability of the evidence and evaluates the main sources of error. 	
6				
7	E7.a <ul style="list-style-type: none"> • justifies proposed improvements to the experimental procedures and/or strategy in terms of increasing the reliability of the evidence and minimising significant sources of error. 		E7.b <ul style="list-style-type: none"> • assesses the significance of the uncertainties in the evidence in terms of their effect on the validity of the final conclusions drawn. 	

6 Exemplars

Introduction

Planning (Skill P)

For the highest levels to be achieved, students are expected to provide more than just a reliable procedure that would address the problem successfully. Students must also give instructions for the experiment that could be followed without modification. It will not be sufficient merely to copy details from an outside source; a full justification of the steps used must be provided. This should extend to explaining the reasons behind the selection of particular quantities or concentrations. Where relevant, the choice and size of apparatus should be explained and pieces of equipment must be selected from those readily available in the laboratory.

Students should clearly explain why their procedure would provide a solution to the problem posed.

Implementing (Skill I)

Most of the exercises appropriate for this skill have a quantitative element. This may involve the recording of results or a physical characteristic such as a melting point. It is essential that the work of each student, including results and any requested observations, is sent in the sample requested by the Moderator.

Some aspects of this skill can only be assessed by the supervising teacher who should provide sufficient details to explain the basis of the judgement made.

Where readings are made it should be emphasised that 17b requires that these must be appropriate to the accuracy of the equipment. Unless Moderators are advised otherwise, it will be assumed that burettes and pipettes are accurate to 0.05 cm^3 .

Normally it is expected that results will be tabulated.

If any modifications are made to the procedures suggested in these exemplars, then the Moderators must be informed since this may affect the level of accuracy expected from the experiment.

Centres must always provide Supervisor's results so that the submitted work can be fairly judged. The Moderators will take account of any local difficulties in their assessment of students' work.

Analysing Evidence and Drawing Conclusions (Skill A)

Students are expected to provide a detailed explanation of the processing of the results of an experiment. Where calculations are required, the final answer should be quoted to an appropriate accuracy. This will normally be governed by the precision of the least accurate piece of equipment. For example, if the accuracy of the balance used in the 'lithium' exemplar is to two decimal places then the final answer for the relative atomic mass will be to two significant figures. The Moderators do not expect a rigorous treatment but, at the higher levels, students are expected to demonstrate that they have appreciated the limitations of the apparatus used.

Care must be taken with graphs, particularly where computers are used. Axes must be clearly labelled and graphs should be of an appropriate size. A decision between joining the points directly or drawing a line of best fit must be made appropriately.

Evaluation (Skill E)

A number of the exemplars deliberately provide a procedure that has clear failings. This is done deliberately so that students are able to approach Skill E more effectively. Centres should inform the Moderators if an amendment to the procedure has been employed which would significantly affect the basis of the evaluation.

Students must attempt to do more than produce a list of every conceivable error in the experiment. At the higher levels it is expected that a clear distinction should be made between those failings in the procedure that are significant and those that are less important. In some experiments students have been required to identify the 'most significant' error. It may not always be possible decisively to evaluate this. In these circumstances, the student must provide an explanation as to why there is uncertainty.

The suggested modifications to the procedure should be based on apparatus normally available in their laboratory and within the student's experience. It is not expected that specialist equipment should be identified.

AS – Exemplar Summary Grid

This section contains six assessments that are suitable for AS. The table below summarises the skill that can be assessed with each.

- Skill P Planning
- Skill I Implementing
- Skill A Analysing Evidence and Drawing Conclusions
- Skill E Evaluating Evidence and Procedures

Experiment	Skill P	Skill I	Skill A	Skill E
Which equation is correct?	✓			
To determine the concentration of a limewater solution.	✓		✓	
Determination of the relative atomic mass of lithium.		✓	✓	✓
Hydrolysis of halogenoalkanes.	✓			
To determine the enthalpy change of a reaction.			✓	✓
The oxidation of ethanol.		✓		

AS – Assessed Practical (Skill P)

Name _____ Date _____

Introduction

Your plan which is likely to be between 500 and 1000 words can be word processed if you wish.

Your plan must show clear evidence that you have consulted at least **two** sources, such as textbooks or CD-ROMs or databases. Books must have chapter or page numbers and any internet references must go beyond the first slash of the web address.

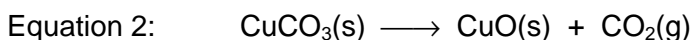
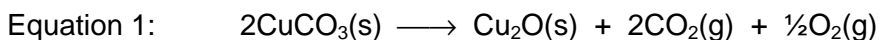
Do not simply copy the resources but give clear evidence that you have read, adapted and used the material to solve the problem set. All resources used should be clearly identified.

You are provided with the following task.

Which equation is correct?

Copper has two oxides, Cu_2O and CuO .

Copper carbonate, CuCO_3 decomposes on heating to form one of these oxides and an equation can be written for each possible reaction:



Using ideas that you have learnt about the mole, plan and design an experiment to measure a **volume of gas** that will prove which of the two equations is correct. You have access to usual laboratory chemicals and apparatus.

Your plan should include the following:

- a list of equipment, apparatus and chemicals;
- the quantities of any reagents used;
- any special set of conditions that are required for a particular procedure;
- a detailed method which provides full instructions and any necessary precautions.

When you have completed your plan it must be handed in to your teacher.

Skill P - Planning

Total 8

The candidate:

Mark	General strategy	Level	Choices within plan	Level
0				
1	P1.a <ul style="list-style-type: none"> recognises the need to measure a volume of gas 		P1.b <ul style="list-style-type: none"> chooses appropriate equipment 	
2				
3	P3.a <ul style="list-style-type: none"> recognises the need to measure a mass of CuCO_3 		P3.b <ul style="list-style-type: none"> suggests that the volume of gas evolved depends upon the molar quantities 	
4				
5	P5.a <ul style="list-style-type: none"> calculates the volume of gas evolved from the selected mass for both equations 		P5.b <ul style="list-style-type: none"> the mass and volumes chosen are suitable for standard laboratory apparatus (size must be quoted) 	
6				
7	P7.a <ul style="list-style-type: none"> retrieves and evaluates information from at least two sources provides a detailed plan which could be used by others without modification uses spelling, punctuation and grammar accurately 		P7.b <ul style="list-style-type: none"> clearly states how they will determine that the reaction is complete provides accurate details of chemicals and apparatus, etc to ensure the highest level of precision, reliability and safety 	

Level 8.

- Explains** why the measured volume may need to be corrected.

AS – Assessed Practical (Skills P and A)

Name _____ Date _____

Introduction

Your plan which is likely to be between 500 and 1000 words can be word processed if you wish.

Your plan must show clear evidence that you have consulted at least **two** sources, such as textbooks or CD-ROMs or databases. Books must have chapter or page numbers and any internet references must go beyond the first slash of the web address.

Do not simply copy the resources but give clear evidence that you have read, adapted and used the material to solve the problem set. All resources used should be clearly identified.

You are provided with the following task.

To determine the concentration of a limewater solution

You are provided with 250 cm^3 of limewater which has been made such that it contains approximately 1 g dm^{-3} of calcium hydroxide.

Also available is hydrochloric acid which has a concentration of exactly 2.00 mol dm^{-3} . This acid is too concentrated to be used and you will need to dilute it.

You are to plan an experiment which will allow you to determine the concentration, in g dm^{-3} , of the limewater as accurately as possible. Normal laboratory apparatus may be selected as required and indicator solutions are available but you may not use any other chemicals.

Your plan should include the following:

- a list of equipment, apparatus and chemicals;
- a balanced equation;
- the quantities and concentrations of any reagents used;
- a detailed method which provides full instructions and any necessary precautions.

When you have completed your plan it must be handed in to your teacher.

Analysis and conclusions

Name _____ Date _____

You should now carry out the experiment.

Record your results in a suitable format in the space below.

Results

Summary

On average,cm³ of required cm³ of

Treatment of results

1. Write an appropriate balanced equation for the reaction.

2. Use your results and the balanced equation to determine the concentration, in g dm⁻³, of the limewater solution.

Show all steps in your calculations.

Skill P - Planning

Total 8

The candidate:

Mark	General strategy	Level	Choices within plan	Level
0				
1	P1.a <ul style="list-style-type: none"> recognises that an acid/base titration is required plans an outline procedure 		P1.b <ul style="list-style-type: none"> suggests suitable apparatus to perform a titration 	
2				
3	P3.a <ul style="list-style-type: none"> provides a balanced equation 		P3.b <ul style="list-style-type: none"> recognises the need for an indicator 	
4				
5	P5.a <ul style="list-style-type: none"> calculates an approximately suitable dilution factor for the titration 		P5.b <ul style="list-style-type: none"> includes apparatus capable of obtaining a suitable dilution provides detail of the dilution method to be used 	
6				
7	P7.a <ul style="list-style-type: none"> retrieves and evaluates information from at least two sources provides a detailed plan which could be used by others without modification uses spelling, punctuation and grammar accurately 		P7.b <ul style="list-style-type: none"> recognises the need to repeat the experiment to obtain concordant results explains carefully the procedure to be adopted in terms of the need for precision, reliability and safety (e.g. apparatus to provide an accurate dilution) 	

Level 8.

- Explains** why dilution of the acid is essential to produce accurate results

The candidate:

Mark	Processing evidence	Level	Drawing conclusions	Level
0				
1	A1.a <ul style="list-style-type: none"> is able to process the titration results 		A1.b <ul style="list-style-type: none"> calculates a value for the number of mol. of acid used in the titration 	
2				
3	A3.a <ul style="list-style-type: none"> writes an equation 		A3.b <ul style="list-style-type: none"> calculates the number of mol. of calcium hydroxide in the pipetted sample taking into account the stoichiometry of the reaction 	
4				
5	A5.a <ul style="list-style-type: none"> shows some regard for significant figures 		A5.b <ul style="list-style-type: none"> calculates the correct concentration of the limewater in mol dm⁻³ 	
6				
7	A7.a <ul style="list-style-type: none"> shows full regard for units, terminology and the use of significant figures consistent with the accuracy of the apparatus correctly selects titration results to produce an average 		A7.b <ul style="list-style-type: none"> calculates the concentration of the limewater in g dm⁻³ shows all steps in the calculation in a clear, well structured format 	

Level 8.

- The final concentration of limewater is quoted, and justified, with regards to all measurements and data used.

AS – Assessed Practical (Skills I, A and E)

Name _____ Date _____

Introduction

For this exercise you are given full instructions for the practical procedure and these must be followed exactly.

It is your responsibility to work safely and to organise your time efficiently.

You should try to work in such a way as to make your results as accurate as possible.

- First you will carry out the experimental work commenting on the hazard of the chemicals used and obtained in the experiment (Skill I).
- You will then analyse your results (Skill A).
- Finally, you will evaluate what you have done (Skill E).

Determination of the relative atomic mass of lithium

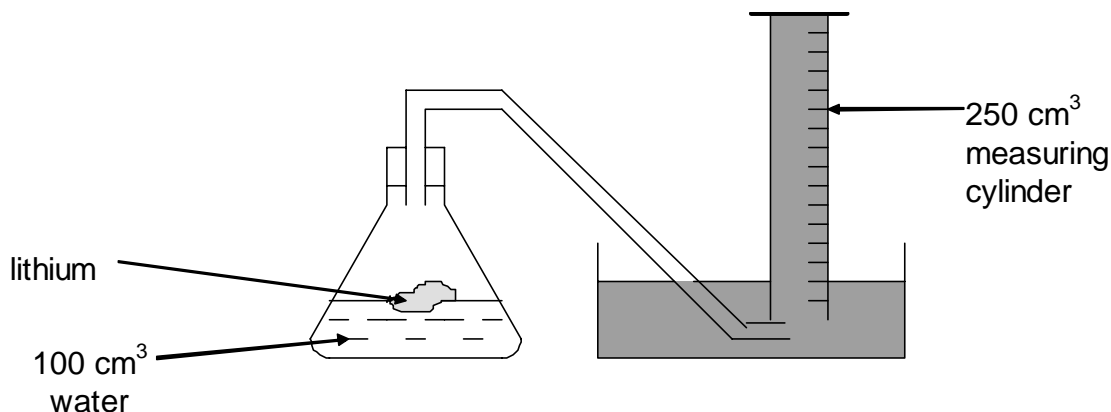
You are going to determine the relative atomic mass of lithium by two different methods.

Method 1 You will measure the volume of hydrogen produced when a known mass of lithium reacts with water.

Method 2 You will titrate the solution of lithium hydroxide produced.

Method 1: Procedure

- 1 Set up the apparatus as shown below. The 250 cm³ conical flask must contain exactly 100 cm³ of distilled water.



- 2 Weigh between 0.08 g and 0.13 g of lithium. Record the exact mass of lithium using an appropriate format in the space at the top of the next page.
- 3 Remove the stopper, add the lithium to the flask and quickly replace the stopper.
- 4 Collect the gas and record the final volume of hydrogen using an appropriate format in the space at the top of the next page.

Evaluation (Skill E)

When you have finished you should evaluate the experiments that you have carried out. Using all the results that have been obtained,

- comment on the overall accuracy of your experiments;
- identify the main sources of error in both the procedures and the measurements;
- compare, with reasons, the accuracy and reliability of the different techniques that you used during the practical task;
- look at your method critically and suggest ways of minimising errors and increasing reliability;
- suggest improvements that could be made to the experimental procedures whilst following essentially the same general methods.

You should consider changes that improve the reliability of the results and that minimise errors.

Errors in procedure

Errors in measurement

Identify those errors that are significant and justify your choice

Suggest and justify improvements to the procedure

Suggest and justify improvements to the methods of taking measurements.

Determination of the relative atomic mass of lithium

Apparatus list

All chemicals should be labelled with the appropriate safety hazard warning label.

Each student will require:

safety spectacles or goggles
protective gloves
access to chemical data or hazard sheets
access to balance
2 x 250 cm³ conical flasks
delivery tube (see below)
250 cm³ measuring cylinder
clamp stand
2 bosses
2 clamps
trough (1 dm³ round strong margarine containers or 2 dm³ ice cream containers make satisfactory troughs)
access to 100 cm³ measuring cylinders, burettes with clamps and stands or 25.00 cm³ pipettes and fillers
pre-weighed lithium pieces of between 0.08g and 0.13g and stored in oil
100 cm³ distilled water
forceps
filter paper
25.00 cm³ pipette
pipette filler
50.00 cm³ burette
burette clamp
clamp stand for burette
small funnel for filling burette
white tile
50 cm³ 0.10 mol dm⁻³ hydrochloric acid
phenolphthalein indicator
balance accurate to two decimal places

The delivery tube should be made up so that it fits the apparatus as shown. If the part of the tube which fits into the bung is made sufficiently long, then it is possible to slide the tube carefully so that it fits into the trough of water. It is suggested that a template be drawn onto paper first. A no 31 bung with one hole usually fits into wide necked conical flasks. The student may wish to clamp the flask neck as well. Lithium metal is very hard to cut, and should be cut into appropriate sized pieces beforehand, and then stored in oil. The student should realise that as much oil as possible should be removed, and should not attempt to cut the lithium.

Note: The quantities of chemicals required are approximate and due allowance should be made for wastage. The student should measure volumes and masses to an appropriate degree of accuracy.

The lithium is unlikely to be pure and it is essential that the Centre carries out control experiments to obtain specimen results. The specimen results should be used in assessing the accuracy of the candidates' results.

Centre (teacher) results MUST be provided and included when Candidate's work is submitted to the Moderator.

Skill I - Implementing

Total 7

The candidate:

Mark	Manipulation	Level	Observing and Recording	Level
0				
1	I.1a <ul style="list-style-type: none"> demonstrates competence in a simple technique (e.g. weighing or use of burette) shows some awareness of the need for safe working (e.g. eye protection) 		I.1b <ul style="list-style-type: none"> makes and records measurements for one of the experiments 	
2				
3	I.3a <ul style="list-style-type: none"> collects hydrogen without significant leakage handles chemicals and apparatus with care 		I.3b <ul style="list-style-type: none"> makes systematic and accurate measurements which are recorded clearly 	
4				
5	I.5a <ul style="list-style-type: none"> shows full awareness for the safety of others shows a competent titration technique with 2 titres within 0.20 cm³ employs procedures to improve experimental accuracy, e.g. removes oil from the lithium, repeats the titration 		I.5b <ul style="list-style-type: none"> records measurements with regard to the precision of the apparatus used obtains at least one result to within 20% of the centre value records measurements in an appropriate format 	
6				
7	I.7a <ul style="list-style-type: none"> obtains at least two accurate titres within 0.10 cm³ makes suitable written comments about the hazard of the chemicals in the context of this experiments 		I.7b <ul style="list-style-type: none"> records all measurements to a correct level of precision and in an appropriate format obtains both results to within 20% of the centre value 	

The percentage accuracy must be assessed by comparison to the control experiments carried out by the Centre. These results must be provided to the Moderator.

Skill A - Analysing Evidence and Drawing Conclusions

Total 8

The candidate:

Mark	Processing evidence	Level	Drawing conclusions	Level
0				
1	A.1a <ul style="list-style-type: none"> is able to process titration results to obtain an average titre 		A.1b <ul style="list-style-type: none"> correctly calculates moles H₂ or moles HCl 	
2				
3	A.3a <ul style="list-style-type: none"> makes use of reacting quantities in one equation 		A.3b <ul style="list-style-type: none"> calculates moles H₂ and moles HCl calculates moles Li or moles LiOH 	
4				
5	A.5a <ul style="list-style-type: none"> makes use of reacting quantities in both equations 		A.5b <ul style="list-style-type: none"> calculates moles Li and moles LiOH calculates the <i>A_r</i> of lithium accurately for one of the experiments 	
6				
7	A.7a <ul style="list-style-type: none"> shows full regard for units, terminology and the use of significant figures consistent with the accuracy of the apparatus 		A.7b <ul style="list-style-type: none"> calculates the <i>A_r</i> of lithium accurately for both experiments, with all steps of the calculation in a clear well structured format 	

Level 8

- The final relative atomic mass of lithium is quoted, and justified, with regards to all measurements and data used.

Skill E - Evaluating Evidence and Procedures

Total 7

The candidate:

Mark	Procedural errors	Level	Errors in measurement	Level
0				
1	E1.a <ul style="list-style-type: none"> identifies one procedural error 		E1.b <ul style="list-style-type: none"> identifies one measurement error inherent in the apparatus used 	
2				
3	E3.a <ul style="list-style-type: none"> identifies two procedural errors OR one procedural error and a suitable modification 		E3.b <ul style="list-style-type: none"> identifies two measurement errors inherent in the apparatus used OR one measurement error and suggests a suitable modification 	
4				
5	E5.a <ul style="list-style-type: none"> identifies two procedural errors and a suitable modification for one of them 		E5.b <ul style="list-style-type: none"> comments on the relative accuracy of the measurements taken and identifies the most significant error 	
6				
7	E7.a <ul style="list-style-type: none"> identifies two procedural errors and a suitable modification for both of them justifies which of the two methods is most accurate 		E7.b <ul style="list-style-type: none"> suggests, with justification, a suitable modification to reduce the most significant measurement error 	
	Procedural errors <ul style="list-style-type: none"> difficult to remove all traces of the oil loss of hydrogen impurities of lithium one measurement for the volume of H₂ but several opportunities for the titration method 		Errors in measurement <ul style="list-style-type: none"> weighing measurements volume of H₂ measurement 	

It is recognised that other errors may be relevant to a particular Centre. If this is the case, the Centre should provide details to the moderator.

AS – Assessed Practical (Skill P)

Name _____ Date _____

Introduction

Your plan which is likely to be between 500 and 1000 words can be word processed if you wish.

Your plan must show clear evidence that you have consulted at least **two** sources, such as textbooks or CD-ROMs or databases. Books must have chapter or page numbers and any internet references must go beyond the first slash of the web address.

Do not simply copy the resources but give clear evidence that you have read, adapted and used the material to solve the problem set. All resources used should be clearly identified.

Rates of reaction of halogenoalkanes

The carbon—halogen bond is polarised: $C^{\delta+}-X^{\delta-}$. The positive charge, $\delta+$, on the carbon promotes nucleophilic attack, which can result in the displacement of the halide: X^- (aq) ion.

You will have first to identify a suitable nucleophilic substitution reaction of a halogenoalkane.

You will then have to plan an experiment to compare how the rate of displacement of the halide ion varies with respect to the C—X bond (C—Cl, C—Br, C—I).

Your plan must include:

- a balanced equation;
- a prediction of the order of reactivity based on a consideration of electronegativities, polarities or bond enthalpies;
- a clear explanation of why your method works;
- a detailed method which provides full instructions and any necessary precautions.

When you have completed your plan it must be handed in to your teacher.

The candidate:

Mark	General strategy	Level	Choices within plan	Level
0				
1	P1.a <ul style="list-style-type: none"> suggests a method which could allow the relative rates of hydrolysis to be measured 		P1.b <ul style="list-style-type: none"> suggests test tubes/ suitable set of halogenoalkanes 	
2				
3	P3.a <ul style="list-style-type: none"> states an order of reactivity writes any suitable equation for a nucleophilic substitution 		P3.b <ul style="list-style-type: none"> provides a method which could be used to displace the halide ion 	
4				
5	P5.a <ul style="list-style-type: none"> predicts the relative rates based on some chemical knowledge and background e.g. 'iodo- will react fastest because it has the lowest bond enthalpy' or 'chloro- will react fastest because of greater charge separation' 		P5.b <ul style="list-style-type: none"> controls the quantities of the reagents used and the reaction conditions suggests a procedure which allows the rates to be compared effectively 	
6				
7	P7.a <ul style="list-style-type: none"> retrieves and evaluates information from at least two sources provides a detailed plan which could be used by others without modification uses spelling, punctuation and grammar accurately 		P7.b <ul style="list-style-type: none"> controls all experimental factors that might influence rate provides a detailed explanation of why the method works provides accurate details of concentrations of solutions and apparatus, etc to ensure the highest level of precision, reliability and safety 	

Level 8

- Molar quantities of RX used.
- Justifies the method of monitoring the rate of the reaction.

AS – Assessed Practical (Skills A and E)

Name _____ Date _____

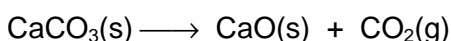
Introduction

For this exercise you are given full instructions for the practical procedure and these must be followed exactly. It is however up to you to consider suitable safety precautions and to organise your time appropriately. You should also carefully consider what is the most effective way of handling the materials and apparatus in order to obtain the maximum reliability.

You will first be required to do the experiments and then, under supervision, to calculate the results (skill A) and evaluate the quality and reliability of your data and suggest suitable improvements to your experimental procedure (skill E).

To determine the enthalpy change of a reaction

Calcium carbonate, CaCO_3 decomposes with heat.

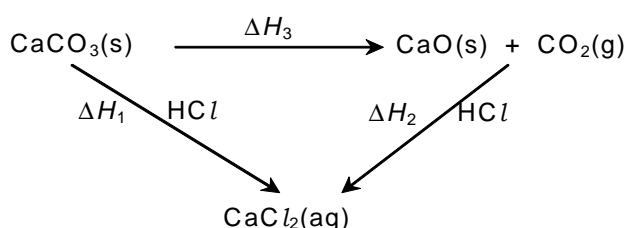


The object of this practical exercise is to determine the enthalpy change for this reaction by an indirect method based on Hess' law.

Background to method

Both calcium oxide and calcium carbonate react readily with 2 mol dm^{-3} hydrochloric acid solution.

The temperature changes during these reactions can be measured and the enthalpy changes ΔH_1 and ΔH_2 calculated.



Using this Hess' cycle it is possible to calculate a value for ΔH_3 .

Carrying out the experiment

You should only use the chemicals and apparatus that are supplied:

Calcium carbonate and calcium oxide

2 mol dm^{-3} hydrochloric acid

250 cm^3 beaker

250 cm^3 measuring cylinder

0 -100 °C thermometer (graduations to 1 °C)

Read the procedure carefully before starting.

If you believe that the experiment can be improved then you can comment upon this when you evaluate the experiment.

Procedure

1. Weigh out a weighing bottle containing between 2.4 and 2.6 g of calcium carbonate. Record your results in Table 1.
2. Using the measuring cylinder provided place 50 cm³ of 2 mol dm⁻³ hydrochloric acid (an excess) into a 250 cm³ glass beaker.
3. Measure the temperature of the acid using the thermometer provided and record this value in Table 1. Be careful not to break the thermometer. It should not be left unsupported resting in the beaker.
4. Add the calcium carbonate to the acid. Take the temperature again when the reaction is complete. Record this value in Table 1.
5. Weigh the weighing bottle and record this value in Table 1.

Repeat steps 1 to 5 using an accurately weighed mass of calcium oxide, in the range 1.3 to 1.5 g, instead of calcium carbonate. Again the acid is in excess. Record all results in Table 1.

Results

Table 1

mass of CaCO ₃ + weighing bottle	g
mass of empty weighing bottle	g
mass of CaCO ₃ used	g
temperature of acid initially	°C
temperature of solution after mixing	°C
temperature change during reaction	°C
mass of CaO + weighing bottle	g
mass of empty weighing bottle	g
mass of CaO used	g
temperature of acid initially	°C
temperature of solution after mixing	°C
temperature change during reaction	°C

Use your values of ΔH_1 and ΔH_2 to obtain a value for ΔH_3 .

ΔH_3 =		units =
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Evaluation

When you have finished, you should evaluate your plan and the experiment that you have carried out.

Using all the results that have been obtained,

- comment on the overall accuracy of your final result;
- identify the main sources of error in both the procedure and the measurements;
- compare, with reasons, the accuracy and reliability of the different techniques that you used during the practical task;
- look at the method critically and suggest ways of minimising errors and increasing reliability;
- suggest improvements that could be made to the experimental procedures whilst following essentially the same general method.

You should consider changes that improve the reliability of the results and that minimise errors.

Errors in procedure

Errors in measurement

Identify those errors that are significant and justify your choice

Suggest and justify improvements to the procedure

Suggest and justify improvements to the methods of taking measurements

To determine the enthalpy change of a reaction

Each student will require:

safety spectacles or goggles
protective gloves
access to chemical data or hazard sheets
access to balance
2.6 g calcium carbonate (lump form)
1.5 g calcium oxide (lump form)
2 weighing bottles
spatulas
250 cm³ measuring cylinder
2 x 250 cm³ beakers
100 cm³ 2 mol dm⁻³ hydrochloric acid
0-110 °C thermometer (graduations to 1°C)

Note: The quantities of chemicals required are approximate and due allowance should be made for wastage. The student should measure volumes and masses to an appropriate degree of accuracy within the limitations of the apparatus provided.

The instructions and materials suggested for this experiment have been deliberately selected to form a procedure which has obvious flaws. This is to help students when they tackle the Evaluation (Skill E).

It is suggested that Centres do not alter the method provided.

If, however, changes are made then the moderators must be informed when the Candidates scripts are submitted for moderation.

The candidate:

Mark	Processing evidence	Level	Drawing conclusions	Level
0				
1	A1.a <ul style="list-style-type: none"> carries out some simple processing of the evidence collected from experimental work, e.g. completes results table 		A1.b <ul style="list-style-type: none"> draws simple conclusions 	
2				
3	A3.a <ul style="list-style-type: none"> uses $mc\Delta T$ 		A3.b <ul style="list-style-type: none"> attempts to use Hess' cycle 	
4				
5	A5.a <ul style="list-style-type: none"> uses an appropriate value of m carries out detailed processing to determine a value for ΔH_1 and ΔH_2 in kJ mol^{-1} including appropriate signs 		A5.b <ul style="list-style-type: none"> attempts to use Hess' cycle obtaining a value for ΔH_3 	
6				
7	A7.a <ul style="list-style-type: none"> shows full regard for units, terminology and the use of significant figures consistent with the accuracy of the apparatus 		A7.b <ul style="list-style-type: none"> uses Hess' Law correctly to obtain a value for ΔH_3 with all steps of the calculation shown in a clear well structured format 	

Level 8

- The accuracy of the final enthalpy change quoted, ΔH_3 , is justified, with regards to all measurements and data used.

Skill E - Evaluating Evidence and Procedures

Total 7

The candidate:

Mark	Procedural errors	Level	Errors in measurement	Level
0				
1	E1.a <ul style="list-style-type: none"> identifies one procedural error. 		E1.b <ul style="list-style-type: none"> identifies one measurement error inherent in the apparatus used. 	
2				
3	E3.a <ul style="list-style-type: none"> identifies two procedural errors OR one procedural error and a suitable modification. 		E3.b <ul style="list-style-type: none"> identifies two measurement errors inherent in the apparatus used OR one measurement error and suggests a suitable modification. 	
4				
5	E5.a <ul style="list-style-type: none"> identifies two procedural errors and a suitable modification for one of them. 		E5.b <ul style="list-style-type: none"> comments on the relative accuracy of the measurements taken and identifies the most significant error. 	
6				
7	E7.a <ul style="list-style-type: none"> identifies two procedural errors and a suitable modification for both of them. justifies which of the two experiments (CaCO₃/HCl or CaO/HCl) is more accurate. 		E7.b <ul style="list-style-type: none"> suggests, with justification, a suitable modification to reduce the most significant measurement error. 	
	Procedural errors <ul style="list-style-type: none"> In the large beaker, there is insufficient depth of solution to cover the bulb of the thermometer. reaction very slow with lumps no insulation/heat losses specify any limitations in the materials used 		Errors in measurement <ul style="list-style-type: none"> temperature measurements weighing measurements volume measurements 	

It is recognised that other errors may be relevant to a particular Centre. If this is the case, the Centre should provide details to the moderator.

AS – Assessed Practical (Skill I)

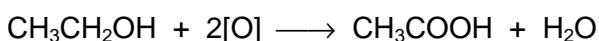
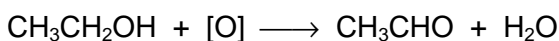
Name _____ Date _____

Introduction

For this exercise you are given full instructions for the practical procedure and these must be followed exactly. It is however up to you to consider suitable safety precautions and to organise your time appropriately. You should also carefully consider what is the most effective way of handling the materials and apparatus in order to obtain the maximum reliability.

The oxidation of ethanol

Ethanol is a primary alcohol and can be oxidised to either an aldehyde or a carboxylic acid.

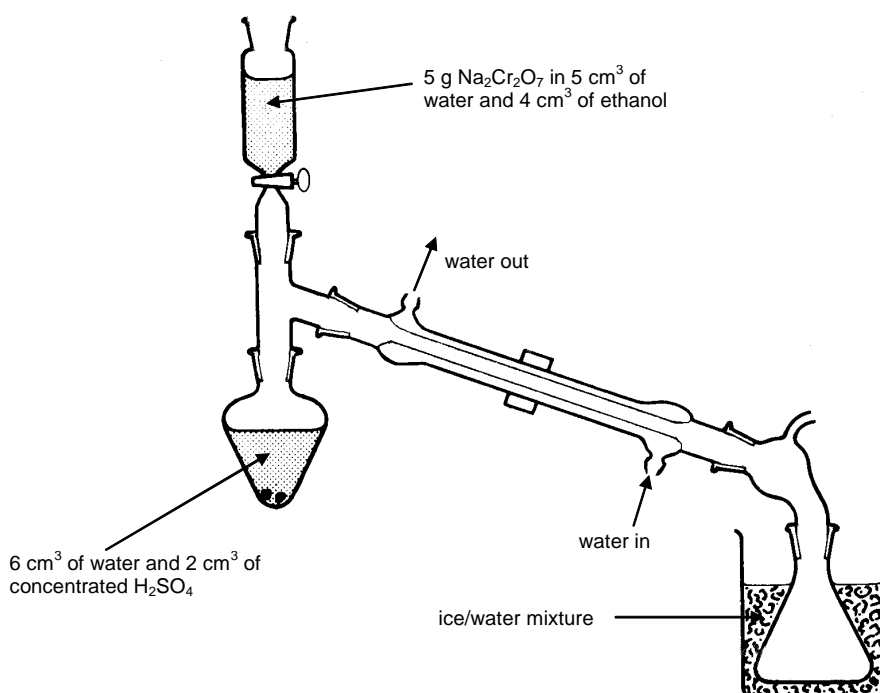


The purpose of this experiment is to oxidise ethanol and then to test the product to determine whether it has been oxidised to ethanal or oxidised to ethanoic acid.

Read through the procedure below before starting the experiment. You should comment on the hazard of the chemicals used in the experiment.

Method

To 6 cm³ of water in the pear-shaped flask, add 2 cm³ of concentrated sulphuric acid, and set up the apparatus as shown below, but with a stopper in place of the dropping funnel. Ensure that all of the glass joints are greased.



During the experiment, you will need to record all your observations clearly in an appropriate format. Record these appropriately in the space below. You should also consider the hazards associated with the materials and techniques used within the experiment and record these in the space below.

1. Make up a solution containing 5 g of sodium dichromate in 5 cm³ of water, add 4 cm³ of ethanol and pour the mixture into the dropping funnel.
2. Warm the acid in the pear shaped flask until it is almost boiling and turn off the bunsen burner.
3. Carefully remove the stopper and put the dropping funnel in position, as shown in the diagram.
4. Add the mixture containing the ethanol at such a rate as to maintain the boiling of the mixture in the pear shaped flask. Collect the distillate and write down all observations in the space below.
5. Carry out the following tests on the distillate and record your observations.

Test 1 Test for the presence of a carbonyl group to find out whether ethanal had been formed.

Put 5 cm³ of 2,4-dinitrophenylhydrazine in a test tube and cautiously add 5 drops of the distillate. Record your observations.

Test 2. Test for the presence of an acid group to find out whether ethanoic acid had been formed.

Put 5 drops of the distillate in a test tube and add 5 drops of universal indicator solution. Record your observations.

Safety

Comment about the hazard of the chemicals in the context of this experiment.

Observations

Conclusion

Use your results to decide whether an aldehyde or a carboxylic acid has been formed during this experiment. Explain how you made your decision.

The oxidation of ethanol

All chemicals should be labelled with the appropriate safety hazard warning label and where appropriate chemicals should be used in a suitable fume cupboard.

Each student will require:

safety spectacles or goggles
protective gloves
access to chemical data or hazard sheets
access to balance
distilled water
2 cm³ concentrated sulphuric acid
5 g sodium dichromate (it should be noted that potassium dichromate is not sufficiently soluble to be used)
4 cm³ ethanol
10 cm³ measuring cylinders or syringes for the distilled water, concentrated sulphuric acid and ethanol
small funnel
spatula
weighing bottle for sodium dichromate
2 clamp stands
2 bosses
2 clamps
50 cm³ pear-shaped Quick-fit flask, or round bottomed Quick-fit flask
Quick-fit still head
Quick-fit stopper
Quick-fit dropping funnel
Quick-fit Leibig condenser
Quick-fit delivery tube
small conical flask to collect distillate
beaker to contain small conical flask
crushed ice (and salt if required)
vaseline or other grease
Bunsen burner
tripod
gauze
2 test tubes
2 dropping pipettes
5 cm³ 2,4-dinitrophenylhydrazine
bung for test tube (no 13)
universal indicator solution

Note: The quantities of chemicals required are approximate and due allowance should be made for wastage. The student should measure volumes and masses to an appropriate degree of accuracy.

Skill I – Implementing

Total 7

The candidate:

Mark	Manipulation	Level	Observing and Recording	Level
0				
1	11.a <ul style="list-style-type: none"> demonstrates competence in simple techniques and some awareness of the need for safe working 		11.b <ul style="list-style-type: none"> makes and records one suitable observation 	
2				
3	13.a <ul style="list-style-type: none"> works safely assembles the distillation apparatus correctly 		13.b <ul style="list-style-type: none"> makes and records some suitable observations observes and responds to any precautions required in setting up the apparatus 	
4				
5	15.a <ul style="list-style-type: none"> obtains colourless distillate has full regard to the safety of others and organises working area efficiently. e.g., no breakages 		15.b <ul style="list-style-type: none"> makes and records observations throughout observes and controls the rate of distillation 	
6				
7	17.a <ul style="list-style-type: none"> makes suitable written comments about the hazard of the chemicals in the context of this experiment no spillage or stains 		17.b <ul style="list-style-type: none"> makes and records all major observations clearly and in appropriate detail observes and maintains full control of all stages of the experimental procedure 	

Candidates' written work must be sent to the moderator to provide evidence of the marks awarded.

A2 – Exemplar Summary Grid

This section contains six assessments that are suitable for A2. The table below summarises the skill that can be assessed with each.

- Skill P Planning
- Skill I Implementing
- Skill A Analysing Evidence and Drawing Conclusions
- Skill E Evaluating Evidence and Procedures

Experiment	Skill P	Skill I	Skill A	Skill E
Identification of an organic unknown.	✓		✓	
Preparation of antifebrin.		✓		
Hydrolysis of an ester.		✓		
The estimation of iron(II) and iron(III) in a mixture containing both.	✓			
The preparation of ions containing vanadium in two oxidation states.		✓		
The determination of the formula of iron(II) sulphate crystals.			✓	✓
The determination of the formula of copper sulphate crystals.			✓	✓
The determination of an equilibrium constant.			✓	
The determination of a rate equation.	✓		✓	✓

A2 – Assessed Practical (Skills P and A)

Name _____ Date _____

Introduction

Your plan which is likely to be between 500 and 1000 words can be word processed if you wish.

Your plan must show clear evidence that you have consulted at least **two** sources, such as textbooks or CD-ROMs or databases. Books must have chapter or page numbers and internet reference must go beyond the first slash of web address.

Do not simply copy the resources but give clear evidence that you have read, adapted and used the material to solve the problem set. All resources used should be clearly identified.

Identification of an organic unknown (Skill P)

You are supplied with an unknown organic compound containing one of the following functional groups:

- alkene
- primary alcohol
- tertiary alcohol
- aldehyde
- ketone
- carboxylic acid
- ester
- phenol

Outline a sequence of simple chemical tests that you could use to identify each group. Each test must be dependent on the result of the previous test. You **must** use a flow chart. You may assume that you can use standard equipment and apparatus and chemicals available in a school or college science laboratory.

Your plan should include the following:

- relevant chemical knowledge from both the AS and A2 parts of your chemistry course;
- the flow chart clearly presented;
- a procedure which provides full details of each test with the expected observations and any necessary safety precautions.

Identification of an organic unknown (Skill A)

You will be given the results of some wet tests that were carried on **two** unknown compounds. In addition you will be given the IR, NMR and mass spectrum of the same **two** unknown compounds. You must fully analyse the results from the wet tests and each of the spectra provided.

You will have to complete this part of the assessment under supervision during lesson time.

The candidate:

Mark	General strategy	Level	Choices within plan	Level
0				
1	P1.a <ul style="list-style-type: none"> • can identify two of the functional groups by simple tests 		P1.b <ul style="list-style-type: none"> • lists basic equipment to perform the tests suggested 	
2				
3	P3.a <ul style="list-style-type: none"> • can identify four of the functional groups by simple tests 		P3.b <ul style="list-style-type: none"> • identifies tests to be carried out but gives no detail 	
4				
5	P5.a <ul style="list-style-type: none"> • can identify six of the functional groups by simple tests using a flow chart 		P5.b <ul style="list-style-type: none"> • gives detail/method for each test 	
6				
7	P7.a <ul style="list-style-type: none"> • can identify all eight functional groups by efficient use of flow chart • retrieves and evaluates information from at least two sources • uses spelling, punctuation and grammar accurately 		P7.b <ul style="list-style-type: none"> • gives precise detail of the tests to be used including, where necessary, essential conditions and safety precautions. • lists the observations expected for each positive test. 	

Level 8

- Displays a depth of knowledge/research beyond that normally expected.

In order to meet the synoptic requirement students must show clear evidence of their ability to draw together knowledge and skills from different parts of the specification.

Candidates **MUST** analyse

- one unknown compound from Set 1 and
- one unknown compound from Set 2

The candidate:

Mark	Processing evidence	Level	Drawing conclusions	Level
0				
1	A1.a <ul style="list-style-type: none"> • carries out some simple processing of the observations collected from either the wet tests or one of the spectra 		A1.b <ul style="list-style-type: none"> • correctly identifies the functional group in one of the unknowns 	
2				
3	A3.a <ul style="list-style-type: none"> • makes use of the observations collected from either of the wet tests and links them with information from two of the spectra 		A3.b <ul style="list-style-type: none"> • correctly identifies one of the unknowns <i>OR</i> correctly identifies the functional groups in both unknowns 	
4				
5	A5.a <ul style="list-style-type: none"> • makes use of the observations collected from the wet tests and links this with information from all of the spectra for at least one of the unknowns 		A5.b <ul style="list-style-type: none"> • makes a valid conclusion from the results of the wet tests, e.g. 'one of the unknowns has at least two isomers with the same functional group'; 'a wet test may be positive for more than one functional group' 	
6				
7	A7.a <ul style="list-style-type: none"> • makes use of ALL of the evidence provided for both of the unknowns • draws on relevant knowledge from both the AS and A2 specifications • writes a report that is coherently linked to underlying scientific knowledge and understanding from more than one area of the specification 		A7.b <ul style="list-style-type: none"> • correctly identifies both unknowns making full use all of the information available 	

Level 8

- Displays a depth of analysis beyond that normally expected.

A2 – Assessed Practical (Skill I)

Name _____ Date _____

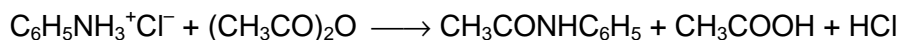
Introduction

For this exercise you are given full instructions for the practical procedure and these must be followed exactly. It is however up to you to consider suitable safety precautions and to organise your time appropriately. You should also carefully consider what is the most effective way of handling the materials and apparatus in order to obtain the best result.

You must provide written evidence that you have given careful consideration about the hazards of the chemicals used in the context of this experiment.

Preparation of Antifebrin.

Antifebrin is an example of an important pharmaceutical. In this experiment, you will prepare this organic compound from readily available chemical reagents. You will be assessed on your organic experimental skills and the techniques that you use in this preparation. Chemically, antifebrin is the amide, phenylethanamide $\text{CH}_3\text{CONHC}_6\text{H}_5$. In this preparation, the antifebrin is prepared from phenylammonium chloride, $\text{C}_6\text{H}_5\text{NH}_3^+\text{Cl}^-$, and ethanoic anhydride, $(\text{CH}_3\text{CO})_2\text{O}$.



While carrying out your experiment you will need to record observations.

You must provide written evidence that you have given careful consideration about the hazards of the chemicals used in the context of this experiment.

Procedure

1. Dissolve 1.0 g of phenylammonium chloride in 30cm^3 of water in a conical flask.
2. Prepare a solution of 6.0 g of sodium ethanoate in 25cm^3 of water in a conical flask.
3. Carefully add 2cm^3 of ethanoic anhydride to the solution of phenylammonium chloride and stir vigorously until all of the ethanoic anhydride has dissolved. Now add the sodium ethanoate solution and continue to stir for a further three minutes.
4. The solid that has collected is a crude sample of antifebrin. This should be collected by filtering under reduced pressure. It should then be washed with a little cold water.
5. Recrystallise the whole of your product from the minimum volume of hot water. Allow the mixture to cool and, when crystallisation is complete, filter off the pure product under reduced pressure.
6. Dry the bulk of your product in air and a small portion between filter paper. Use this small portion to determine the melting point of your sample.
7. Weigh the **dry** product and record your yield in a suitable format.

8. Submit your product for inspection in a specimen tube labelled with your name, the mass of the product and its melting point.

Preparation of the pharmaceutical, Antifebrin

All chemicals should be labelled with the appropriate safety hazard warning label and where appropriate chemicals should be used in a suitable fume cupboard.

Each student will require:

safety spectacles or goggles
protective gloves
access to balance
access to chemical data or hazard sheets
specimen tubes (or watch glasses) to weigh reagents
1.0 g phenylammonium chloride
6.0 g sodium ethanoate
spatulas for reagents
2 cm³ ethanoic anhydride
2 conical flasks (100cm³)
small beaker or conical flask for recrystallisation
10 cm³ measuring cylinder for ethanoic anhydride
25 cm³ or 50 cm³ measuring cylinders
Buchner flask
Buchner funnel
2 pieces filter paper for funnel
filter pump (water pump)
larger sheets of filter paper for drying sample
stirring rods
distilled water
iced water
wash bottle
Bunsen burner
tripod
gauze
melting point apparatus with tube and thermometer
specimen tube + label

Note: The quantities of chemicals required are approximate and due allowance should be made for wastage. The student should measure volumes and masses to an appropriate degree of accuracy.

Skill I – Implementing

Total 7

The candidate:

Mark	Manipulation	Level	Observing and Recording	Level
0				
1	11.a <ul style="list-style-type: none"> demonstrates competence in simple techniques such as weighing shows some awareness of the need for safe working 		11.b <ul style="list-style-type: none"> records one suitable observation records one suitable reading 	
2				
3	13.a <ul style="list-style-type: none"> demonstrates competence in three of the techniques shown below is able to manipulate materials and equipment with precision follows the procedure correctly regard is paid to all essential safety precautions 		13.b <ul style="list-style-type: none"> records two suitable observations records two suitable readings 	
4				
5	15.a <ul style="list-style-type: none"> works with accuracy and competence throughout observes all safety precautions works with consideration for others 		15.b <ul style="list-style-type: none"> records three suitable observations records three suitable readings 	
6				
7	17.a <ul style="list-style-type: none"> shows a high level of skill and efficiency in all the techniques below and obtains an accurate melting point obtains a white crystalline product makes suitable written comments about the hazard of the chemicals in the context of this experiment 		17.b <ul style="list-style-type: none"> records all observations in an appropriate format records all readings with due regard to units and to significant figures 	
	Techniques used include: <ul style="list-style-type: none"> weighing filtering under reduced pressure recrystallisation drying determination of melting point 		Observations <ul style="list-style-type: none"> colour changes precipitation appearance of product Recording <ul style="list-style-type: none"> mass melting point yield 	

Candidate's work must be sent to the moderator to provide evidence of the marks awarded BUT samples of the product MUST not be sent to the moderator.

A2 – Assessed Practical (Skill I)

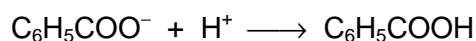
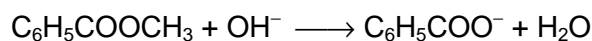
Name _____ Date _____

Introduction

For this exercise you are given full instructions for the practical procedure and these must be followed exactly. It is however up to you to consider suitable safety precautions and to organise your time appropriately. You should carefully consider what is the most effective way of handling the materials and apparatus in order to obtain the best result.

Hydrolysis of an Ester

In this experiment, you will hydrolyse the ester methyl benzoate to prepare benzoic acid, C₆H₅COOH.



You must provide written evidence that you have given careful consideration about the hazards of the chemicals used in the context of this experiment.

At each stage of the hydrolysis you should record clearly all observations and any measurements taken.

Procedure

1. Measure 2.0 cm³ of methyl benzoate into a 50 cm³ or 100 cm³ round-bottomed flask. Add 10 cm³ of the dilute 2.0 mol dm⁻³ sodium hydroxide solution provided, about 10 cm³ of ethanol and a few anti-bumping granules. Fit the water-cooled condenser supplied.
2. Heat the flask gently, without allowing the contents to boil, for about 5 minutes and then boil gently under reflux for a further 15 minutes.
3. Allow the contents of the flask to cool, remove the condenser and decant the solution from the anti-bumping granules into a beaker. Add ten drops of methyl orange indicator and acidify with 2.0 mol dm⁻³ hydrochloric acid. (You should need no more than 20 cm³ of HCl for this purpose). Filter the resulting product under reduced pressure.
4. Purify the whole of the acid produced by recrystallisation from the **minimum** amount of boiling water. Filter the purified product under reduced pressure and allow it to dry in air on a fresh piece of filter paper.
5. Dry a small sample of the product by pressing between filter papers and determine its melting point (which is greater than 100°C). Record this value in your report.
6. Weigh the **dry** product and record your yield in a suitable format.
7. Submit your product for inspection in a specimen tube labelled with your name, the mass of the product and its melting point.

Hydrolysis of an Ester

All chemicals should be labelled with the appropriate safety hazard warning label.

Each student will require:

2.0 cm³ of methyl benzoate

10 cm³ of 2M NaOH

10 cm³ of ethanol

methyl orange Indicator

20 cm³ of 2M HCl

50 cm³ or 100 cm³ round bottomed flask

3 × 10 cm³ measuring cylinders

anti-bumping granules

Water filled condenser and rubber tubing

Bunsen burner

Stand and Clamp

gauze

retort ring

250 cm³ beaker

stirring rod

spatula

access to vacuum filtration apparatus

access to boiling water

access to balance

access to melting point apparatus

Skill I – Implementing

Total 7

The candidate:

Mark	Manipulation	Level	Observing and Recording	Level
0				
1	11.a <ul style="list-style-type: none"> demonstrates competence in simple techniques such as weighing shows some awareness of the need for safe working 		11.b <ul style="list-style-type: none"> records one suitable observation records one suitable reading 	
2				
3	13.a <ul style="list-style-type: none"> demonstrates competence in three of the techniques shown below is able to manipulate materials and equipment with precision follows the procedure correctly regard is paid to all essential safety precautions 		13.b <ul style="list-style-type: none"> records two suitable observations records two suitable readings 	
4				
5	15.a <ul style="list-style-type: none"> works with accuracy and competence throughout observes all safety precautions works with consideration for others 		15.b <ul style="list-style-type: none"> records three suitable observations records three suitable readings 	
6				
7	17.a <ul style="list-style-type: none"> shows a high level of skill and efficiency in all the techniques below and obtains an accurate melting point obtains a white crystalline needle-like product makes suitable written comments about the hazard of the chemicals in the context of this experiment 		17.b <ul style="list-style-type: none"> records five suitable observations records three suitable readings 	
	Techniques used include: <ul style="list-style-type: none"> weighing refluxing filtering under reduced pressure recrystallisation drying determination of melting point 		Observations <ul style="list-style-type: none"> colour changes precipitation appearance of product Recording <ul style="list-style-type: none"> mass melting point yield 	

Candidate's work must be sent to the moderator to provide evidence of the marks awarded BUT samples of the product MUST not be sent to the moderator.

A2 – Assessed Practical (Skill P)

Name _____ Date _____

Introduction

Your plan which is likely to be between 500 and 1000 words can be word processed if you wish.

Your plan must show clear evidence that you have consulted at least **two** sources, such as textbooks or CD-ROMs or databases. Books must have chapter or page numbers and internet reference must go beyond the first slash of web address.

Do not simply copy the resources but give clear evidence that you have read, adapted and used the material to solve the problem set. All resources used should be clearly identified.

The estimation of iron(II) and iron(III) in a mixture containing both.

You have to devise a volumetric procedure to determine the percentage of iron(II) and iron(III) in a mixture containing both.

You are provided with 200 cm³ of a solution containing between 1.1 g and 1.3 g of iron ions as a mixture of Fe²⁺(aq) or Fe³⁺(aq). You may assume that each of the two ions is present to at least 30% by mass. You have the normal apparatus required for volumetric analysis **but a balance is not available**.

Your plan should include the following:

- relevant chemical knowledge from both the AS and A2 parts of your chemistry course;
- a list of equipment, apparatus and the solutions you would require;
- the concentrations and quantities of any solutions used;
- a detailed method which provides full instructions and any necessary precautions you would take to ensure the efficiency, accuracy and safety of your procedure;
- how the results you obtain would be used to calculate the percentage composition of the mixture.

You may assume that you can use standard equipment and apparatus and chemicals available in a school or college science laboratory.

The candidate:

Mark	General strategy	Level	Choices within plan	Level
0				
1	P.1a • suggests a method that could be used to estimate the amount of either Fe ²⁺ or Fe ³⁺		P.1b • chooses appropriate apparatus for the estimation of either Fe ²⁺ or Fe ³⁺	
2				
3	P.3a • suggests methods that could be used to estimate the amounts of both Fe ²⁺ and Fe ³⁺		P.3b • chooses appropriate apparatus for the estimation of both Fe ²⁺ and Fe ³⁺	
4				
5	P.5a • takes into account the need for safe working • provides detailed procedures which would allow both concentrations to be determined		P.5b • gives detail of reagents required for both methods	
6				
7	P.7a • chooses a method which allow a high level of accuracy • retrieves and evaluates information from a variety of sources as necessary • provides a plan which is well structured, logical and linked coherently to underlying scientific knowledge and understanding, with accurate spelling, punctuation and grammar throughout		P.7b • provides accurate details of concentrations of solutions and apparatus, etc to ensure the highest level of precision, reliability and safety	

Level 8

- Provides full quantitative details of the reagents required.
- Provides full detail to ensure the accuracy of the experiment.

In order to meet the synoptic requirement for skills P and A, students must show clear evidence of their ability to draw together knowledge and skills from different parts of the specification. In this experiment students would be expected to use the following:

AS: Foundation Chemistry, use of the mole concept and reacting quantities (5.1.1(j), (k)), and **A2:** Trends and Patterns, redox titrations (5.5.3(j), (k), (l)).

A2 – Assessed Practical (Skill I)

Name _____ Date _____

Introduction

For this exercise you are given full instructions for the practical procedure and these must be followed exactly. It is however up to you to consider suitable safety precautions and to organise your time appropriately. You should also carefully consider what is the most effective way of handling the materials and apparatus in order to obtain the maximum reliability.

You must provide written evidence that you have given careful consideration about the hazards of the chemicals used in the context of this experiment.

The preparation of ions containing vanadium in two oxidation states

You are provided with 0.02 mol dm^{-3} ammonium (or sodium) vanadate(V) and 0.01 mol dm^{-3} potassium manganate(VII).

In this experiment, you are to use two methods of reduction to convert the vanadate(V) ions into two other vanadium-containing ions in which the vanadium exists in different oxidation states. The solutions thus obtained are each titrated with aqueous potassium manganate(VII), $\text{KMnO}_4(\text{aq})$. In each titration, the vanadium-containing ion is oxidised back to vanadate(V).

By comparing the titres, you are to deduce the likely changes in the oxidation states of vanadium after reduction by the two methods.

When carrying out both of your experiments you will need to record:

- all relevant observations and colour changes
- your titration results in an appropriate format.

Method 1

1. Pipette 25.00 cm^3 of the aqueous vanadate(V) provided into a conical flask and add to it about 40 cm^3 of water and 25 cm^3 of 2.0 mol dm^{-3} sulphuric acid. Now add to the flask about 5 g of zinc.
2. Place a small filter funnel in the neck of the flask (to minimise the entry of air) and gently boil the contents of the flask until they become pale purple in colour. (This may take about thirty minutes and further water - preferably boiled - may be added if the volume of solution becomes too small.)
3. While waiting for the reduction to be completed, fill a burette with the aqueous potassium manganate(VII) provided. From the burette run exactly 25.00 cm^3 into a second conical flask and place the small filter funnel containing a small tuft of glass-wool into the neck of the flask.

Caution: the glass-wool should not be handled.

4. When the reduction is complete, filter the hot contents of the 'reduction' flask through the glass-wool and into the $\text{KMnO}_4(\text{aq})$. (The glass-wool filter removes unreacted zinc.)

5. Using previously boiled distilled water, rinse out the reduction flask and wash the glass-wool to ensure that all the vanadium ions are transferred to the titration flask.
6. Complete the titration by running in $\text{KMnO}_4(\text{aq})$ from the burette until an end-point is reached. Carry out the titration briskly whilst the solution remains hot.
7. The total titre is the original 25.00 cm^3 plus the additional volume required.

Method 2

1. As before, pipette 25.00 cm^3 of the vanadate(V) solution into a conical flask and add to it 40 cm^3 of water and 25 cm^3 of 2.0 mol dm^{-3} sulphuric acid.
2. In a fume cupboard, gently pass $\text{SO}_2(\text{g})$ into the solution for a few minutes. The solution will turn blue as the vanadium is reduced to a new oxidation state.
3. Still using a fume cupboard, boil the contents of the flask to expel any excess of sulphur dioxide - use a piece of filter paper moistened with aqueous potassium dichromate(VI) to check that all the sulphur dioxide has been expelled. The paper moistened with aqueous potassium dichromate(VI) will turn pale green if any sulphur dioxide is still present. This process must be completed before you undertake the next titration.
4. Remove the solution from the fume cupboard and heat to approximately $70 \text{ }^\circ\text{C}$ and titrate with the $\text{KMnO}_4(\text{aq})$. Record the titre.

The preparation of ions containing vanadium in two oxidation states

All chemicals should be labelled with the appropriate safety hazard warning label and where appropriate chemicals should be used in a suitable fume cupboard.

Each student will require:

safety spectacles or goggles
protective gloves
access to chemical data or hazard sheets
access to balance
access to sulphur dioxide generator in a fume cupboard (see below)
access to Bunsen, tripod and gauze within the fume cupboard
50 cm³ 0.02 mol dm⁻³ ammonium (or sodium vanadate)
approx 100 cm³ 0.01 mol dm⁻³ potassium manganate(VII)
50 cm³ 2.0 mol dm⁻³ sulphuric acid
5 g granulated zinc or powdered zinc
small beaker (or watch glass) to weigh zinc
spatula for zinc
25.00 cm³ pipette
pipette filler
50.00 cm³ burette
burette clamp
clamp stand for burette
small funnel for filling burette
white tile
3 conical flasks (250 cm³)
beaker or another conical flask to boil water
small filter funnel to fit neck of conical flask
50 cm³ measuring cylinder
distilled water
Bunsen burner
tripod
gauze
glass wool (+ gloves and tongs to handle it)
small piece of filter paper + tongs + aqueous potassium dichromate (1 or 2 cm³ per student)
thermometer

(A sulphur dioxide generator can be made by dripping dilute sulphuric acid onto a sulphite (eg sodium sulphate IV). The gas should be generated by downwards delivery with a piece of rubber tubing to enable it to be bubbled through the conical flask.)

Note: The quantities of chemicals required are approximate and due allowance should be made for wastage. The student should measure volumes and masses to an appropriate degree of accuracy.

Skill I – Implementing

Total 7

The candidate:

Mark	Manipulation	Level	Observing and Recording	Level
0				
1	I1.a <ul style="list-style-type: none"> demonstrates competence in simple techniques shows some awareness of the need for safe working generally follows the procedure correctly 		I1.b <ul style="list-style-type: none"> makes and records observations and/or measurements which are adequate for the activity records one observation 	
2				
3	I3.a <ul style="list-style-type: none"> demonstrates competence in practised techniques is able to manipulate materials and equipment with precision the reduction is completed without the solution boiling dry the procedure is followed correctly there are no significant safety lapses during the experimentation 		I3.b <ul style="list-style-type: none"> makes systematic and accurate measurements which are recorded clearly at least one of the measurements is accurate to within 10% of the centre value records two observations 	
4				
5	I5.a <ul style="list-style-type: none"> works with accuracy and secure competence throughout observes all safety precautions employs procedures to improve experimental accuracy, e.g. in Method I adds more water during the reduction as required and performs the titration briskly to avoid oxidation, in Method II, checks carefully that sulphur dioxide has been expelled 		I5.b <ul style="list-style-type: none"> measurements are recorded with regard to the precision of the apparatus use obtains both results with at least one of them within 5% of the centre value records measurements in an appropriate format records three observations 	
6				
7	I7.a <ul style="list-style-type: none"> demonstrates a high level of skill and efficiency throughout makes suitable written comments about the hazard of the chemicals in the context of this experiment. 		I7.b <ul style="list-style-type: none"> records all measurements to a correct level of precision and in an appropriate format obtains both results, one within 5% and one within 10% of the centre value records five observations 	
			Observations <ul style="list-style-type: none"> Colour changes 	

Candidate's work **MUST** be sent to the moderator to provide evidence of the marks awarded.

A2 – Assessed Practical (Skills A and E)

Name _____ Date _____

Introduction

For this exercise you are given full instructions for the practical procedure and these must be followed exactly. It is however up to you to consider suitable safety precautions and to organise your time appropriately. You should also carefully consider what is the most effective way of handling the materials and apparatus in order to obtain the maximum reliability. You will first be required to do the experiments and then, under supervision, to calculate the results (skill A) and evaluate the quality and reliability of your data and suggest suitable improvements to your experimental procedure (skill E).

Determination of the formula of Hydrated Iron(II) Sulphate Crystals

In this experiment you are to use two methods to provide results which will enable you to calculate the formula of the hydrated iron(II) sulphate crystals, $\text{FeSO}_4 \cdot x\text{H}_2\text{O}$.

Method 1

1. Using a balance that weighs to two decimal places, weigh a crucible. Add between 1.30 – 1.50 g of hydrated iron II sulphate crystals. Record the masses.
2. Place the crucible containing the hydrated iron(II) sulphate crystals on the pipe-clay triangle and gently heat for about two minutes. The heating should be carried out in either a fume cupboard or a well-ventilated room.
3. Allow to cool and weigh the crucible and the iron(II) sulphate.
4. Repeat steps 2 and 3.
5. Record all of the masses.

Method 2

1. Weigh as accurately as possible between 2.85 and 3.10 g of hydrated iron(II) sulphate crystals, $\text{FeSO}_4 \cdot x\text{H}_2\text{O}$. Record the mass and then dissolve the crystals in 50.0 cm³ of 1 mol dm⁻³ $\text{H}_2\text{SO}_4(\text{aq})$ and make up to 250 cm³ in a volumetric flask with distilled water. Invert the volumetric flask several times to ensure that the solution is evenly mixed.
2. Using a pipette filler, pipette 25.0 cm³ of the solution of iron(II) sulphate into a conical flask and add approximately 20.0 cm³ of the 1 mol dm⁻³ $\text{H}_2\text{SO}_4(\text{aq})$ solution provided.
3. Titrate the acidified $\text{Fe}^{2+}(\text{aq})$ solution with 0.0100 mol dm⁻³ potassium permanganate, $\text{KMnO}_4(\text{aq})$, and continue the titration to the normal end-point.
4. Repeat the titration until you have obtained concordant results

Analysis of the results (Skill A)

Method 1

Use your results to calculate the moles of FeSO_4 and the moles of water and hence deduce the formula of the hydrated iron(II) sulphate crystals, $\text{FeSO}_4 \cdot x\text{H}_2\text{O}$.

Method 2

Use your results to calculate the moles of Fe^{2+} and hence deduce the formula of the hydrated iron(II) sulphate crystals, $\text{FeSO}_4 \cdot x\text{H}_2\text{O}$.

Evaluation of the Experiment (Skill E)

When you have finished, you should compare your results for both methods and evaluate the experiment by critically looking at both methods.

You should:

- identify clearly any anomalous results;
- comment on the overall accuracy of your final result;
- identify the main sources of error in both the procedure and the measurements;
- compare, with reasons, the accuracy and reliability of the different techniques that you used during the practical task;
- look at the method critically and suggest ways of minimising errors and increasing reliability;
- suggest improvements that could be made to the experimental procedures whilst following essentially the same general method. You should consider changes that improve the reliability of the results and that minimise errors.

Determination of the formula of Hydrated Iron(II) Sulphate Crystals

All chemicals should be labelled with the appropriate safety hazard warning label and where appropriate chemicals should be used in a suitable fume cupboard.

Each student will require:

- safety spectacles or goggles
- protective gloves
- access to chemical data or hazard sheets
- access to balance
- access to Bunsen and tripod
- pipeclay triangle
- crucible
- spatula
- matches and splints
- hydrated iron(II) sulphate labelled 'hydrated iron(II) sulphate (No formula should be visible.) Each student will need approx 6 g.
- weighing bottle or weighing boat
- access to measuring cylinders
- 250 cm³ 1 mol dm⁻³ sulphuric acid
- approx 100 cm³ 0.0100 mol dm⁻³ potassium manganate(VII)
- small beaker
- glass rod
- 250 cm³ volumetric flask
- 25.00 cm³ pipette
- pipette filler
- 50.00 cm³ burette
- burette clamp
- clamp stand for burette
- small funnel for filling burette
- white tile
- 3 conical flasks (250 cm³)
- distilled water
- dropping pipettes

Note: The quantities of chemicals required are approximate and due allowance should be made for wastage. The student should measure volumes and masses to an appropriate degree of accuracy.

The candidate:

Mark	Processing evidence	Level	Drawing conclusions	Level
0				
1	A1.a <ul style="list-style-type: none"> • makes use of titration results to obtain an average titre 		A1.b <ul style="list-style-type: none"> • calculates the initial mass of hydrated FeSO_4 in method 1 • calculates the mass of water given off in method 1. 	
2				
3	A3.a <ul style="list-style-type: none"> • makes use of relative molecular masses/molar masses 		A3.b <ul style="list-style-type: none"> • calculates the number of moles of FeSO_4 in method 1 • calculates the number of moles of $\text{FeSO}_4/\text{Fe}^{2+}$ in method 2 	
4				
5	A5.a <ul style="list-style-type: none"> • makes use of reacting quantities 		A5.b <ul style="list-style-type: none"> • calculates the number of moles of H_2O in method 1 • calculates the number of moles of H_2O in method 2 	
6				
7	A7.a <ul style="list-style-type: none"> • shows full regard for units, terminology and the use of significant figures consistent with the accuracy of the apparatus • correctly selects titration results to produce an average titre 		A7.b <ul style="list-style-type: none"> • calculates a value for x in both methods • calculates the formula accurately for both methods, with all steps of the calculation in a clear well structured format 	

Level 8

- The accuracy of the formula is derived and justified, with regards to all measurements and data used.

Skill E - Evaluating Evidence and Procedures

Total 7

The candidate:

Mark	Procedural errors	Level	Errors in measurement	Level
0				
1	E1.a <ul style="list-style-type: none"> identifies one procedural error 		E1.b <ul style="list-style-type: none"> identifies one measurement error inherent in the apparatus used 	
2				
3	E3.a <ul style="list-style-type: none"> identifies two procedural errors or one procedural error and a suitable modification 		E3.b <ul style="list-style-type: none"> identifies two measurement errors inherent in the apparatus used or one measurement error and suggests a suitable modification 	
4				
5	E5.a <ul style="list-style-type: none"> identifies two procedural errors and a suitable modification for one of them 		E5.b <ul style="list-style-type: none"> comments on the relative accuracy of the measurements taken and identifies the most significant error 	
6				
7	E7.a <ul style="list-style-type: none"> identifies two procedural errors and a suitable modification for both of them/ or justifies why a modification to either method is not required 		E7.b <ul style="list-style-type: none"> suggests, with justification, a suitable modification to reduce the most significant measurement error 	
	Procedural errors <ul style="list-style-type: none"> relative amounts of the reagent thermal stability of the reagent comments on relative reliability of the two methods 		Errors in measurement <ul style="list-style-type: none"> volumes of reagents weighings 	

It is recognised that other errors may be relevant to a particular Centre. If this is the case, the Centre should provide details to the moderator.

A2 – Assessed Practical (Skills A and E)

Name _____ Date _____

Introduction

For this exercise you are given full instructions for the practical procedure and these must be followed exactly. It is however up to you to consider suitable safety precautions and to organise your time appropriately. You should also carefully consider what is the most effective way of handling the materials and apparatus in order to obtain the maximum reliability. You will first be required to do the experiments and then, under supervision, to calculate the results (skill A) and evaluate the quality and reliability of your data and suggest suitable improvements to your experimental procedure (skill E).

Determination of the formula of Hydrated Copper Sulphate Crystals

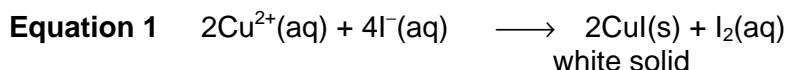
Experiment 1

1. Using a balance that weighs to two decimal places weigh a crucible. Add between 2.40 – 2.60 g of hydrated copper sulphate crystals and record the mass.
2. Place the crucible containing the hydrated copper sulphate crystals on the pipe-clay triangle and gently heat for about five minutes.
3. Allow to cool and weigh the crucible and the copper sulphate.
4. Repeat steps 2 and 3 until constant mass is achieved.
5. Record all of your results in an appropriate format.
6. Calculate the percentage by mass of water of crystallisation present in the crystals.

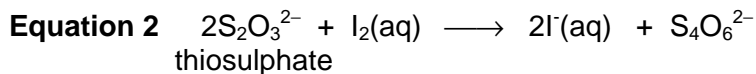
Experiment 2

1. Weigh as accurately as possible between 5.70 and 6.20 g of hydrated copper sulphate crystals, dissolve it in distilled water and make up to 250 cm³ in a volumetric flask. Invert the volumetric flask several times to ensure that the solution is evenly mixed.
2. Using a pipette filler, pipette 25.0 cm³ of the solution of copper sulphate into a conical flask and add approximately 10 cm³ of the 10% potassium iodide solution provided.

The copper(II) ion in the salt reacts with the iodide ion according to the equation below:



3. Titrate the iodine formed with $0.100 \text{ mol dm}^{-3}$ sodium thiosulphate, $\text{Na}_2\text{S}_2\text{O}_3(\text{aq})$, solution until the mixture becomes pale yellow. Add approximately 1 cm^3 starch indicator. The solution will turn a dark blue/black colour indicating that there is still some iodine present. Continue the titration until the solution becomes colourless. This is the end-point of the reaction.



4. Repeat the titration until you have obtained concordant results.
5. Record your results in a suitable format.
6. Use equations 1 and 2 to deduce the relationship between the number of moles of Cu^{2+} and the number of moles of $\text{S}_2\text{O}_3^{2-}$.
7. Calculate the percentage by mass of Cu^{2+} in your sample of copper sulphate crystals.

Analysis of the results from both experiments (Skill A)

Use your results from **both** experiments to calculate the mass of water of crystallisation and the mass of copper ions that would be present in a 1.0 g sample of copper sulphate crystals.

Hence calculate the mass of sulphate ion that would be present in a 1.0 g sample of copper sulphate crystals.

Hence deduce the formula of hydrated copper sulphate crystals.

Evaluation of the Experiment (Skill E)

When you have finished, you should compare your results for both methods and evaluate the experiment by critically looking at both methods.

You should:

- identify clearly any anomalous results;
- comment on the overall accuracy of your final result;
- identify the main sources of error in both the procedure and the measurements;
- compare, with reasons, the accuracy and reliability of the different techniques that you used during the practical task;
- look at the method critically and suggest ways of minimising errors and increasing reliability;
- suggest improvements that could be made to the experimental procedures whilst following essentially the same general method. You should consider changes that improve the reliability of the results and that minimise errors.

Determination of the formula of Hydrated Copper Sulphate Crystals

All chemicals should be labelled with the appropriate safety hazard warning label and where appropriate chemicals should be used in a suitable fume cupboard.

Each student will require:

- safety spectacles or goggles
- protective gloves
- access to chemical data or hazard sheets
- access to balance
- access to Bunsen and tripod
- pipeclay triangle
- crucible
- spatula
- matches and splints
- hydrated copper sulphate labelled 'hydrated copper sulphate (No formula should be visible.) Each student will need approx 10 g.
- weighing bottle or weighing boat
- access to measuring cylinders
- approx 50 cm³ 10% potassium iodide solution
- approx 100 cm³ 0.100 mol dm⁻³ sodium thiosulphate
- approx 5 cm³ starch
- small beaker
- glass rod
- 250 cm³ volumetric flask
- 25.00 cm³ pipette
- pipette filler
- 50.00 cm³ burette
- burette clamp
- clamp stand for burette
- small funnel for filling burette
- white tile
- 3 conical flasks (250 cm³)
- distilled water
- dropping pipettes

Note: The quantities of chemicals required are approximate and due allowance should be made for wastage. The student should measure volumes and masses to an appropriate degree of accuracy.

The candidate:

Mark	Processing evidence	Level	Drawing conclusions	Level
0				
1	A1.a <ul style="list-style-type: none"> • makes use of titration results to obtain an average titre in experiment 2 		A1.b <ul style="list-style-type: none"> • calculates the initial mass of hydrated CuSO_4 in method 1 • calculates the mass of water given off in experiment 1 	
2				
3	A3.a <ul style="list-style-type: none"> • makes use of relative molecular masses/molar masses 		A3.b <ul style="list-style-type: none"> • calculates the percentage by mass of water of crystallisation in experiment 1 • calculates the number of moles of $\text{S}_2\text{O}_3^{2-}$ in experiment 2 	
4				
5	A5.a <ul style="list-style-type: none"> • makes use of reacting quantities 		A5.b <ul style="list-style-type: none"> • deduces the mole ratio $\text{Cu}^{2+} : \text{S}_2\text{O}_3^{2-}$ in experiment 2 • calculates the percentage by mass of Cu^{2+} in experiment 2 	
6				
7	A7.a <ul style="list-style-type: none"> • shows full regard for units, terminology and the use of significant figures consistent with the accuracy of the apparatus • correctly selects titration results to produce an average titre 		A7.b <ul style="list-style-type: none"> • calculates the formula of hydrated copper sulphate accurately from both methods, with all steps of the calculations in a clear well structured format 	

Level 8

- The accuracy of the formula is derived and justified, with regards to all measurements and data used.

Skill E - Evaluating Evidence and Procedures

Total 7

The candidate:

Mark	Procedural errors	Level	Errors in measurement	Level
0				
1	E1.a • identifies one procedural error		E1.b • identifies one measurement error inherent in the apparatus used	
2				
3	E3.a • identifies two procedural errors or one procedural error and a suitable modification		E3.b • identifies two measurement errors inherent in the apparatus used or one measurement error and suggests a suitable modification	
4				
5	E5.a • identifies two procedural errors and a suitable modification for one of them		E5.b • comments on the relative accuracy of the measurements taken and identifies the most significant error	
6				
7	E7.a • identifies two procedural errors and a suitable modification for both of them		E7.b • suggests, with justification, a suitable modification to reduce the most significant measurement error	
	Procedural errors <ul style="list-style-type: none"> • relative amounts of the reagent • thermal stability of the reagent • reliability of the two methods 		Errors in measurement <ul style="list-style-type: none"> • volumes of reagents • weighings 	

It is recognised that other errors may be relevant to a particular Centre. If this is the case, the Centre should provide details to the moderator.

A2 – Assessed Practical (Skill A)

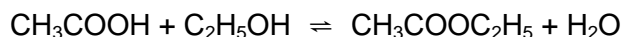
Name _____ Date _____

Introduction

For this exercise you are given full instructions for the practical procedure and these must be followed exactly. It is however up to you to consider suitable safety precautions and to organise your time appropriately. You should also carefully consider what is the most effective way of handling the materials and apparatus in order to obtain the maximum reliability. You will first be required to do the experiments and then, under supervision, to calculate the results (skill A).

To determine an equilibrium constant.

Several mixtures of ethanoic acid, ethanol, ethyl ethanoate and water have been set up and left for seven days to reach equilibrium.



The table below shows the initial composition of each mixture. You will be given one of the mixtures to analyse.

experiment	volume CH_3COOH $/\text{cm}^3$	volume $\text{C}_2\text{H}_5\text{OH}$ $/\text{cm}^3$	volume $\text{CH}_3\text{COOC}_2\text{H}_5$ $/\text{cm}^3$	volume H_2O $/\text{cm}^3$
1	15.0	15.0	15.0	5.0
2	15.0	15.0	0.0	20.0
3	15.0	0.0	15.0	20.0
4	0.0	15.0	15.0	20.0

The densities, in g cm^{-3} , of the substances are as follows:

CH_3COOH 1.05; $\text{C}_2\text{H}_5\text{OH}$ 0.79; $\text{CH}_3\text{COOC}_2\text{H}_5$ 0.92; H_2O 1.0.

5 cm^3 of 1.0 mol dm^{-3} hydrochloric acid was added to each of the mixtures to ensure that equilibrium was reached in a reasonable length of time. Its presence does not alter the position of equilibrium. This 5 cm^3 has been included in the volume of water given in the table.

The total volume of each mixture is 50 cm^3 .

Procedure

You will be provided with one of the mixtures and your task is to determine the equilibrium concentration of ethanoic acid by titration.

Using a graduated pipette, take a 1.00 cm^3 sample from your mixture and put it into a conical flask containing about 25 cm^3 of deionised water. Add a few drops of phenolphthalein indicator. Put the $0.200 \text{ mol dm}^{-3}$ sodium hydroxide solution into the burette and carry out the titration. Repeat the titration as many times as you think necessary.

Analysis of results (Skill A)

- 1 Using the data in the table and the densities given, calculate the mass of each substance in the initial mixture (mass = density x volume).
- 2 Hence calculate the number of moles of each substance in the initial mixture.
- 3 Using the results of your titration calculate the number of moles of sodium hydroxide run into the conical flask from the burette.
- 4 Using the information given about the amount of hydrochloric acid added to the reaction mixture work out how many moles of sodium hydroxide reacted with the hydrochloric acid in the titration.
- 5 From the answers to 3 and 4 work out how many moles of ethanoic acid were present in the titration flask.
- 6 How many moles of ethanoic acid were present in the 50 cm³ of equilibrium mixture?
- 7 By deduction, work out the numbers of moles of ethanol, ethyl ethanoate and water which were present in the 50 cm³ of equilibrium mixture.
- 8 Obtain a value for the equilibrium constant.

The Determination of an Equilibrium Constant

Required to be made up in advance for the quantities given:

250 cm³ pure (glacial) ethanoic acid

250 cm³ ethanol

250 cm³ ethyl ethanoate

1.00 mol dm⁻³ hydrochloric acid (as calculated = number of students x 25 cm³ + 100 cm³)

distilled water

conical flasks with bungs

The mixtures given in the table will need to be made up a week in advance using a burette to measure each reactant. Each solution has a volume of 50 cm³. Ideally the mixtures should be left in a thermostatically controlled water bath for one week. The conical flasks should be carefully stoppered to prevent evaporation. Each experiment should provide sufficient solution for 25 students, and volumes should be scaled according to number. Each of the mixtures should be made up and distributed to students equally.

All chemicals should be labelled with the appropriate safety hazard warning label.

Each student will require:

safety spectacles or goggles

access to chemical data or hazard sheets

2 beakers or conical flasks for control solution and allocated experiment solution

chinagraph pencil or labels

1.00 cm³ pipette

pipette filler

250 cm³ conical flask

100 cm³ measuring cylinder

distilled water

50.00 cm³ burette

burette clamp

clamp stand for burette

small funnel for filling burette

white tile

200 cm³ 0.200 mol dm⁻³ sodium hydroxide solution

distilled water wash bottle

phenolphthalein indicator

Note: The quantities of chemicals required are approximate and due allowance should be made for wastage. The student should measure volumes and masses to an appropriate degree of accuracy.

The candidate:

Mark	Processing evidence	Level	Drawing conclusions	Level
0				
1	A1.a <ul style="list-style-type: none"> • makes use of titration results to obtain an average titre 		A1.b <ul style="list-style-type: none"> • calculates the initial mass of each component in the mixture used 	
2				
3	A3.a <ul style="list-style-type: none"> • makes use of relative molecular masses/molar masses 		A3.b <ul style="list-style-type: none"> • calculates the initial number of moles of each component in the mixture used 	
4				
5	A5.a <ul style="list-style-type: none"> • makes use of reacting quantities 		A5.b <ul style="list-style-type: none"> • calculates the total acid content at equilibrium • calculates the change in the number of moles of ethanoic acid in attaining equilibrium 	
6				
7	A7.a <ul style="list-style-type: none"> • shows full regard for units, terminology and the use of significant figures consistent with the accuracy of the apparatus • correctly selects titration results to produce an average titre 		A7.b <ul style="list-style-type: none"> • calculates equilibrium values for all components of the equilibrium • calculates the equilibrium constant accurately with all steps of the calculation in a clear well structured format 	

Level 8

- The accuracy of the equilibrium constant is derived and justified, with regards to all measurements and data used.

A2 – Assessed Practical (Skills P, A and E)

Name _____ Date _____

Introduction

Your plan which is likely to be between 500 and 1000 words can be word processed if you wish.

Your plan must show clear evidence that you have consulted at least **two** sources, such as textbooks or CD-ROMs or databases. Books must have chapter or page numbers and internet reference must go beyond the first slash of web address.

Do not simply copy the resources but give clear evidence that you have read, adapted and used the material to solve the problem set. All resources used should be clearly identified.

The determination of a rate equation (Part 1: Skill P)

You are to plan an experimental procedure leading to a **graphical** method to determine how the **concentration**, or **volume**, of each component affects the rate of the reaction whose equation is given below.



You must also explain how you would use suitable graphs to determine the rate equation for the reaction between the sodium thiosulphate, $\text{Na}_2\text{S}_2\text{O}_3$ and the hydrochloric acid, HCl .

You are supplied with the following solutions:

- 0.4 mol dm^{-3} sodium thiosulphate, $\text{Na}_2\text{S}_2\text{O}_3$
- 2.0 mol dm^{-3} hydrochloric acid, HCl

Observe what happens when your teacher mixes together 50 cm^3 $\text{Na}_2\text{S}_2\text{O}_3(\text{aq})$ (0.4 mol dm^{-3}) with 5.0 cm^3 $\text{HCl}(\text{aq})$ (2.0 mol dm^{-3}) diluted with 20 cm^3 H_2O .

You will need to use this demonstration as a basis to justify the choice of concentrations/volumes of each reagent used in your subsequent plan.

You may assume that you can use standard equipment and apparatus and chemicals available in a school or college science laboratory.

Your plan should include the following:

- a list of equipment and apparatus and chemicals;
- the concentrations and quantities of any solutions used;
- justify how you vary the concentration/volume of each reagent compared to those used in the demonstration.
- the variables that need to be controlled and how you would control them;
- a detailed method which provides full instructions, including any necessary precautions;
- how your results and graphs can be used to determine the rate equation;
- a consideration of the safety of the procedure. This should include both reagents and products.

The determination of a rate equation (Part 2: Skills A and E)

You will either be given the opportunity to carry out your plan or your teacher will provide you with a set of instructions for the practical.

You will then be able to analyse your experimental results and draw suitable conclusions (Skill A).

You will then need to evaluate the quality and reliability of your data and suggest suitable improvements to the experimental procedure (Skill E).

You will have to complete part 2 of this assessment under supervision during lesson time.

Analysis and Conclusions

When you have completed your experiments:

- record your results in a suitable format,
- analyse the data collected graphically,
- draw any relevant conclusions.

Evaluation

When you have finished, you should evaluate your plan and the experiment that you have carried out.

Using all the results that have been obtained:

- identify clearly any anomalous results;
- comment on the overall accuracy of your graph and final result;
- identify the main sources of error in both the procedure and the measurements;
- compare, with reasons, the accuracy and reliability of the different techniques that you used during the practical task;
- look at the method critically and suggest modifications to minimise errors and to increase reliability;
- identify, with justification, the most significant error. Suggest (and justify) how you would minimise this error.

Skill P - Planning

Total 8

The candidate:

Mark	General strategy	Level	Choices within plan	Level
0				
1	P.1a <ul style="list-style-type: none"> suggests a method which could allow the rate of reaction to be measured 		P.1.b <ul style="list-style-type: none"> suggests suitable apparatus 	
2				
3	P.3a <ul style="list-style-type: none"> recognises the need to change each variable independently 		P.3b <ul style="list-style-type: none"> gives some detail of concentrations/volumes required 	
4				
5	P.5a <ul style="list-style-type: none"> identifies a series of experiments that will generate sufficient points to enable appropriate graphs to be plotted 		P.5b <ul style="list-style-type: none"> identifies the appropriate graphs to enable the order of reaction with respect to each reagent to be deduced 	
6				
7	P.7a <ul style="list-style-type: none"> retrieves and evaluates information from at least two sources provides a detailed plan which could be used by others without modification uses spelling, punctuation and grammar accurately 		P.7b <ul style="list-style-type: none"> explains how the graphs chosen will allow the rate equation to be determined justifies the choice of solutions with respect to the teacher demonstration provides accurate details of concentrations of solutions and apparatus, etc to ensure the highest level of precision, reliability and safety 	

Level 8

- Identifies limitations of the method beyond that normally expected

In order to meet the syllabus synoptic requirement for skills P and A, students must show clear evidence of their ability to draw together knowledge and skills from different parts of the specification. In this experiment students would be expected to use some of the following:

AS: Foundation Chemistry, Moles, Atoms and Stoichiometry (5.1.1(j), (k)); AS: How Far, How Fast? Reaction Rates (5.3.2) and A2: Unifying Concepts, How Far? (5.11.1).

Skill A - Analysing Evidence and Drawing Conclusions

Total 8

The candidate:

Mark	Processing evidence	Level	Drawing conclusions	Level
0				
1	A.1a <ul style="list-style-type: none"> processes results to plot a graph 		A.1b <ul style="list-style-type: none"> completes one graph 	
2				
3	A.3a <ul style="list-style-type: none"> correctly plots one graph with labelled axes. (units not essential) 		A.3b <ul style="list-style-type: none"> interprets one graph to determine the order of reaction with respect to one reagent or justifies why it cannot be determined. 	
4				
5	A.5a <ul style="list-style-type: none"> correctly plots a graph for each reagent with labelled axes and units 		A.5b <ul style="list-style-type: none"> analyses each graphs to determine the order of reaction with respect to both reagents or justifies why the order of reaction cannot be determined from the graphs 	
6				
7	A.7a <ul style="list-style-type: none"> chooses appropriate scales to determine the order of reaction with respect to each reagent shows full regard for units, terminology and use of significant figures consistent with the accuracy of the apparatus used 		A.7b <ul style="list-style-type: none"> plots each graph to a high degree of precision and accuracy determines the rate equation or justifies why it cannot be determined provides a detailed explanation in a clear well structured format 	

Level 8

- Rate equation is deduced and justified with regards to **ALL** data collected.

Skill E - Evaluating Evidence and Procedures

Total 7

The candidate:

Mark	Procedural errors	Level	Errors in measurement	Level
0				
1	E1.a <ul style="list-style-type: none"> identifies one procedural error 		E1.b <ul style="list-style-type: none"> identifies one measurement error inherent in the apparatus used 	
2				
3	E3.a <ul style="list-style-type: none"> identifies two procedural errors or one procedural error and a suitable modification 		E3.b <ul style="list-style-type: none"> identifies two measurement errors inherent in the apparatus used or one measurement error and suggests a suitable modification.. 	
4				
5	E5.a <ul style="list-style-type: none"> identifies two procedural errors and a suitable modification for one of them. 		E5.b <ul style="list-style-type: none"> comments on the relative accuracy of the measurements taken and identifies the most significant error. 	
6				
7	E7.a <ul style="list-style-type: none"> identifies two procedural errors and a suitable modification for both of them. 		E7.b <ul style="list-style-type: none"> suggests, with justification, a suitable modification to reduce the most significant measurement error. 	
	Procedural errors <ul style="list-style-type: none"> difficult to mix solutions and simultaneously start the timing relative amounts of each reagent no temperature control 		Errors in measurement <ul style="list-style-type: none"> volumes of reagents time 	

It is recognised that other errors may be relevant to a particular Centre. If this is the case, the Centre should provide details to the moderator.

Appendix 1: Analysis data

The following are some compounds and spectra suitable for use in the exercise to identify an organic unknown.

Each student should be supplied with results of the wet tests and a spectra for:

- **one** compound from **Set 1**
- **one** compound from **Set 2**

Set 1

Compound A :	propanone
Compound B :	ethanal
Compound C :	ethanoic acid
Compound D :	benzaldehyde

Set 2

Compound E :	2-methylpropan-2-ol
Compound F :	methyl propanoate
Compound G :	pentan-3-one
Compound H :	ethyl benzoate

SET 1

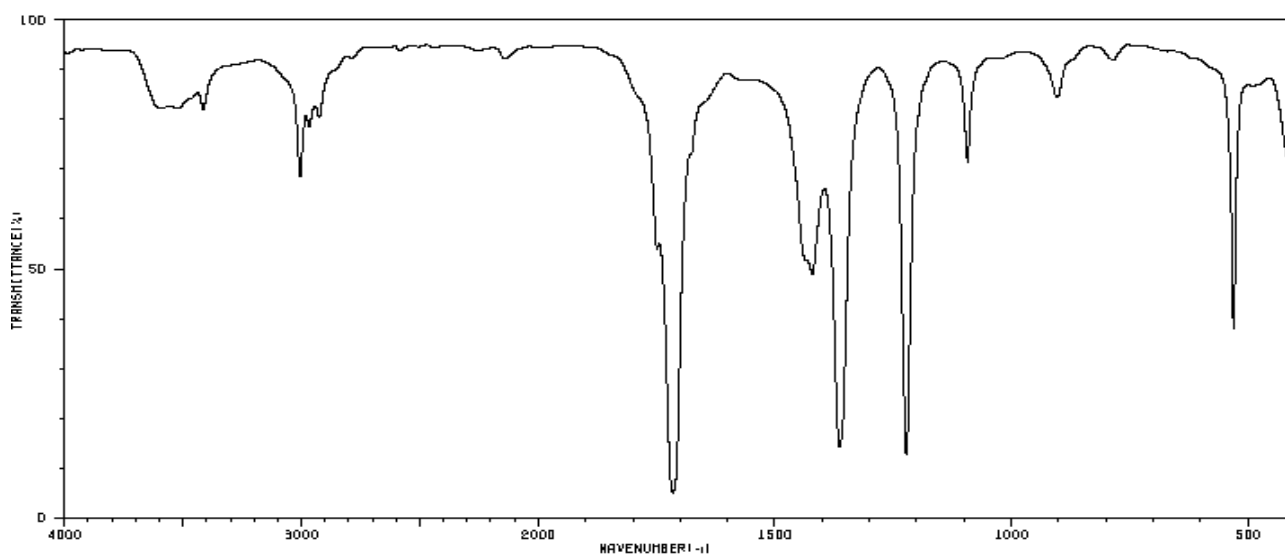
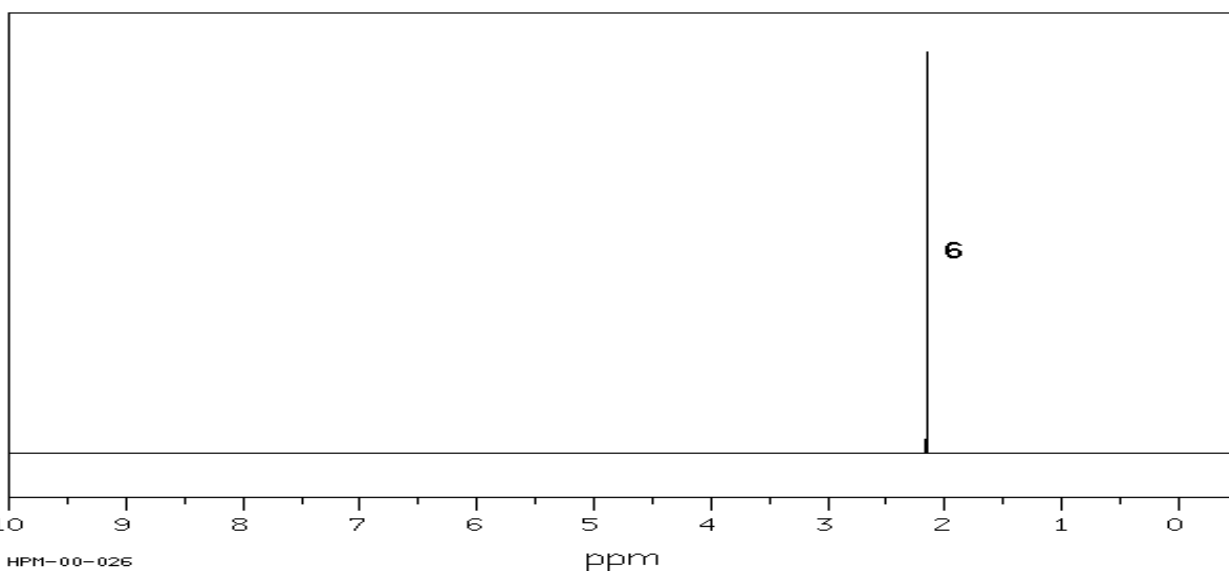
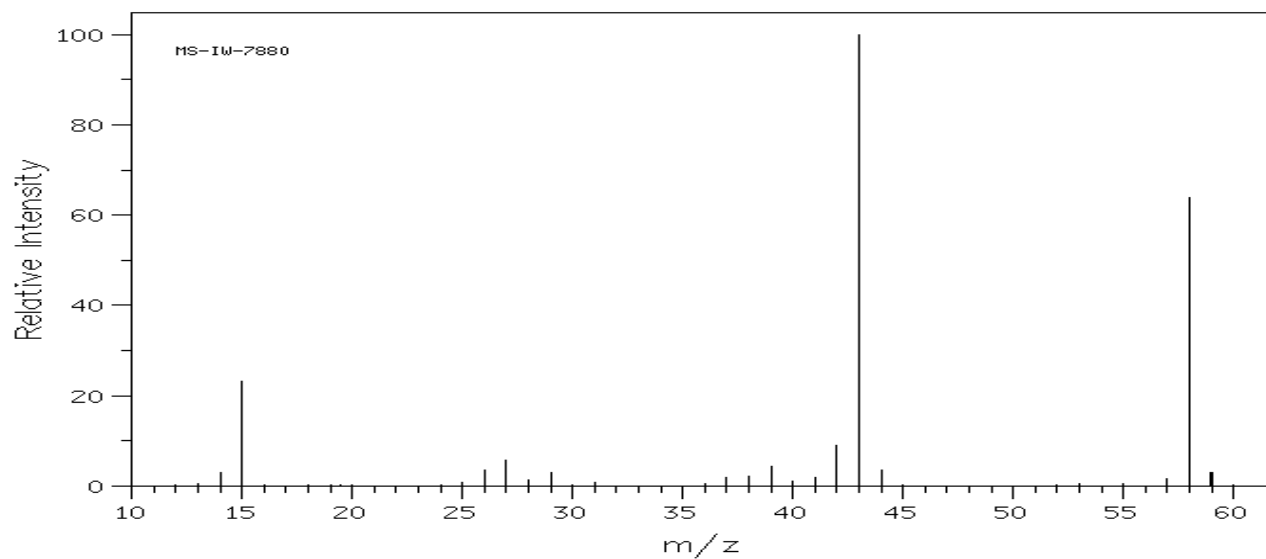
Compound A

Wet tests

Reagent	Observations
Blue litmus	Remains blue
Acidified potassium dichromate	No observable change
Phosphorous pentachloride	No observable change
2,4-dinitrophenylhydrazine	Orange precipitate formed
Sodium carbonate	No observable change
Neutral iron(III) chloride	No observable change
Tollens' Reagent	No observable change
Sodium metal	No observable change
Bromine water	No observable change
Warmed with ethanoic acid and sulphuric acid	No observable change
Fehling's Solution	No observable change

Compound A

Spectra



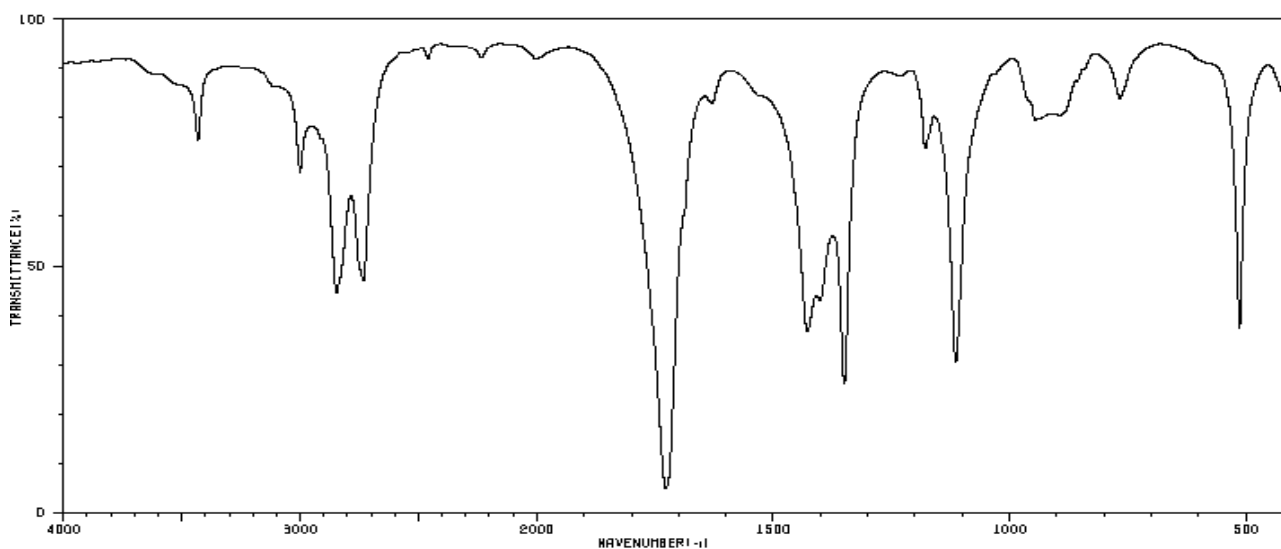
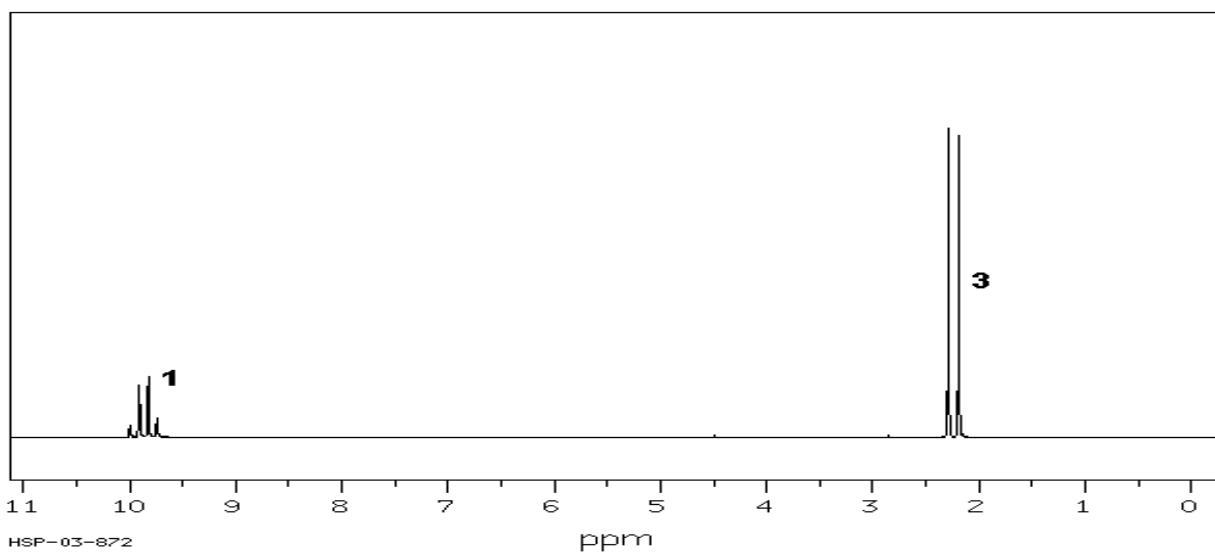
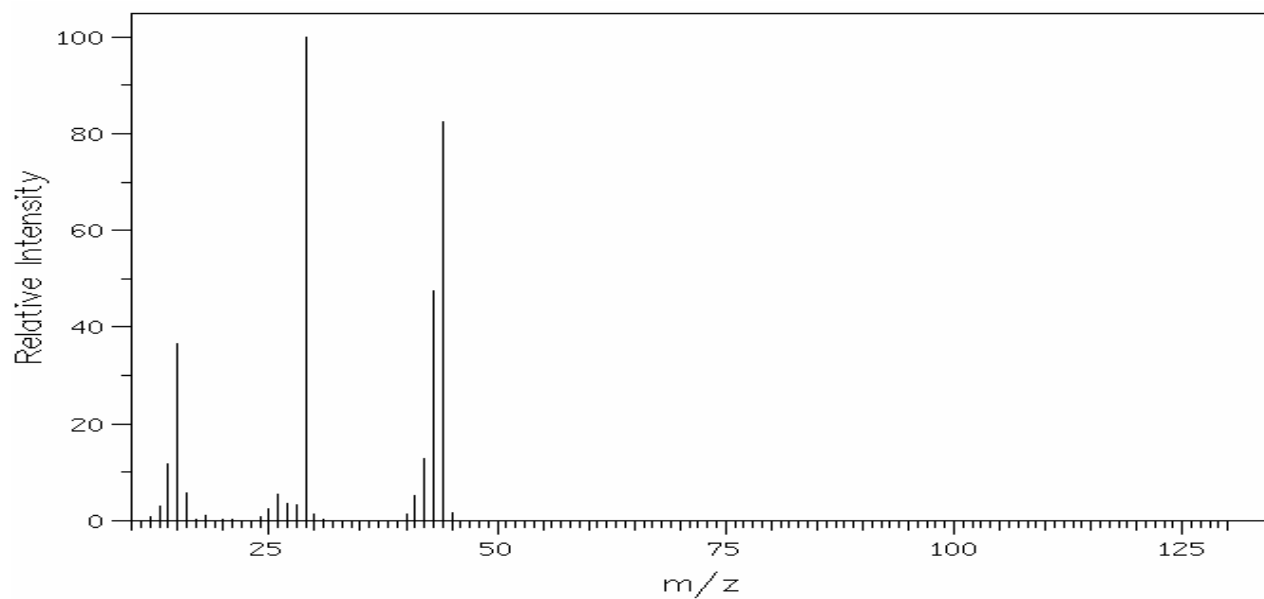
Compound B

Wet tests

Reagent	Observations
Blue litmus	Remains blue
Acidified potassium dichromate	Colour change from orange to green
Phosphorous pentachloride	No observable change
2,4-dinitrophenylhydrazine	Orange precipitate formed
Sodium carbonate	No observable change
Neutral iron(III) chloride	No observable change
Tollens' Reagent	Brown/silver solid deposited
Sodium metal	No observable change
Bromine water	No observable change
Warmed with ethanoic acid and sulphuric acid	No observable change
Fehling's Solution	Brick red precipitate formed

Compound B

Spectra



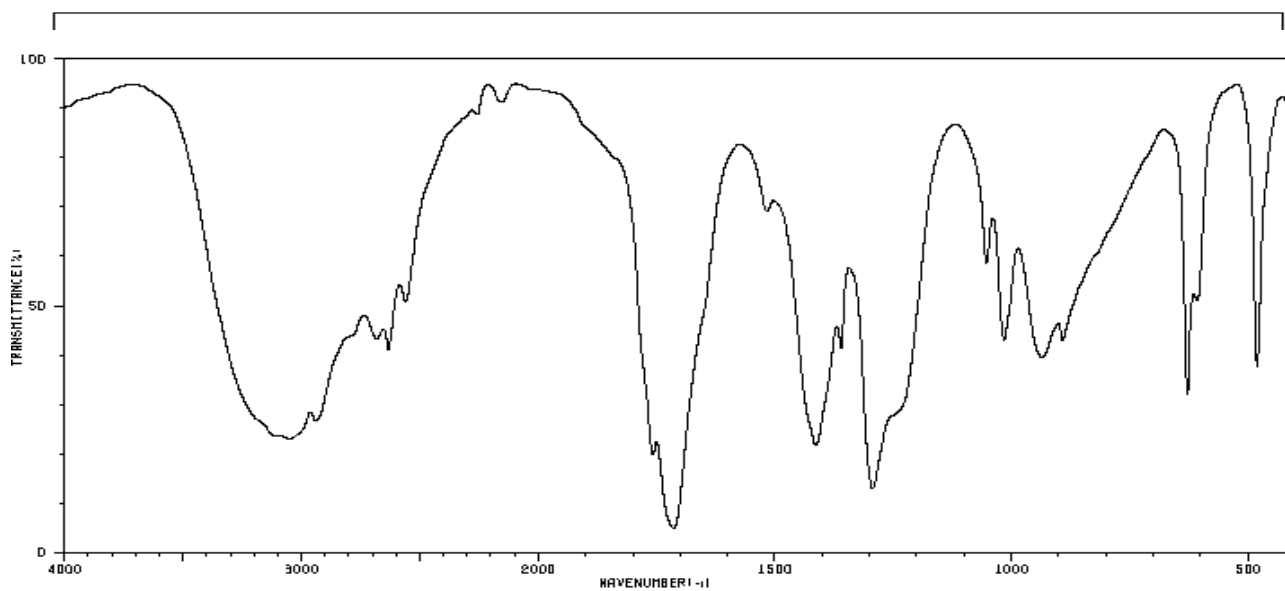
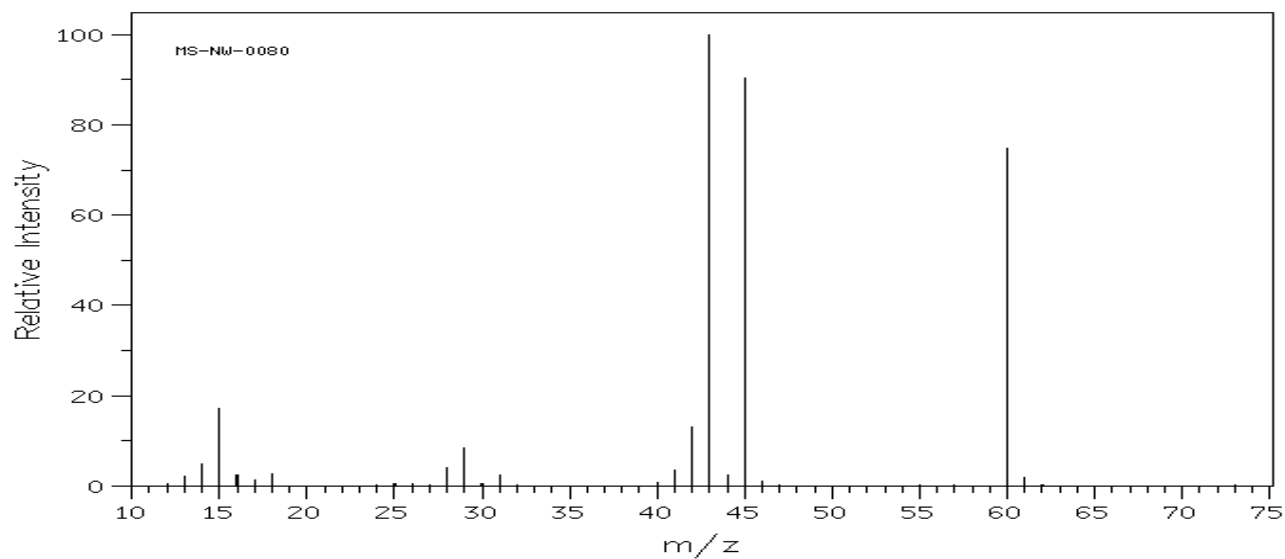
Compound C

Wet tests

Reagent	Observations
Blue litmus	Blue litmus appears red
Acidified potassium dichromate	No observable change
Phosphorous pentachloride	Steamy white fumes evolved which turns moist blue litmus paper red
2,4-dinitrophenylhydrazine	No observable change
Sodium carbonate	Gas evolved which turns lime water milky
Neutral iron(III) chloride	No observable change
Tollens' Reagent	No observable change
Sodium metal	Effervescence and gas evolved which ignites with a squeaky pop
Bromine water	No observable change
Warmed with ethanoic acid and sulphuric acid	No observable change
Fehling's Solution	No observable change

Compound C

Spectra



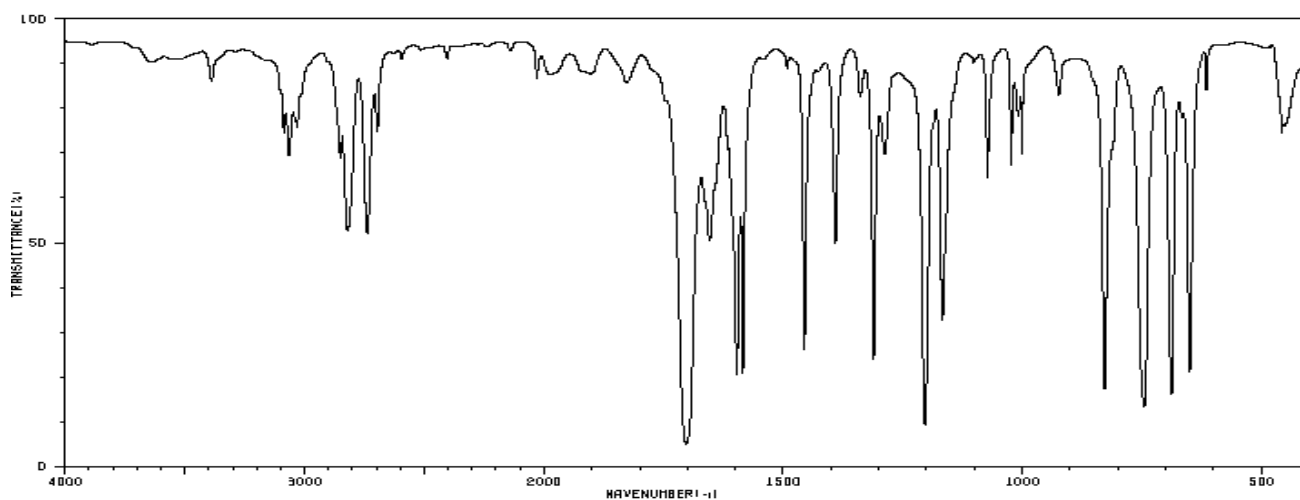
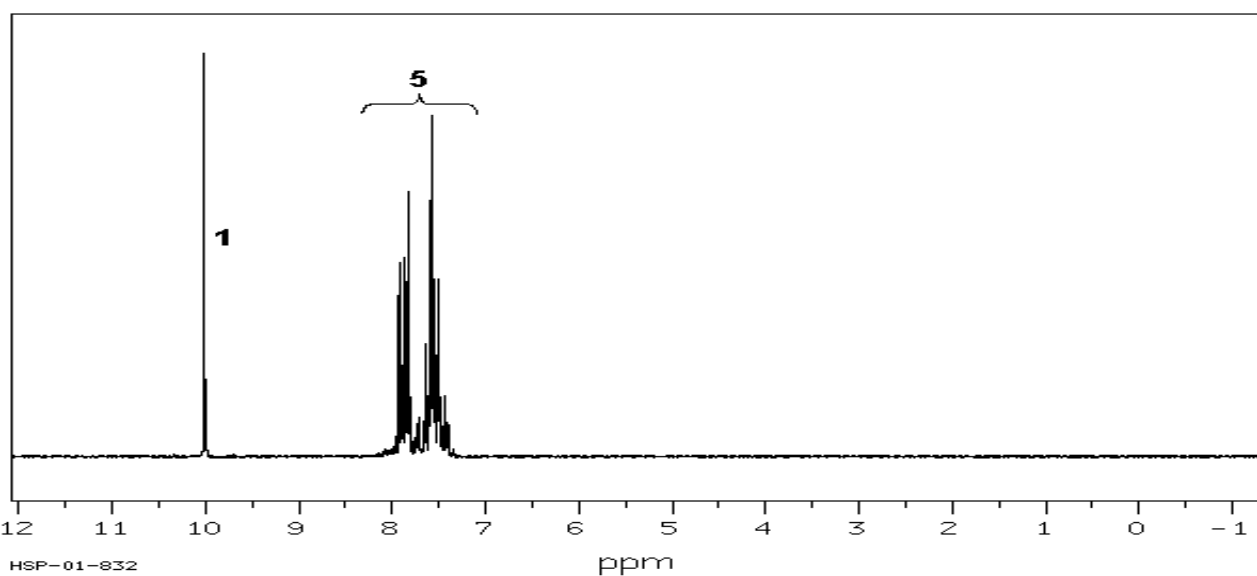
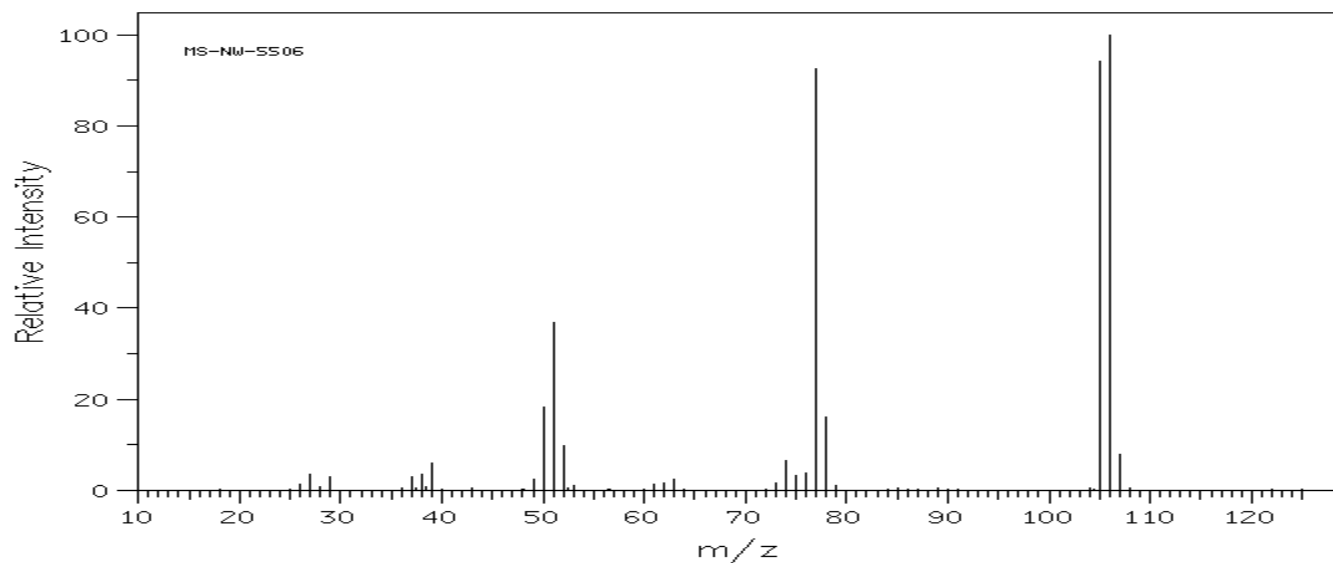
Compound D

Wet tests

Reagent	Observations
Blue litmus	Remains blue
Acidified potassium dichromate	Colour change from orange to green
Phosphorous pentachloride	No observable change
2,4-dinitrophenylhydrazine	Orange precipitate formed
Sodium carbonate	No observable change
Neutral iron(III) chloride	No observable change
Tollens' Reagent	Brown/silver solid deposited
Sodium metal	No observable change
Bromine water	No observable change
Warmed with ethanoic acid and sulphuric acid	No observable change
Fehling's Solution	No observable change

Compound D

Spectra



SET 2

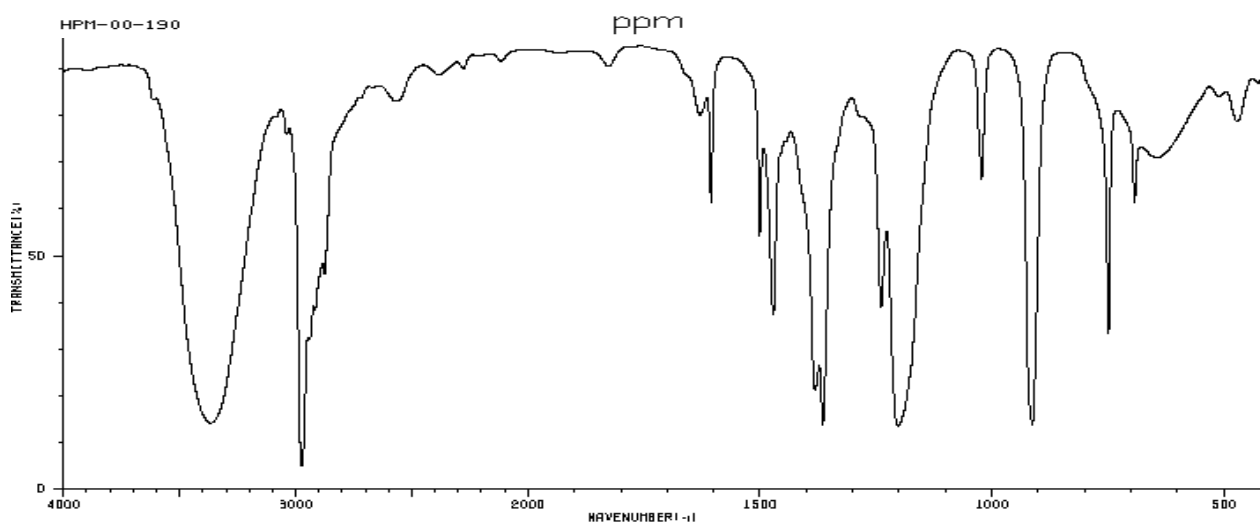
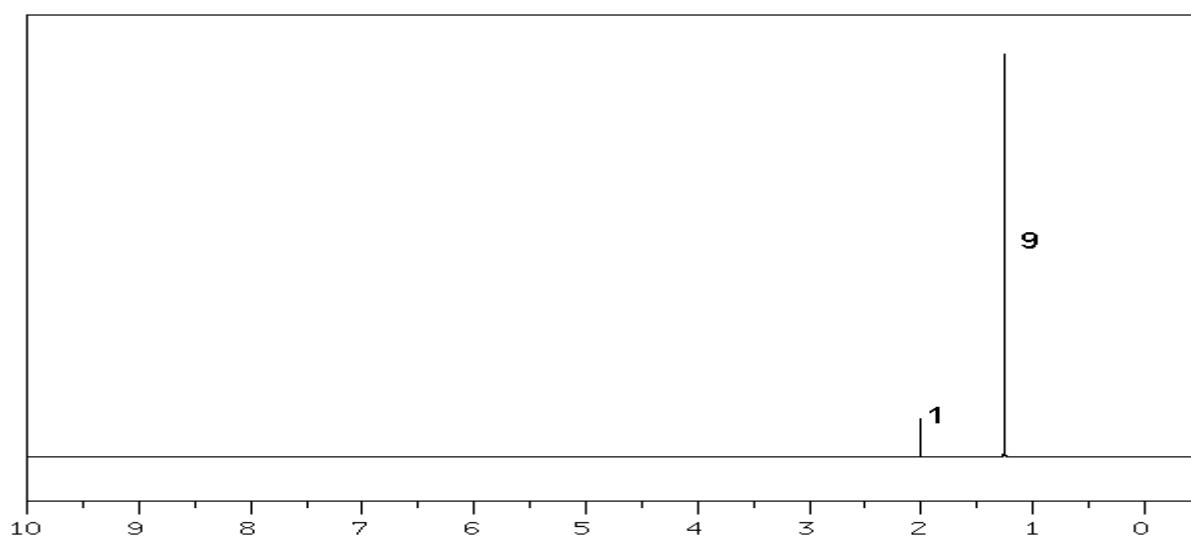
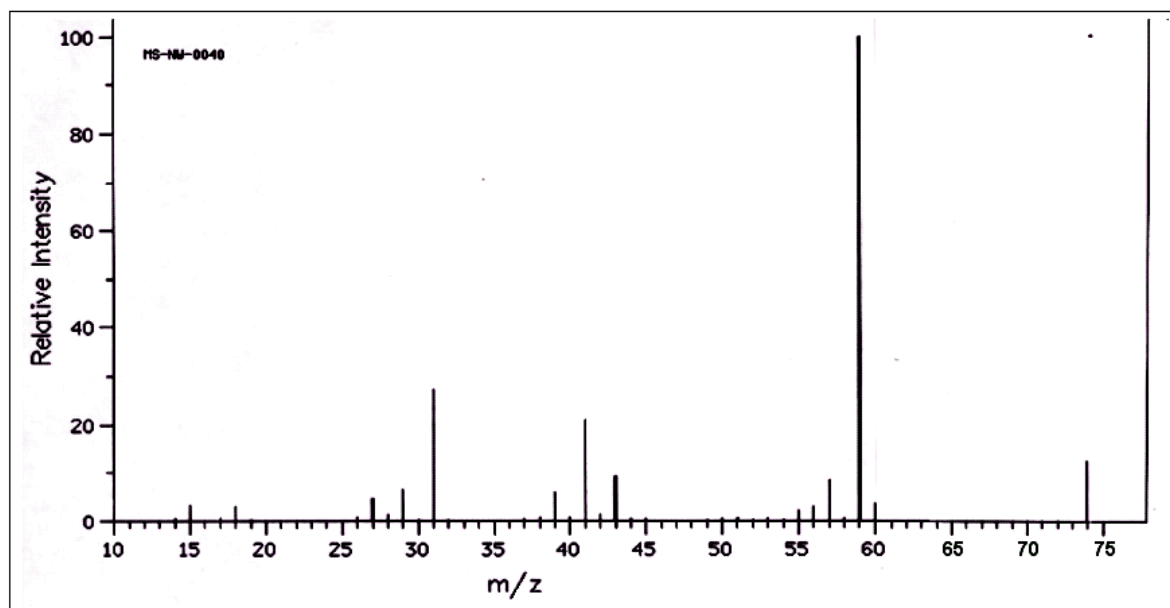
Compound E

Wet tests

Reagent	Observations
Blue litmus	Remains blue
Acidified potassium dichromate	No observable change
Phosphorous pentachloride	Steamy white fumes evolved which turns moist blue litmus paper red
2,4-dinitrophenylhydrazine	No observable change
Sodium carbonate	No observable change
Neutral iron(III) chloride	No observable change
Tollens' Reagent	No observable change
Sodium metal	Effervescence and gas evolved which ignites with a squeaky pop
Bromine water	No observable change
Warmed with ethanoic acid and sulphuric acid	Oily sweet smelling liquid formed when the product is added to water
Fehling's Solution	No observable change

Compound E

Spectra



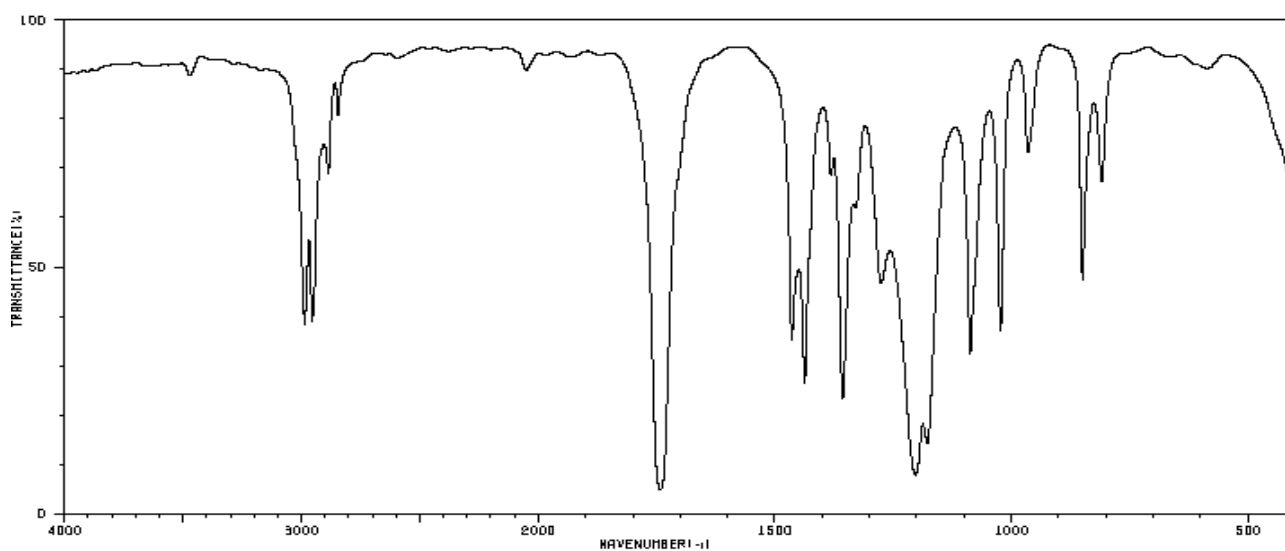
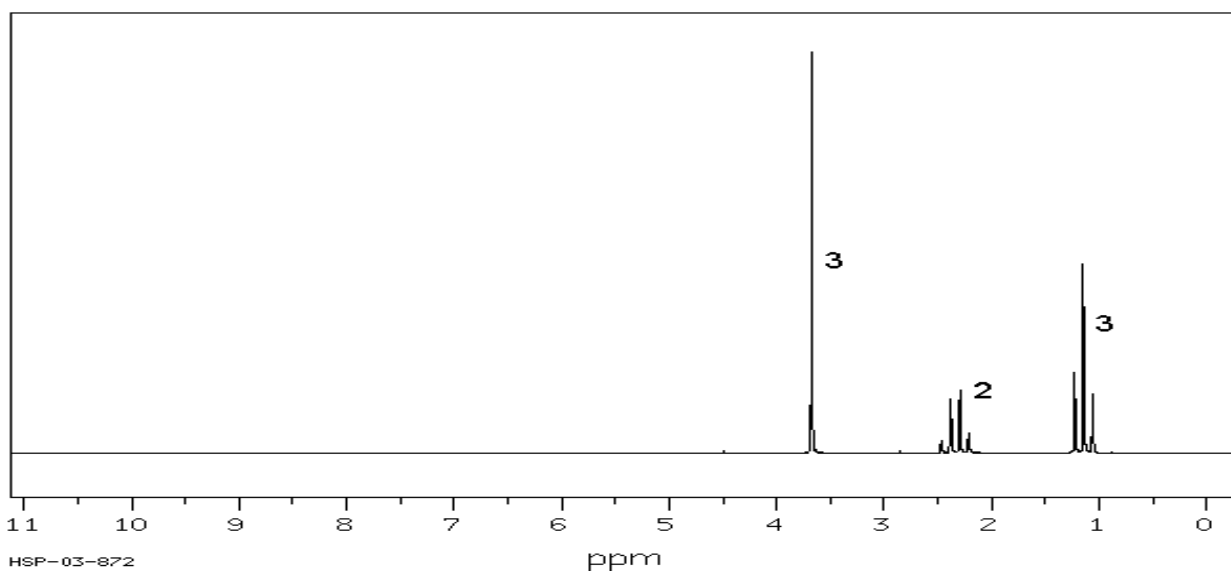
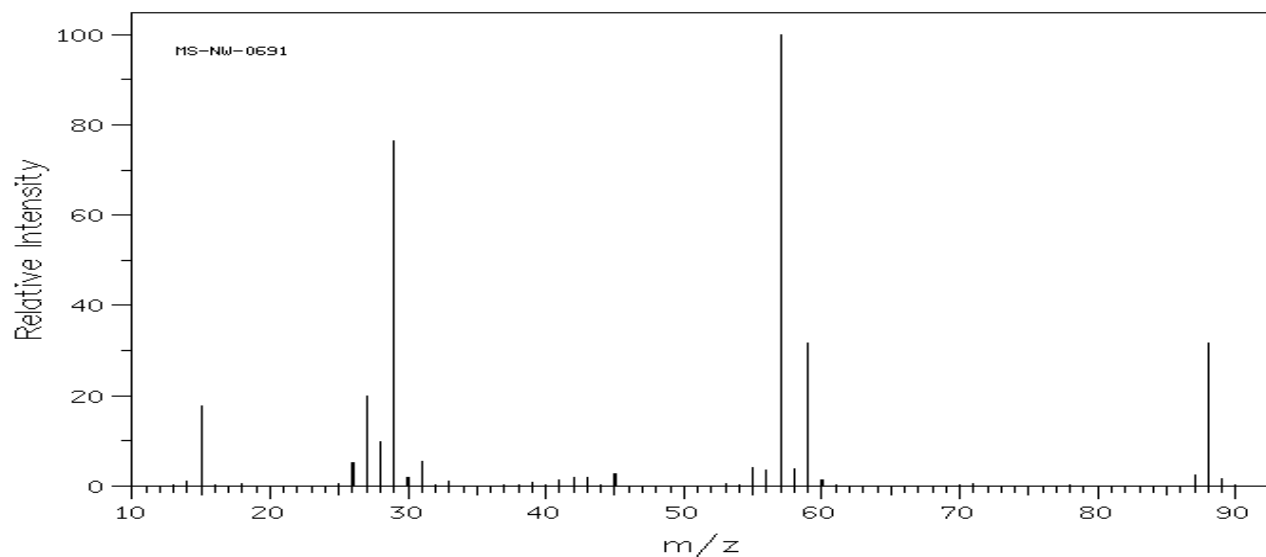
Compound F

Wet tests

Reagent	Observations
Blue litmus	Remains blue
Acidified potassium dichromate	No observable change
Phosphorous pentachloride	No observable change
2,4-dinitrophenylhydrazine	No observable change
Sodium carbonate	No observable change
Neutral iron(III) chloride	No observable change
Tollens' Reagent	No observable change
Sodium metal	No observable change
Bromine water	No observable change
Warmed with ethanoic acid and sulphuric acid	No observable change
Fehling's Solution	No observable change

Compound F

Spectra



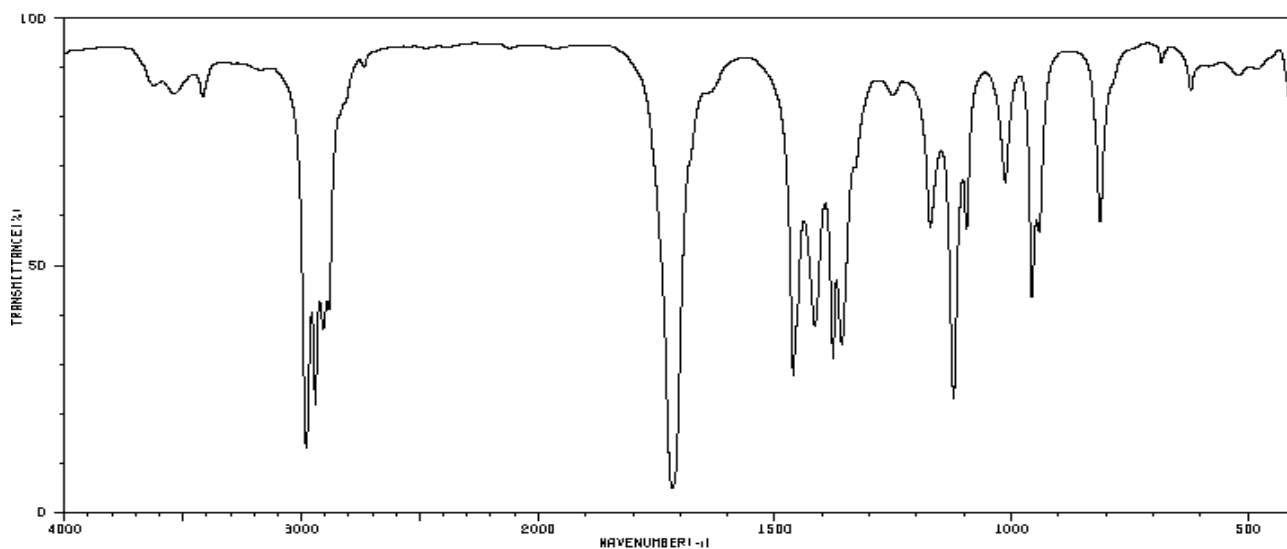
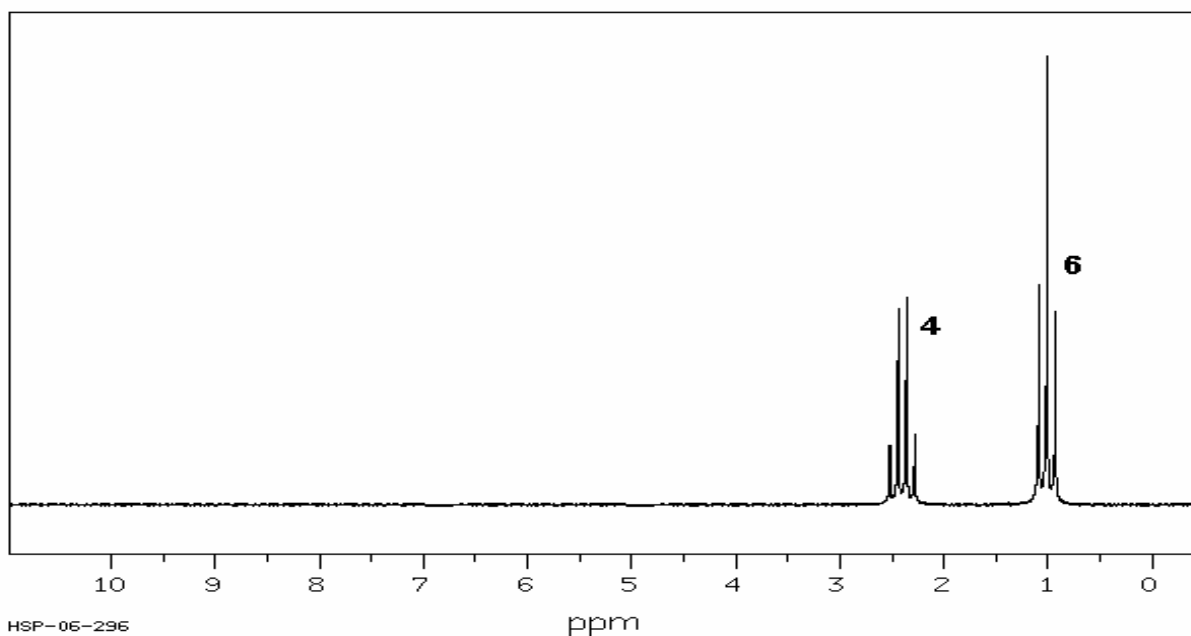
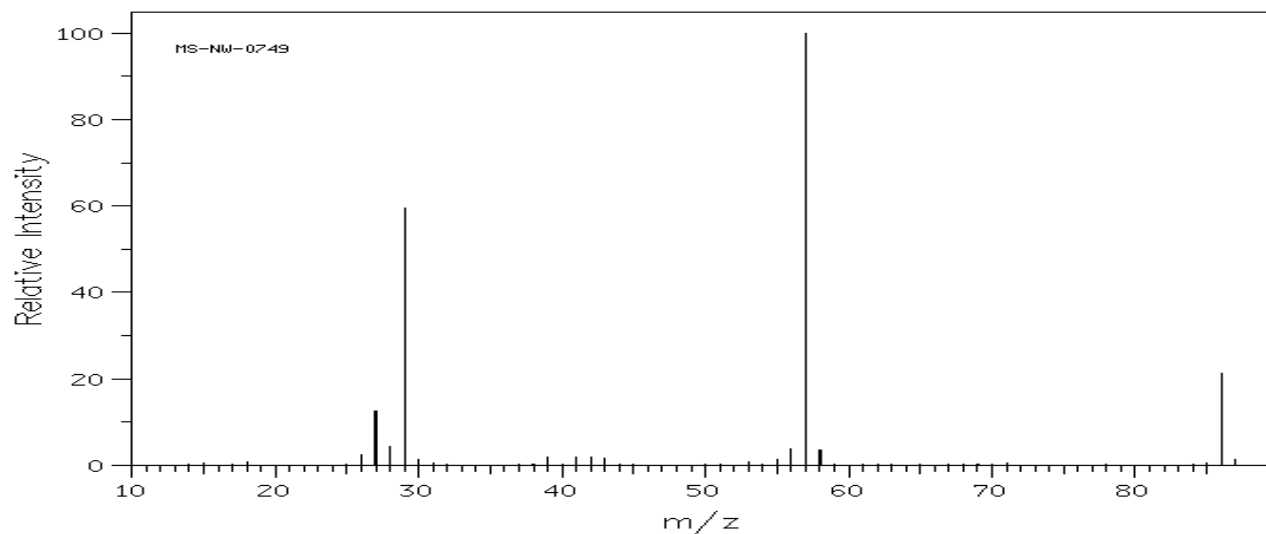
Compound G

Wet tests

Reagent	Observations
Blue litmus	Remains blue
Acidified potassium dichromate	No observable change
Phosphorous pentachloride	No observable change
2,4-dinitrophenylhydrazine	Orange precipitate formed
Sodium carbonate	No observable change
Neutral iron(III) chloride	No observable change
Tollens' Reagent	No observable change
Sodium metal	No observable change
Bromine water	No observable change
Warmed with ethanoic acid and sulphuric acid	No observable change
Fehling's Solution	No observable change

Compound G

Spectra



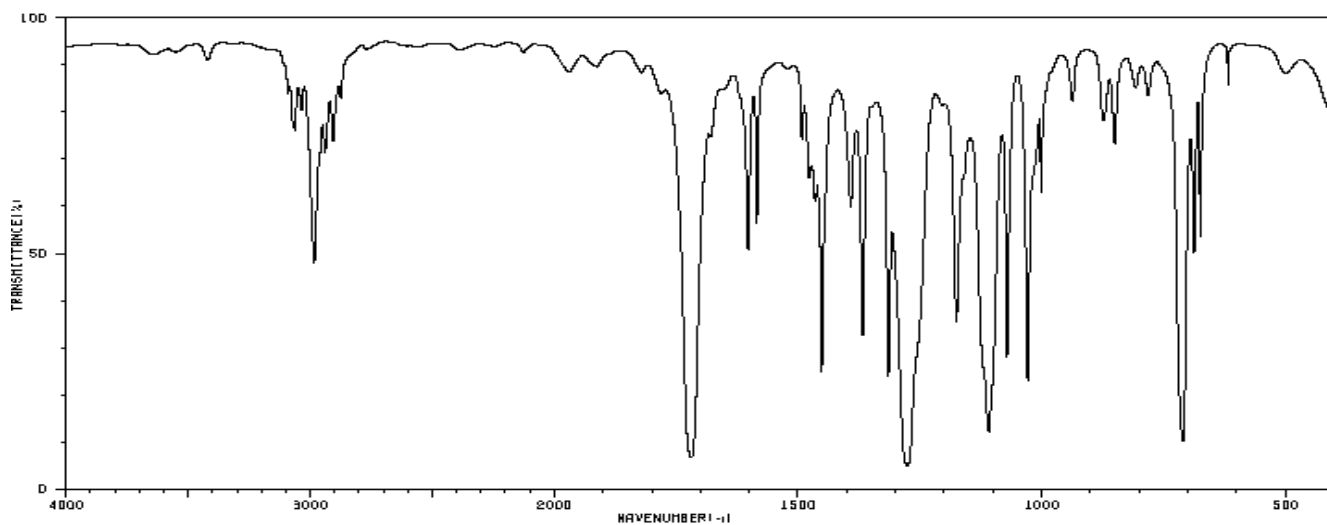
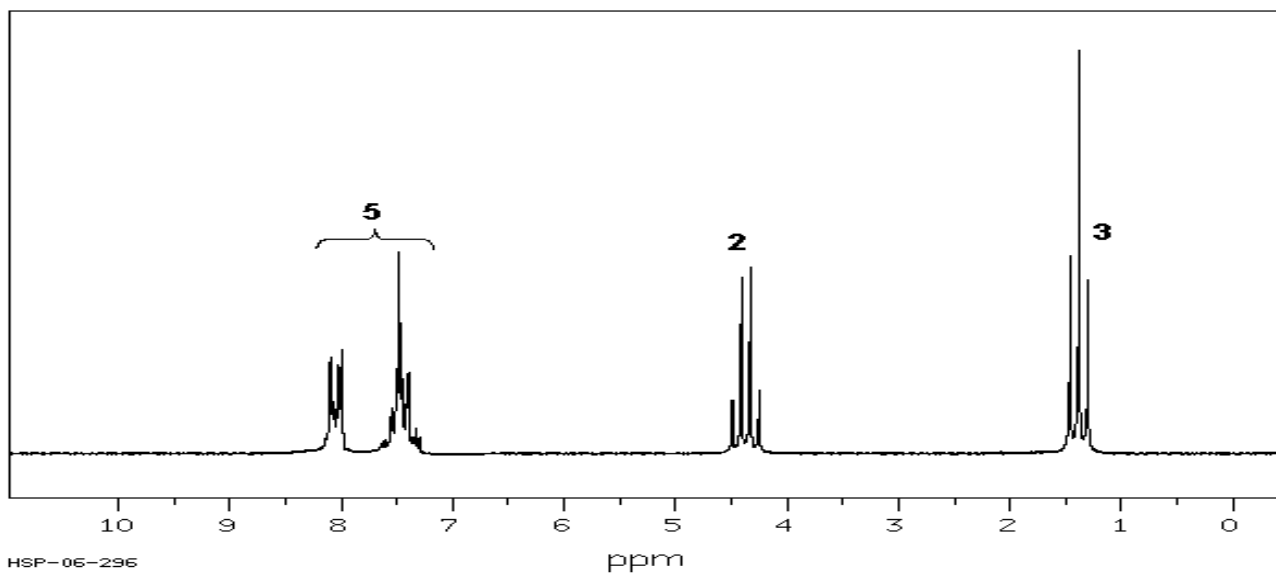
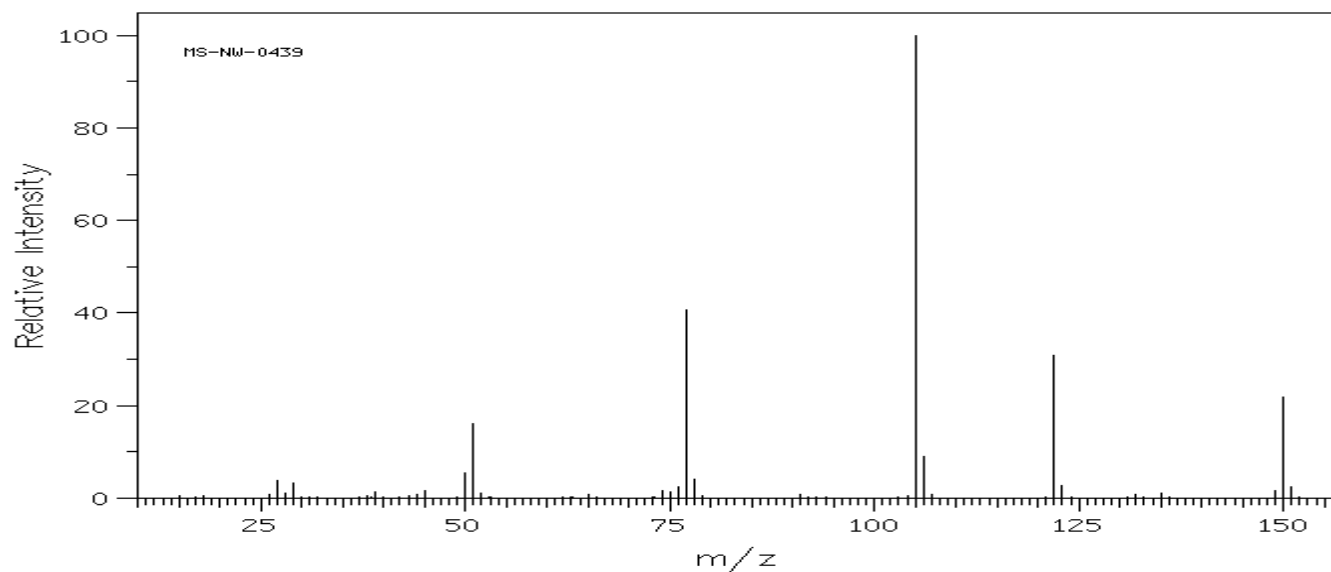
Compound H

Wet tests

Reagent	Observations
Blue litmus	Remains blue
Acidified potassium dichromate	No observable change
Phosphorous pentachloride	No observable change
2,4-dinitrophenylhydrazine	No observable change
Sodium carbonate	No observable change
Neutral iron(III) chloride	No observable change
Tollens' Reagent	No observable change
Sodium metal	No observable change
Bromine water	No observable change
Warmed with ethanoic acid and sulphuric acid	No observable change
Fehling's Solution	No observable change

Compound H

Spectra



Appendix 2: Some definitions

Hypothesis

An hypothesis is a model, based on scientific knowledge and understanding, proposed to explain a particular problem or a set of observations or measurements. Having devised an hypothesis, it is possible to make predictions based on it, and these can be tested by experiment.

The 'scientific method' is based on the idea that an hypothesis can be disproved by experiment (when predictions are found to be untrue) but can never be proved (since an experimenter may, in the future, disprove it). Thus, an hypothesis which is not disproved remains in place and, when it has general acceptance, may come to be called a theory or law.

Accuracy

The accuracy of an observation or measurement is the degree to which it approaches a notional 'true' value or outcome.

The accuracy of an observation or measurement depends on the experimental techniques used, the skill of the experimenter and the equipment (including measuring instruments) used. Removing or minimising sources of error improves accuracy and the degree of accuracy can be estimated by evaluating sources of error (either qualitatively or quantitatively as appropriate).

Precision is here taken as being that part of accuracy which is wholly in the hands of the experimenter. So, having devised an experimental technique and selected the apparatus, the experimenter may choose to take observations or measurements to different degrees of precision (or may do so through lack of skill or carelessness). Decisions about the precision with which observations or measurements are made may take into account the nature of the investigation and an assessment of the sources of error.

Reliability

Reliability is a measure of the confidence that can be placed in a set of observations or measurements. The closer a set of observations or measurements approaches to conformity with an underlying model, process, structure etc. (which may be known or unknown), the more reproducible it is likely to be.

If the underlying model, process or structure is known, or a suitable hypothesis can be drawn up, reliability can be judged by reference to this. So, for example, the distance between data points and the line of a graph may provide evidence of reliability and statistical techniques may be used to provide a quantitative assessment of reliability in such cases. If observations or measurements are replicated, then the closeness of the replicates provides another way of judging reliability.

The reliability of a set of observations or measurements depends on the number and accuracy of the individual observations or measurements. Replicating observations or measurements increases the reliability of the set.

Validity

The validity of a conclusion is a measure of the confidence that can be placed in it. The validity of an experiment or investigation depends upon factors such as the range and reliability of the observations or measurements that underpin it, any assumptions made in developing hypotheses or planning the investigation, and the nature of the investigation itself.

A conclusion may relate to whether or not a proposed hypothesis can be rejected or accepted. In such cases statistical techniques may be used to place a value on the reliability of data by generating a probability that the data do conform with the hypothesis. Such techniques should be used where appropriate.

Appendix 3: Frequently asked questions (FAQs)

1. Can a single coursework exercise be used to assess more than one skill?

Yes, skills may be assessed separately or in combination. All four skills can be tested at any one time, in a 'whole investigation'. However, it is the responsibility of candidates and their centres to ensure that it is clear where each skill is being covered. This should be achieved by the use of titles and sub-titles.

2. Is it advisable to test more than one skill in any one exercise?

This depends very much on the nature of the task and how it is set up. Generally, candidates achieve higher marks for planning if they are able to perform their investigation since this gives them opportunities to revise the plan in the light of experience. Thus, Skills P and I are often assessed together. Similarly, candidates who have not planned and carried out an investigation (or at least seen it demonstrated) will find it difficult to evaluate the investigation. Skill E may therefore be better assessed in a whole investigation. If all four skills are to be tested in one 'whole investigation', it is essential that it is clear to moderators, by means of titles, subtitles, teachers' comments, etc., which are being tested where.

3. Is there any size or word limit on coursework submissions?

*No, **but** there is absolutely nothing to be gained by submitting particularly large volumes of work for each assessment, especially where the same technique is repeated several times. Moderators will be looking at the quality of the work rather than the quantity and clear evidence that candidates have achieved the criteria listed under each skill.*

4. Do centres need to show evidence of marking **on** candidate's work?

Yes; the minimum requirement is that the 'shorthand' mark descriptors (e.g. P.3b or A.5a) are written in the margin of the script at the point where the work has met the descriptors concerned. However, the more comments clearly written on submitted work, the easier it is for moderators to judge whether candidates have been fairly assessed.

5. Do centres need to submit copies of the worksheets, exercises and resources given to students?

Yes; moderators need to know exactly what candidates were asked to do, and what help they received.

6. Do centres need to submit mark schemes?

*The general descriptors given in the specification (and in Section 5) may be used directly by centres to mark candidates' work. However, centres may choose to develop specific sets of descriptors for particular tasks, to allow consistency of marking from year to year, and from teacher to teacher. If such 'contextualised' descriptors are used, they must be very closely based on the standard descriptors and they **must** be sent to the moderator with the sample of work. It should be noted that the moderator will mark using the general set of descriptors (given in the specification), to ensure that the standard of work is the same from centre to centre. For Skill I, teachers should provide details of the aspects of the work that were scrutinised, in the form of check lists or written notes.*

7. Some candidates find coursework very difficult. What advice can you offer which will increase candidates' prospects of achieving good marks?

It is clearly important that candidates are taught the skills and given opportunities to practice, before being assessed. Candidates may find it helpful if staff go through a worked exemplar

showing how they themselves would tackle a particular topic, provided that candidates are not allowed to produce work on the same topic for submission. Candidates should be made aware of the descriptors used to assess their work, so that they can ensure that all aspects of the descriptors are addressed. Worksheets clearly give considerable assistance to candidates, but if they are too specific, the help which they give may prevent candidates making choices and so limit access to the highest marks, so they should be used carefully.

8. Do all candidates have to do completely different topics for Skill P assessments?

No; a single task may be set by the teacher for all candidates, but they must work individually.

9. In Skill P work, do candidates have to put their plans into action and examine the results in order to evaluate and modify their plans?

No, but candidates who do not have the opportunity to carry out their plans and modify them in the light of experience will be at a considerable disadvantage.

10. I am having trouble deciding whether my exercises properly address the demands of the skills listed in the specification. What advice is available?

A proposed task may be submitted to OCR on form OPF and a response on its suitability will be provided. Copies of form OPF may be obtained from OCR in Cambridge and should be sent to the subject officer (a contact address is given in Section 10). INSET courses are provided each year; details are sent to centres, and a contact address for the Training and Customer Support section is also given in Section 10.

11. None of my candidates has produced work that is as good as the best exemplars in this guide. Does this mean they cannot achieve full marks for their assessments?

*No. As long as candidates' work meets all the mark descriptors, including the top band, there is no reason why full marks should not be awarded. There can be a big range of performances **within** the top band. If you have one or two brilliant students, do not let this persuade you that those who are only 'very good' must be worth less than full marks. Conversely, if all your candidates are of more limited ability, do not be misled into giving the best of them full marks.*

12. Can candidates use the Internet during their investigations?

*Yes; there is some excellent material available and the highest mark descriptors for Skill P require candidates to draw together material from several sources. All URLs should be listed (with any other sources) in a bibliography. It should be noted that unless this information is processed or modified in some way and **used** in the development of the strategy, it is unlikely to be worthy of credit.*

13. Will candidates improve their chances of achieving high marks by making extensive use of Information and Communication Technology in their reports?

Computer generated material is not in itself worth any more marks than hand-written work. However, if the use of I.C.T. enables the mark descriptors for any of the skills to be more effectively addressed, then candidates could gain extra credit. It should be noted that many graph-plotting packages, if not used expertly, may not produce the most appropriate graphs and therefore that the use of such software may actually penalise candidates.

14. My candidates have completed several assessments in a notebook that includes some unassessed work. Can I submit the book to the moderator?

No; only assessed work should be sent. Centres should avoid this practice because it adds to the cost of postage and makes unnecessary extra demands on moderators.

15. Does all coursework have to be carried out under the direct supervision of the teacher?

No; in order to meet the requirements of the descriptors, particularly for Skills P and A, candidates will need to carry out research which may require the use of library facilities, the Internet etc.. Also, it may not be possible to devote sufficient time in the laboratory/classroom to allow candidates to write up their work. However, sufficient work must be completed under direct supervision to allow the teacher to authenticate the marks awarded, and this is left to the discretion of the Centre.

16. How much help can I give students with their coursework?

This is a difficult question to answer. In general terms, direct help in the form of suggesting to a student how to carry out an investigation, or how to interpret the results, is unacceptable, while it is acceptable to draw the attention of the student to aspects of the assessment descriptors that he or she has not addressed.

In some circumstances it may be necessary to give direct help to students, for example to ensure that they are working safely or to get them through a difficulty. Such help should be taken into account in the award of marks and details must be provided to the moderator.

If students are to be given the opportunity to choose their own coursework tasks, guidance should be given by the teacher to ensure that the tasks are of appropriate demand and likely to generate results capable of analysis. In a whole investigation, or if students are to be asked to carry out an investigation that they have planned, it is suggested that the draft plans are submitted to the teacher for an initial assessment to be made of the suitability of the strategy. Such assistance is acceptable without penalty provided that candidates are not given direct guidance about what to do.

17. Can I take in the work of my students, mark it, and then give it back to them for any errors to be corrected before taking it in again for a final mark to be awarded?

No; once the work has been handed in for marking, the marks awarded should stand. Assistance can be given to students while they are carrying out their work provided that it is limited to the identification of aspects of the assessment descriptors that have not been addressed. However, it is suggested that work for Skill P should be collected in for an assessment of its suitability to be made before any practical work has been carried out, though Skill P should not be marked until the whole assessment has been completed.

18. Can I use worksheets to set the tasks that my students are to carry out?

Yes; worksheets are very helpful, particularly if students are not being asked to plan the investigation themselves. However, a worksheet used to set a planning task which gives too much guidance as to the method to be used or the number of readings to be taken etc. may reduce the level of demand of the task and so limit the marks which can be awarded to candidates.

19. Where more than one skill is being assessed on a single piece of work, for example in a whole investigation, is it acceptable for the skills to be given widely differing marks?

It is unlikely that skills will be awarded marks that differ by more than two. If the level of demand of the task is limited, this will have an effect on all four skill areas. The marks awarded for Skill P will relate closely to the other skill areas since it is unlikely that a poor plan will generate a good set of data and that such data can be analysed or evaluated to generate high marks. However, a good plan may produce good results but the analysis and/or evaluation may be poor. Where marks do differ widely, they should be scrutinised carefully and if a teacher feels that widely differing marks can be justified, information must be provided to the moderator to support the marks awarded.

20. Can work completed in the AS year be submitted for assessment for A2?

Yes; though the work submitted for AS must be set in the context of AS units and work for A2 must be in the context of A2 units. This means that candidates will need to draw on the knowledge and understanding of the appropriate units in order to plan and/or analyse the experiment/investigation.

However, there are some topics that relate to work in both AS and A2 but teachers should be aware of the need to provide tasks of appropriate demand for A2.

21. If units 2813 or 2816 are re-taken, can the coursework marks be carried forward?

Yes; an entry for one of these units is for the written paper and either the coursework component or the practical examination. Entry options for these units are provided for coursework marks to be carried forward, but it should be noted that marks for the written paper and the practical examination components may not be carried forward.

Appendix 4: Coursework forms

The appropriate Coursework Summary Form (CSF) should be used to record candidates' marks to be submitted to OCR. The marks for each skill should be recorded and the total mark should be transferred to the computer printed mark sheet (MS1) supplied by OCR, or transferred to OCR directly (by EDI). A copy of the relevant Coursework Summary Form should be submitted to the moderator, together with the moderator copy of the MS1 form (or a printout of the EDI submission). A Centre wishing to use a computer to keep a record of marks (for example on a spreadsheet) may submit a printout to the moderator as an alternative to the Coursework Summary Forms, provided that it includes all the necessary information.

The appropriate Coursework Cover Sheet (CCS) should be attached to the front of each candidate's portfolio of work submitted to the moderator. Cover sheets do not need to be completed for candidates whose work does not form part of the sample of work sent for moderation.

Copies of these forms will be provided to each Centre by OCR according to the number of entries made, but teachers are free to photocopy the forms which follow if they wish.

CHEMISTRY: UNIT 2813, COMPONENT 02

Marking and Internal Moderation

- 1 Teachers must be thoroughly familiar with the appropriate sections of the specification and with the general coursework regulations.
- 2 This form should only be used for recording coursework marks for Unit 2813, Component 02. A print out from a suitable software package is an acceptable alternative to this form if the same information is given.
- 3 Complete the information at the head of the form.
- 4 List the candidates in an order which will allow ease of transfer of information to a computer-printed internal assessment mark sheet (Form MS1) or to EDI at a later stage. The candidate number and the teaching group/set should also be shown.
- 5 Carry out internal standardisation to ensure that the total marks awarded to the candidates reflect a single valid and reliable order of merit for the unit/component.
- 6 Enter the Skill Area marks selected for aggregation in the appropriate spaces, together with the total mark out of 30.
- 7 Multiply this total mark by 2 to produce a new total mark out of 60.
- 8 Ensure that all mark transcriptions and additions are independently checked.
- 9 You are advised to keep a copy of this form for reference.

CHEMISTRY
Advanced GCE



UNIT 2816, COMPONENT 02
Coursework Summary Form

Please read the instructions printed overleaf before completing this form.

Examination Session	January/June*	*please delete as appropriate	Year	2	0	0	
---------------------	---------------	-------------------------------	------	---	---	---	--

Centre Number					
---------------	--	--	--	--	--

Centre Name	
-------------	--

Candidate Number	Candidate Name	Teaching Group/Set	Skill Area P Planning (max 8)	Skill Area I Implementing (max 7)	Skill Area A Analysing evidence and drawing conclusions (max 8)	Skill Area E Evaluating evidence and procedures (max 7)	TOTAL (max 30)	FINAL TOTAL (x2) (max 60)

PAGE ____ OF ____

Authentication by the teacher

I declare that, to the best of my knowledge, the marks submitted represent the unaided work of the candidates concerned. I have attached details of any assistance given beyond that which is acceptable under the scheme of assessment.

Signature _____

Date _____

CHEMISTRY: UNIT 2816, COMPONENT 02

Marking and Internal Moderation

- 1 Teachers must be thoroughly familiar with the appropriate sections of the specification and with the general coursework regulations.
- 2 This form should only be used for recording coursework marks for Unit 2816, Component 02. A print out from a suitable software package is an acceptable alternative to this form if the same information is given.
- 3 Complete the information at the head of the form.
- 4 List the candidates in an order which will allow ease of transfer of information to a computer-printed internal assessment mark sheet (Form MS1) or to EDI at a later stage. The candidate number and the teaching group/set should also be shown.
- 5 Carry out internal standardisation to ensure that the total marks awarded to the candidates reflect a single valid and reliable order of merit for the unit/component.
- 6 Enter the Skill Area marks selected for aggregation in the appropriate spaces, together with the total mark out of 30.
- 7 Multiply this total mark by 2 to produce a new total mark out of 60.
- 8 Ensure that all mark transcriptions and additions are independently checked.
- 9 You are advised to keep a copy of this form for reference.

CHEMISTRY
Advanced Subsidiary GCE



UNIT 2813, COMPONENT 02
Coursework Cover Sheet

Please read the instructions printed overleaf before completing this form. One of these cover sheets, suitably completed, should be attached to the assessed work of **each** candidate in the moderation sample.

Examination session	January/June*	*please delete as necessary	Year	2	0	0	
----------------------------	---------------	-----------------------------	-------------	---	---	---	--

Centre name	
--------------------	--

Centre number					
----------------------	--	--	--	--	--

Candidate name		Candidate number				
-----------------------	--	-------------------------	--	--	--	--

Skill Area	Mark	Title of assessed work
P (max 8)		
I (max 7)		
A (max 8)		
E (max 7)		
Total (max 30)		
Final Total (max 60)		

Authentication by the teacher

I declare that, to the best of my knowledge, the work submitted is that of the candidate concerned. I have attached details of any assistance given beyond that which is acceptable under the scheme of assessment.

Signature _____ Date _____

INSTRUCTIONS FOR COMPLETION OF THIS FORM

- 1 One form should be used for each candidate.
- 2 Please ensure that the appropriate boxes at the top of the form are completed.
- 3 Enter the highest mark awarded for each Skill Area in the appropriate boxes together with the titles of the assessed work where these marks were awarded.
- 4 Add the marks for Skill Areas P, I, A and E together to give a total out of 30. Enter this total in the relevant box.
- 5 Multiply the mark out of 30 by 2 to give a final total out of 60. Enter this mark in the *Final Total* box.

CHEMISTRY
Advanced GCE



UNIT 2816, COMPONENT 02
Coursework Cover Sheet

Please read the instructions printed overleaf before completing this form. One of these cover sheets, suitably completed, should be attached to the assessed work of **each** candidate in the moderation sample.

Examination session	January/June*	*please delete as necessary	Year	2	0	0	
----------------------------	---------------	-----------------------------	-------------	----------	----------	----------	--

Centre name	
--------------------	--

Centre number					
----------------------	--	--	--	--	--

Candidate name		Candidate number				
-----------------------	--	-------------------------	--	--	--	--

Skill Area	Mark	Title of assessed work
P (max 8)		
I (max 7)		
A (max 8)		
E (max 7)		
Total (max 30)		
Final Total (max 60)		

Authentication by the teacher

I declare that, to the best of my knowledge, the work submitted is that of the candidate concerned. I have attached details of any assistance given beyond that which is acceptable under the scheme of assessment.

Signature _____

Date _____

INSTRUCTIONS FOR COMPLETION OF THIS FORM

- 1 One form should be used for each candidate.
- 2 Please ensure that the appropriate boxes at the top of the form are completed.
- 3 Enter the highest mark awarded for each Skill Area in the appropriate boxes together with the titles of the assessed work where these marks were awarded.
- 4 Add the marks for Skill Areas P, I, A and E together to give a total out of 30. Enter this total in the relevant box.
- 5 Multiply the mark out of 30 by 2 to give a final total out of 60. Enter this mark in the *Final Total* box.

Appendix 5: Contacts

Subject Officer for AS/A Level Chemistry (syllabus-specific queries only)

OCR
1 Hills Road
Cambridge
CB1 2EU

Customer Support Division (INSET enquiries)

OCR
Mill Wharf
Mill Street
Birmingham
B6 4BU

Tel: 0121 628 2950
Fax: 0121 628 2940
email: training@ocr.org.uk

OCR Information Bureau (other queries)

Tel: 01223 553998
email: helpdesk@ocr.org.uk