GCE

A2 CHEMISTRY

2001–2002

COURSEWORK SUPPORT MATERIAL

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1 ASSESSMENT OF PRACTICAL WORK

1.1 INTRODUCTION

Practical work for the A2 part of the A Level programme will be assessed as follows:

Assessment Unit A2 3B

Assessing Module 6B Teacher – assessed coursework (40 marks) covering the skill areas of:

1 Manipulation, measuring and recording;

2 Observing and recording;

3 Concluding and communication (quantitative);

4 Concluding and communication (qualitative).

Credit gained by candidates in Module 6B will be added to that in Module 6A and an overall outcome reported as a single uniform mark.

The assessment of practical skills through internal assessment contributes 6.7% of the total assessment.

1.2 ASSESSMENT CRITERIA

The criteria described below should be used for the award of marks in each of the skill areas.

Each assessment criterion is marked on a scale of 0–2 where:

2 marks; criterion is fully met without teacher assistance;

1 mark; criterion is only partly met, or fully met after a little teacher assistance*;

0 marks; criterion is not met or met only after further teacher assistance.

Half marks **cannot** be used.

* See Making Assessment point 4.

1.3 SKILL AREAS

Skill 1: Manipulation, Measuring and Recording

This skill area should be assessed in a context in which a titration* is used as one stage in a more detailed experiment, eg kinetics, equilibrium or solubility.

Marks should be awarded where the candidate:

	Assessment Criteria	Max. Marks Available
(i)	chooses appropriate apparatus and demonstrates full competence in setting up, and dexterity in operating, all the apparatus used in an experiment;	2
(ii)	takes all sensible precautions to ensure the safety of personnel and the maintenance and conservation of equipment;	2
(iii)	during the titration step, makes measurements to a high degree of precision, ie two or more titres agree within 0.1 cm^3;	2
(iv)	during the titration step, repeats sufficient readings to ensure a suitable level of accuracy, ie average titre within 0.1 cm^3 of the teacher identified value;	2
(v)	clearly displays and neatly presents results to an appropriate and consistent number of significant figures with units indicated and using a table where necessary. (The table should not be provided by the teacher.) Where appropriate, uses IT for the logging and processing of data.	2
		10

Skill 2: Manipulation, Observing and Recording

A minimum of ten observations will be required to meet this criterion. This skill may be carried out using more than one substance and should incorporate both organic and inorganic aspects.

Marks should be awarded where the candidate:

	Assessment Criteria	Max. Marks Available
(i)	demonstrates full competence and dexterity in operating all the apparatus used in an experiment;	2
(ii)	makes all relevant observations of colour changes and the formation and colour of precipitates;	2
(iii)	accurately observes the evolution of gases and performs suitable tests to identify them where necessary;	2
(iv)	accurately observes all other changes such as temperature, the appearance of substances, smells and so on;	2
(v)	clearly expresses and neatly displays the record of observations.	2
		10

* A titration is understood to involve pipetting, using a burette and determining an end-point.

Skill 3: Concluding and Communicating (Quantitative)

Results from the experiment used to assess Skill 1 may be used to assess this skill area. In an experiment involving a titration, marks should be awarded where the candidate:

Assessment Criteria	Max. Marks Available
(i) manipulates all data correctly, including the use of graphs where appropriate, and accurately calculates the outcome;	2
(ii) draws appropriate conclusions in relation to the problem set and uses chemical knowledge to explain these conclusions;	2
(iii) critically evaluates the results obtained, identifying any errors and where necessary, ignores them in drawing conclusions;	2
(iv) suggests improvements to the experiment in light of (iii) above;	2
(v) clearly and concisely presents all conclusions, using appropriate nomenclature and terminology, to an appropriate number of significant figures and with correct use of language.	2
	10

Skill 4: Concluding and Communicating (Qualitative)

Results from the experiment used to assess Skill 2 may be used to assess this skill area. In a qualitative experiment, marks should be awarded where the candidate:

Assessment Criteria	Max. Marks Available
(i) interprets qualitative observations correctly;	2
(ii) draws appropriate conclusions in relation to the problem set and uses chemical knowledge to explain these conclusions;	2
(iii) critically evaluates the results obtained, identifies any conflicts or ambiguities in them and where necessary, ignores them in drawing conclusions;	2
(iv) suggests improvements or additions to the original experiment in light of (iii) above;	2
(v) clearly and concisely presents all conclusions, using appropriate nomenclature and terminology, with correct use of language.	2
	10

1.4 MAKING ASSESSMENTS

Candidates should be made aware at the beginning of the course that their individual practical work will be assessed for examination purposes.

Teachers are advised to carry out assessments in experimental situations with which candidates have some familiarity, but candidates are not to be rehearsed in particular experiments which are further repeated for the purpose of assessment.

Teachers are free to devise their own practical work, within the limitations set out in the previous paragraphs. Centres **must** confirm with the Council that any assessments they propose, with related mark schemes, satisfy the requirements of this specification. It is realised that practical work set by an individual teacher will differ from that set by other teachers depending on the facilities and resources available. However, centres should be aware of the requirement for internal moderation and standardisation so that a consistent approach by teachers within individual centres is achieved.

Candidates' work **must** be annotated **in detail** showing where mark descriptors for assessment criteria within each skill were satisfied.

Assessments should take place, as appropriate, during normal laboratory teaching rather than by means of end-of-session practical examinations. Teachers are free to choose when to carry out assessment throughout the course.

The teacher must exercise control and supervision of all practical work on which the assessments are carried out to ensure that the work assessed is that of the individual candidate concerned. Work done at home should not be used for assessments. Experiments assessed should be carried out by the candidate working individually, not as a member of a group, though pooling of class results for the purpose of individual interpretation is permissible.

Guidance to candidates may be given by the teacher as follows:

(i) minor assistance which is penalised by 1 mark so that the maximum available mark under this assessment criterion is 1;

(ii) further assistance or direct instructions in order to be able to attempt any part of a skill area results in the candidate being awarded no marks.

Teachers will be required to sign a declaration to certify that, to the best of their knowledge, all the work submitted for assessment is the candidate's own.

1.5 RECORDING ASSESSMENTS

Teachers may make as many assessments of each of the skill areas as they wish but a minimum of **two** should be recorded on the individual record sheet. The **best** assessment in any skill area should be circled and used to calculate the final total mark. Such individual record sheets should be completed for each candidate. The forms will be supplied by the Council.

1.6 MODERATION OF ASSESSMENTS

Centres will be required to submit selected samples of candidates' coursework, chosen according to criteria supplied annually by the Council. Mark schemes showing how the mark descriptors for each skill were satisfied **must** also be submitted for moderation. This will act as a safeguard for candidates should the moderators disagree with the circled marks.

Prior to moderation, centres **must** ensure that a process of internal standardisation has been carried out since adjustments made during moderation will apply to all candidates from any centre.

Agreement trials will be conducted annually, prior to the date of submission of coursework samples, where teachers will be briefed on the application of the assessment criteria and will engage in trial marking.

1.7 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, ie 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 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 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, 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 0-95317760-2.

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

Where an employer had 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 teacher's 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 or chemicals, 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.

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.

1.8 EXEMPLAR SUPPORT MATERIAL

This exemplar material contains a total of nine practical activities covering all four skill areas.

Each practical activity follows a common format:

1 Student Instructions;

2 Mark Scheme for the teacher;

3 Suggested further tests.

Note that students are expected to draw up their own method of presenting their results.

The mark schemes are based on the assessment criteria for each skill area. In certain cases these have been grouped together for the award of marks.

Skill Areas 1 and 3 are covered by three titration exercises.

List of Experiments

Skill Areas 1 and 3: Titrations

(a) Solubility of Calcium hydroxide.

(b) Analysis of vinegars.

(c) Analysis of bleaches.

It is recognised that assessment criteria (iii) and (iv) of Skill Area 1 would render a kinetics experiment, sampled by titre, as not being an appropriate experiment in which to assess Skill Area 1.

Skill Areas 2 and 4 are covered by three inorganic experiments and three organic experiments.

Skill Areas 2 and 4: Observation and Deduction Exercises

1 Iron(III) ammonium sulphate.

2 Potassium bromide and nickel carbonate.

3 Copper(II) chloride and sodium sulphite.

4 Citric acid.

5 Chloroethanoic acid and cinnamic acid.

6 Organic liquids identification.

Unless otherwise specified all reagents should be of normal bench concentration.

2 CHEMISTRY COURSEWORK – SKILLS 1 AND 3

2.1 EXPERIMENT (a): THE SOLUBILITY OF CALCIUM HYDROXIDE:

The published value for the solubility of calcium hydroxide at 20.0ºC is 0.156 g/100 g water or 2.10×10^{-2} mol dm^{-3}.

You are to determine the solubility of the given sample of calcium hydroxide at room temperature and compare this with the published value.

Skill 1: Manipulation, Measuring and Recording

Procedure

Make a saturated solution of calcium hydroxide at room temperature as follows:

Add approximately 1.5 g of calcium hydroxide to 200 cm^3 of deionised water and warm with stirring to about 40ºC on a steam/hot water bath. Remove from the heat and cool to room temperature. Record this temperature.

Filter using a Buchner flask and funnel and collect the filtrate in a clean dry flask. (Whatman No. 1 or finer filter paper.)

Titrate 25.0 cm^3 portions of filtrate using standard hydrochloric acid (0.10 mol dm^{-3} to 0.05 mol dm^{-3}) using methyl orange indicator. Record all your results clearly using an appropriate table and units.

Skill 3: Concluding and Communication (Quantitative)

Assessment Criteria	Description	Marks	
(i) and (ii)	(a) Write a balanced equation for the titration reaction	1	4
	(b) Explain the choice of indicator for this titration	1	
	(c) (i) From your results determine the solubility of calcium hydroxide at the recorded temperature in mol dm^{-3}	1	
	(c) (ii) From your results determine the solubility of calcium hydroxide at the recorded temperature in g/100g water	1	
(iii)	Compare your calculated value with the published data given above and outline at least two possible sources of error which could account for any difference.	2	2
(iv)	In the light of (iii) suggest at least two possible improvements to the given procedure.	2	2
(v)	Present your conclusions clearly and concisely using appropriate nomenclature and terminology	1	2
	and to an appropriate number of significant figures	1	
		Total	**10**

2.2 EXPERIMENT (b): THE ANALYSIS OF VINEGARS

In this experiment you will investigate which of the two given brands of vinegar offers the better value for money in terms of ethanoic acid content. The ethanoic acid concentration of the vinegar can be found by titration with standard sodium hydroxide solution and converted to grams of ethanoic acid per 100 cm^3 of solution. A cost comparison can then be carried out to evaluate value for money.

Equation: $CH_3COOH + NaOH \rightarrow CH_3COONa + H_2O$

Skill 1: Manipulation, Measuring and Recording

Procedure

Fill a burette to the mark with standard 0.1 mol dm^{-3} sodium hydroxide solution.

Pipette 10.0 cm^3 of vinegar A into a 100 cm^3 volumetric flask and make up to the mark with deionised water. Mix well. Pipette 25.0 cm^3 portions of this diluted vinegar solution into conical flasks and titrate with the standard sodium hydroxide solution using phenolphthalein indicator. Repeat until consistent results are obtained. Record your results clearly using an appropriate table and units.

Repeat the whole experiment using vinegar B.

Skill 3: Concluding and Communicating (Quantitative)

Assessment Criteria	Description	Marks	
(i) and (ii)	(a) Explain the choice of indicator for this titration.	1	4
	(b) Determine the concentration of CH_3COOH in mol/dm^3 for each diluted vinegar.	1	
	(c) Determine the concentration of CH_3COOH in mol/dm^3 for each undiluted vinegar.	1	
	(d) Calculate the mass of CH_3COOH in 100 cm^3 of each undiluted vinegar.	1	
(iii)	Given the current price of each brand of vinegar evaluate which gives the best value for money in terms of ethanoic acid content.	2	2
(iv) (adapted)	Outline at least two aspects of experimental technique necessary to minimise error in your determination.	2	2
(v)	Present your conclusions clearly and concisely using appropriate nomenclature and terminology	1	2
	and to an appropriate number of significant figures.	1	
		Total	**10**

2.3 EXPERIMENT (c): TO DETERMINE WHICH SAMPLE OF DOMESTIC BLEACH IS THE BEST VALUE FOR MONEY

Background information: A solution of domestic bleach contains sodium chlorate (I) NaClO. If this solution is acidified it produces chlorine.

$ClO^-_{(aq)} + 2H^+_{(aq)} + Cl^-_{(aq)} \rightarrow Cl_{2(g)} + H_2O_{(l)}$

The amount of chlorine which may be produced from a fixed amount of bleach is referred to as "available chlorine". The amount of "available chlorine" in bleach may be determined by using the bleach to liberate iodine from acidified aqueous potassium iodide.

$2I^-_{(aq)} + 2H^+_{(aq)} + ClO^-_{(aq)} \rightarrow I_{2(aq)} + 2H_2O + Cl^-_{(aq)}$

The liberated iodine is then titrated with aqueous sodium thiosulphate.

$2S_2O_3{}^{2-}_{(aq)} + I_{2(aq)} \rightarrow S_4O_6{}^{2-}_{(aq)} + 2I^-_{(aq)}$

The colour of the iodine disappears at the end point. This can be made sharper by the addition of starch solution near the end point.

You will investigate one of the three samples of bleach supplied, carry out the titration and collect the results for the other two samples from your teacher. Then use these results in your calculation.

Skill 1: Manipulation, Measuring and Recording

Method

Using a pipette filler, pipette exactly 10.0 cm^3 of the bleach allocated to you into a 250 ml volumetric flask and make it up to the mark.

Transfer 25.0 cm^3 of this solution to a conical flask; add 1.5 g (approximately) of potassium iodide and 20.0 cm^3 dilute sulphuric acid (2 M). Swirl the mixture. Titrate the contents of the flask with standard 0.1 M sodium thiosulphate solution adding 1 ml of starch solution when the contents of the flask are a straw colour. Continue adding sodium thiosulphate until the colour changes from blue/black to colourless. Repeat this titration until you obtain two concordant results. Record all your results in a suitable table, with units.

Other Information

1 Record the names of the bleaches supplied, the total volume of each bottle and the cost of the bleach.

2 Record the volume of 0.1 M sodium thiosulphate required to react with the released iodine from the other two samples.

Experiment (c): An Evaluation of Domestic Bleaches (continued):

Skill 3: Concluding and Communicating (quantitative)

Assessment Criteria	For Each Bleach Sample	Marks	
(i) and (ii)	(a) Calculate the moles of sodium thiosulphate required for 25.0 cm^3 diluted bleach.	1	4
	(b) Calculate the moles of iodine reacting with this.	1	
	(c) Determine the moles of "available chlorine" in 25.0 cm^3 of diluted bleach.	1	
	(d) Calculate the mols of "available chlorine" in the 10.0 cm^3 undiluted bleach.	1	
(iii)	Given the cost of each bleach, evaluate which gives the best value for money in terms of "available chlorine".	1	2
	Mention one possible source of error (chemical) in your determination.	1	
(iv) (adapted)	Outline at least two aspects of experimental technique necessary to minimise error in your determination.	2	2
(v)	Present your conclusions clearly and concisely using appropriate nomenclature and terminology	1	2
	and to an appropriate number of significant figures.	1	
		Total	**10**

2.4 Mark Schemes Skills 1 and 3 – Experiment (a): Solubility of Calcium Hydroxide

Skill 1: Manipulation, Measuring and Recording

Assessment Criteria	Description	Mark	Maximum Marks
(i)	Apparatus set up competently and used with dexterity.	2	2
	Some assistance given in setting up and using apparatus.	1	
	Unable to set up or use apparatus without major assistance.	0	
(ii)	Uses apparatus safely with due care and attention	2	2
	Intervention needed to ensure safety and care in the use of equipment.	1	
	Major intervention needed to prevent harm to personnel or equipment.	0	
(iii)	Two or more titres within 0.1 cm^3	2	2
	Two or more titres within 0.2 cm^3	1	
	Difference in titre values > 0.2 cm^3	0	
(iv)	Accuracy within 0.1 cm^3 of identified value ie teacher's identified value.	2	2
	Accuracy within 0.2 cm^3 of identified value	1	
	Result differs by more than 0.2 cm^3 from identified value.	0	
(v)	Clear neat presentation, with suitable table (showing initial, final values and volume delivered), correct units given and titre figures to at least one decimal place.	2	2
	one major omission (–1)	1	
	two major omissions (–2)	0	
		Total	**10**

Skill 3: Concluding and Communication (Quantitative)

Sample Results

$Ca(OH)_2$ Philip Harris commercial.
25.0 cm^3 $Ca(OH)_{2(aq)}$ required 10.2 cm^3 of 0.1 mol dm^{-3} $HCl_{(aq)}$
Thus $[OH^-] = 4.08 \times 10^{-2}$ mol dm^{-3}
and $[Ca(OH)_2] = 2.04 \times 10^{-2}$ mol dm^{-3}
Assuming M. Mass $Ca(OH)_2$ = 74 g mol^{-1}
and 100 g water ≡ 100 cm^3 solution
solubility of $Ca(OH)_2$ = 0.151 g/100 g water.

Assessment Criteria	Description	Mark	Maximum Marks
(i) and (ii)	(a) $2HCl + Ca(OH)_2 \rightarrow CaCl_2 + 2H_2O$	1	4
	(b) Strong acid/weak base titration therefore Methyl orange suitable.	1	
	From Results (c) (i) Correct $[Ca(OH)]_2$ – mol dm^{-3}	1	
	(ii) Correct $Ca(OH)_2$ solubility – g/100 g	1	
(iii)	• Comparison of calculated and published data, highlighting any differences in determination, eg temperature.	1	2
	• Two possible sources of error, eg: – difficulties determining end point – temperature fluctuations during determination – reaction of $Ca(OH)_{2(aq)}$ with $CO_{2(q)}$ in air.	1	
(iv)	• Two possible improvements, eg: – improved indicator, eg screened methyl orange – thermostatically controlled water bath	2	2
(v)	• Presentation of results and conclusions: – appropriate nomenclature and terminology	1	2
	– appropriate significant figures, ie temperature to one decimal place and concentration/solubility as per published data.	1	
		Total	**10**

Experiment (b): The Analysis of Vinegars

Skill 1: Manipulation, Measuring and Recording

Assessment Criteria	Description	Mark	Maximum Marks
(i)	Apparatus set up competently and used with dexterity.	2	2
	Some assistance given in setting up and using apparatus.	1	
	Unable to set up or use apparatus without major assistance.	0	
(ii)	Uses apparatus safely with due care and attention	2	2
	Intervention needed to ensure safety and care in the use of equipment.	1	
	Major intervention needed to prevent harm to personnel or equipment.	0	
(iii)	Two or more titres within 0.1 cm^3	2	2
	Two or more titres within 0.2 cm^3	1	
	Difference in titre values > 0.2 cm^3	0	
(iv)	Accuracy within 0.1 cm^3 of identified value, ie teacher's identified value.	2	2
	Accuracy within 0.2 cm^3 of identified value	1	
	Result differs by more than 0.2 cm^3 from identified value.	0	
(v)	Clear neat presentation, with suitable table (showing initial, final values and volume delivered), correct units given and titre figures to at least one decimal place.	2	2
	one major omission (–1)	1	
	two major omissions (–2)	0	
		Total	**10**

Skill 3: Concluding and Communicative (Quantitative)

Specimen Results:

Vinegar 1 25.0 cm^3 diluted required 21.6 cm^3 0.1 M $NaOH_{(aq)}$ giving a diluted sample of concentration 8.6×10^{-2} mol dm^{-3}.

Vinegar 2 25.0 cm^3 diluted required 19.7 cm^3 0.1 M $NaOH_{(aq)}$ giving a diluted sample of concentration 7.9×10^{-2} mol dm^{-3}.

Assessment Criteria	Description	Mark	Maximum Marks
(i)	(a) Weak acid/strong base titration therefore Phenolphthalein is suitable	1	4
	(b) Correct [CH_3COOH] in mol/dm^3 for the diluted vinegars	1	
	(c) Correct [CH_3COOH] in mol/dm^3 for undiluted vinegars	1	
	(d) Correct mass of CH_3COOH in 100 cm^3 of each vinegar	1	
(iii)	Value for money evaluation for each vinegar in terms of CH_3COOH content.	1	2
	One possible source of error	1	
(iv)	Any two applications of good experimental technique, eg: • washing burette twice with small volumes of standard alkali before filling • dropwise addition of titrant to the end point • using only results which are precise, ie agree within 0.1 cm^3, to average One mark for each.	2	2
(v)	Presentation of results and conclusions: • appropriate nomenclature and terminology	1	2
	• appropriate significant figures, eg volumes to 0.1 cm^3	1	
		Total	**10**

Experiment (c): An Evaluation of Domestic Bleaches

Skill 1: Manipulation, Measuring and Recording

Assessment Criteria	Description	Mark	Maximum Marks
(i)	Apparatus set up competently and used with dexterity.	2	2
	Some assistance given in setting up and using apparatus.	1	
	Unable to set up or use apparatus without major assistance.	0	
(ii)	Uses apparatus safely with due care and attention	2	2
	Intervention needed to ensure safety and care in the use of equipment.	1	
	Major intervention needed to prevent harm to personnel or equipment.	0	
(iii)	Two or more titres within 0.1 cm^3	2	2
	Two or more titres within 0.2 cm^3	1	
	Difference in titre values > 0.2 cm^3	0	
(iv)	Accuracy within 0.1 cm^3 of identified value, ie teacher's identified value.	2	2
	Accuracy within 0.2 cm^3 of identified value	1	
	Result differs by more than 0.2 cm^3 from identified value.	0	
(v)	Clear neat presentation, with suitable table (showing initial, final values and volume delivered), correct units given and titre figures to at least one decimal place.	2	2
	one major omission (–1)	1	
	two major omissions (–2)	0	
		Total	**10**

Skill 3: Concluding and Communicating (Quantitative)

Teacher Information

Domestos, Parazone and most of the "own brand" domestic bleaches work quite well. If 10.0 cm^3 of the bleach is diluted to 250 cm^3 and titrated with 0.1 M $Na_2S_2O_{3(aq)}$, approximately 12–13 cm^3 of thiosulphate is required.

The concentration of the NaOCl is ~ 0.6 M.

Assessment Criteria	Description	Mark	Maximum Marks
(i) and (ii)	From Results (a) Correct number of moles of $Na_2S_2O_3$	1	4
	(b) Correct number of moles of I_2	1	
	(c) Moles of "available chlorine" in 25.0 cm^3 diluted bleach	1	
	(d) Mole of available chlorine in 10.0 cm^3 undiluted bleach	1	
(iii)	Best value for money evaluation	1	2
	One possible source of error (chemical) eg: • an incomplete reaction; • any possible side reaction.	1	
(iv)	Any two applications of good experimental technique eg: • washing burette twice with small volumes of standard sodium thiosulphate solution before filling; • dropwise addition of titrant to the end point; • using only results which are precise, ie agree within 0.1 cm^3, to average	2	2
(v)	Presentation of results and conclusions • appropriate nomenclature and terminology	1	2
	• appropriate significant figures, eg volumes to 0.1 cm^3	1	
		Total	**10**

3 CHEMISTRY COURSEWORK – SKILLS 2 AND 4

3.1 EXPERIMENT 1: AN INORGANIC OBSERVATION DEDUCTION EXERCISE

Instructions to students

Skill 2: Observing and Recording

You are provided with an inorganic solid double salt. Carry out the following tests on the solid and record, neatly and accurately, all observations including: appearances of solids and solutions, colour changes, the formation and colour of precipitates, the evolution of gases, temperature changes, smells etc.

Draw up a table for your results under the headings: Test number, Observations, Interpretation.

Skill 4: Concluding and Communication (Qualitative)

(i) Interpret your observations as fully as possible.

(ii) Identify the inorganic double salt based on your interpretations made in (i).

(iii) Write a concise account justifying the conclusions reached in (i) and (ii) and highlight any uncertainties regarding your conclusions.

(iv) Describe any two tests you could perform to clarify any ambiguities.

Substance A

Procedures/tests

1 Describe fully the appearance of A.

2 Mix about two spatula measures of A with an approximately equal quantity of calcium hydroxide and heat gently.

(a) Smell carefully.

(b) Test any gas produced with moist litmus and/or Universal Indicator paper.

3 Dissolve about six spatula measures of A in about 15 cm^3 of deionised water. Test the solution with moist Universal Indicator paper. Divide the solution into three approximately equal portions in three test tubes, one for each of the following tests:

(a) Add a spatula measure of sodium carbonate and warm.

(b) Add a small volume of potassium or ammonium thiocyanate solution and shake.

(c) Add one or two cm^3 of barium chloride solution, record your observations and then add dilute hydrochloric acid.

3.2 EXPERIMENT 2: AN INORGANIC OBSERVATION DEDUCTION EXERCISE

Instructions to students

Skill 2: Observing and Recording

You are provided with two inorganic separate single salts. Carry out the following tests on the solids and record, neatly and accurately, all observations including: appearances of solids and solutions, colour changes, the formation and colour of precipitates, the evolution of gases, temperature changes, smells etc.

Draw up a table for your results under the headings: Test number, Observations, Interpretation.

Skill 4: Concluding and Communication (Qualitative)

(i) Interpret your observations as fully as possible.

(ii) Identify the two single salts based on your interpretations made in (i)).

(iii) Write a concise account justifying the conclusions reached in (i) and (ii) and highlight any uncertainties regarding your conclusions.

(iv) Describe any two tests you could perform to clarify any ambiguities.

Substances B and C – two single salts

Skill 2: Procedures/Tests – Sample B

1 Describe fully the appearance of salt B.

2 Carry out a flame test on B.

3 Make up a solution of the salt in about 10 cm^3 of water.

(a) To about 2 cm^3 of solution add about five drops of silver nitrate solution followed by a little dilute nitric acid.

Divide the contents of the test tube into two separate portions.

(b) To the first portion add excess dilute ammonia solution.

(c) To the second portion add excess concentrated ammonia solution – use a fume cupboard.

Skill 2: Procedures/Tests – Sample C

1 Describe fully the appearance of salt C.

2 Heat a small amount of the solid in a test tube.

3 Place one or two spatula measures of solid in a test tube, add dilute hydrochloric acid, warm gently and test any gas evolved.

4 Place about 5 cm^3 of dilute hydrochloric acid in a large test tube, warm gently and add solid C by spatula measures until the reaction stops and there is excess solid present.

Filter and carry out the following tests on the filtrate.

(a) To about 1 cm^3 of filtrate add dilute sodium hydroxide solution, dropwise at first and then until in excess.

(b) To about 1 cm^3 of filtrate add dilute ammonia solution drop by drop at first and then until in excess. Stopper the test tube and shake.

3.3 EXPERIMENT 3: AN INORGANIC OBSERVATION DEDUCTION EXERCISE

Instructions to students

Skill 2: Observing and Recording

You are provided with two inorganic separate single salts. Carry out the following tests on the solids and record, neatly and accurately, all observations including: appearances of solids and solutions, colour changes, the formation and colour of precipitates, the evolution of gases, temperature changes, smells etc.

Draw up a table for your results under the headings: Test number, Observations, Interpretation.

Skill 4: Concluding and Communication (Qualitative)

(i) Interpret your observations as fully as possible.

(ii) Identify the two single salts based on your interpretations made in (i).

(iii) Write a concise account justifying the conclusions reached in (i) and (ii) and highlight any uncertainties regarding your conclusions.

(iv) Describe any two tests you could perform to clarify any ambiguities.

Substances D and E – Two single salts

Skill 2: Procedures/Tests – Sample D

1 Describe fully the appearance of salt D.

2 Cautiously heat a small sample of the salt.

3 Carry out a flame test on the salt.

4 Make up a solution of the salt in about 10 cm^3 of water.

(a) To about 1 cm^3 of the solution add dilute sodium hydroxide solution, dropwise at first and then until in excess.

(b) To a separate 1 cm^3 portion of the solution add about five drops of silver nitrate solution followed by a little dilute nitric acid.

Skill 2: Procedures/Tests – Sample E

1 Describe fully the appearance of salt E.

2 Carry out a flame test on the salt.

3 (a) Add dilute hydrochloric acid to a small sample of the salt in a test tube.

(b) Now warm the test tube gently.

(c) Cautiously smell any gas evolved.

(d) Test the gas with:

(i) damp Universal Indicator paper;

(ii) Filter paper dipped in acidified potassium manganate (VII) solution.

3.4 EXPERIMENT 4: ORGANIC TEST TUBE REACTIONS

Instructions to students

Skill 2: Observing and Recording

You are provided with a single organic compound. Carry out the following tests and record, neatly and accurately, all observations including: appearances of solids and solutions, colour changes, the formation and colour of precipitates, the evolution of gases, temperature changes, smells etc.

Draw up an appropriate table for your results under the headings: Test number, Observations, Interpretation.

Skill 4: Concluding and Communication (Qualitative)

(i) Interpret your observations as fully as possible.

(ii) Identify the functional groups present in the compound.

(iii) Write a concise account justifying the conclusions reached in (i) and (ii) and highlighting any uncertainties regarding your conclusions.

(iv) Describe at least two tests you could perform to help clarify any ambiguities.

Procedures/Tests – Substance X

1 Describe fully the appearance of X.

2 Heat a few spatula measures of X in a test tube. Test any gaseous product with blue cobalt chloride paper. Allow the sample to cool and note its appearance.

3 Dissolve five spatula measures of X in 10–12 cm^3 of deionised water and use this solution for tests 4, 5 and 6.

4 Test the solution with Universal Indicator paper.

5 Add solid sodium carbonate to the solution and identify any gas evolved.

6 Warm about 2 cm^3 of the solution of X and add dilute potassium manganate(VII) solution.

7 Place about 1 cm^3 of ethanol in a boiling tube and add a few drops of concentrated sulphuric acid (care), some anti-bumping granules and two to three spatula measures of X. Warm for a few minutes and then pour the contents of the boiling tube into cold water in a beaker.

3.5 EXPERIMENT 5: ORGANIC TEST TUBE REACTIONS

Instructions to students

Skill 2: Observing and Recording

You are provided with two separate organic compounds. Carry out the following tests and record, neatly and accurately, all observations including: appearances of solids and solutions, colour changes, the formation and colour of precipitates, the evolution of gases, temperature changes, smells etc.

Draw up an appropriate table for your results under the headings: Test number, Observations, Interpretation.

Skill 4: Concluding and Communication (Qualitative)

(i) Interpret your observations as fully as possible.

(ii) Identify the functional groups present in the compound/compounds.

(iii) Write a concise account justifying the conclusions reached in (i) and (ii) and highlighting any uncertainties regarding your conclusions.

(iv) Describe at least two tests you could perform to help clarify any ambiguities.

Skill 2: Organic Test Tube Reaction – Substance Y

1 Describe fully the appearance of Y.

2 Add about two or three spatula measures of Y to about 10 cm^3 of deionised water. Warm gently to dissolve if necessary.

3 Test the solution with Universal Indicator paper.

4 Add solid sodium carbonate to about 2 cm^3 of the solution of Y.

5 To about 4 cm^3 of the solution of Y add sodium carbonate until it is in excess. Filter the solution and collect the filtrate.

6 To the filtrate from 5, add silver nitrate solution and shake. Now add dilute ammonia until it is in excess, with shaking.

Skill 2: Substance Z

1 Put a small amount of Z on a crucible lid and ignite from above.

2 Prepare a solution of Z in about 10 cm^3 of hot water.

3 Test the solution of Z with litmus paper.

4 Add bromine water dropwise to the solution of Z and shake.

5 Add a spatula measure of Z to about 2 cm^3 of ethanol, add a few drops of concentrated sulphuric acid and warm carefully. Now pour contents of test tube into cold water in a beaker.

3.6 EXPERIMENT 6: IDENTIFICATION OF ORGANIC COMPOUNDS

Instructions to students

Skill 2: Observing and Recording

You are provided with five unknown organic liquids labelled (a) to (e). They are known to be:

- Ethanal (solution)
- Ethanol
- Propanone
- Ethanoic acid (glacial)
- Pentyl ethanoate

but **not** in that order.

Carry out the tests given and use the results of the tests to identify each of the liquids. As you proceed through the tests and identify a particular liquid do not carry out any further tests on it.

Record, neatly and accurately all observations including appearances of solids and solutions, colour changes, the formation and colours of precipitates, the evolution of gases, temperature changes, smells etc.

Draw up an appropriate table for your results under the headings: Test number, Observations, Interpretation.

Skill 2: Procedures/Tests

1 **Cautiously** smell each of the liquids (a), (c) and (e) in turn by gently wafting the vapour towards you with your hand. Record your results and interpret them as far as possible.

2 Add an equal volume of water to about 2 cm^3 of each of the liquids in turn. Shake and allow each mixture to settle.

3 To about 2 cm^3 **of each of the remaining liquids** add dropwise a solution of 2, 4-dinitrophenyl hydrazine (Brady's Reagent).

4 Warm about 1 cm^3 of each liquid that tested positively in 3 with about 2 cm^3 of Fehling's solution in a hot water bath.

5 (i) To fresh 2 cm^3 portions of each of the remaining liquids (in a fume cupboard) add a small spatula measure of phosphorus (V) chloride.

(ii) Test any gas given off with a drop of concentrated ammonia solution on a glass rod.

6 (i) To fresh 2 cm^3 portions of the liquids tested in 5 add a spatula measure of sodium carbonate.

(ii) Test any gas evolved with a burning splint.

Skill 4: Concluding and Communication (Qualitative)

(i) Interpret your observations as fully as possible.

(ii) Identify each of the liquids labelled (a) to (e).

(iii) Write a concise account justifying the conclusions reached in (i) and (ii) and highlighting any uncertainties regarding your conclusions.

(iv) Describe at least two tests you could perform to help clarify any ambiguities.

3.7 Mark Schemes – Skills 2 and 4 – Experiment 1: Substance A

Skill 2: Manipulation, Observing and Recording

Procedure	Assessment Criteria	Description	Mark	Maximum Marks
1	(iv)	Pale violet	1	2
		crystalline solid	1	
2	(ii)	Brown	1	4
		solid on heating	1	
	(iv)	Pungent/sharp smell	1	
	(iii)	Red litmus turned blue/U.I. turned blue-green	1	
3	(ii) (iv)	Yellow to orange/brown solution	1	2
	(iv)	Universal Indicator paper turned red	1	
(a)	(ii)	Solution darkens/turns dark brown	1	4
	(iii)	Effervescence/bubbles of gas	1	
	(ii)	Red-brown	1	
		precipitate	1	
(b)	(ii)	A deep red	1	2
		solution formed	1	
(c)	(ii)	An immediate precipitate	1	4
		White (on settling)	1	
	(ii)	Solution turned yellowish-green with $HCl_{(aq)}$	1	
	(ii)	Precipitate remains	1	
			Total	**18**

Up to 18 observations – scale to 6

0–1	2–3	4–6	7–9	10–11	12–14	15–18
0	1	2	3	4	5	6

Mark Scheme – Experiment 1: Substance A

Skill 4: Concluding and Communicating (Qualitative)

Procedure	Assessment Criteria (i) and (ii) – Observations	Mark	Maximum Marks
1	A transition metal	1	2
	Two suggestions from Cr^{3+}, Fe^{3+}, Co^{2+}, Mn^{2+}	1	
2	Alkaline gas	1	3
	Suggests ammonia	1	
	Therefore ammonium compound NH_4^+	1	
3	Suggests Fe^{3+}	1	3
	Acidic solution	1	
	Hydrolysis of cation or correct equation	1	
(a)	Acid with carbonate gives carbon dioxide gas	1	2
	Insoluble hydroxide/$Fe(OH)_3$ (Accept carbonate as a possible suggestion)	1	
(b)	Complex ion formed	1	2
	$[Fe(H_2O)_5SCN]^{2+}$	1	
(c)	Sulphate	1	3
	or sulphite	1	
	Confirms sulphate or not sulphite	1	
Conclusion	Compound is iron(III)	1	3
	ammonium	1	
	sulphate	1	
		Total	**18**

Up to 18 deductions/conclusions – scale to 4

0–1	2–5	6–10	11–13	14–18
0	1	2	3	4

SKILL 2 – Application of Assessment Criteria

Assessment Criteria	Description	Mark	Maximum Marks
(i) Use of apparatus	Fully competent	2	2
	Fairly good	1	
	Incompetent	0	
(ii), (iii), (iv) Making observations	Observations as above scaled to 6	6	6
(v) Record of observations	Immediate record, clear and neat	2	2
	Untidy, disorganised or difficult to read	1	
	Illegible	0	
		Total	**10**

SKILL 4 – Application of Assessment Criteria

Assessment Criteria	Description	Mark	Maximum Marks
(i) and (ii)	Interpretations, conclusions and explanations as above – scaled to 4	4	4
(iii)	A concise written report justifying conclusions	1	2
	Any one uncertainty regarding conclusions	1	
(iv)	Any two **appropriate** additional tests	2	2
	Any one **appropriate** additional test	1	
	No appropriate additional tests	0	
(v)	Clear concise presentation	1	2
	Appropriate use of chemical terminology including any correct equations/formulae	1	
		Total	**10**

Notes for Teacher

Skill 4: $Fe(NH_4)(SO_4)_2$

Suggested possible additional tests

1 For ammonia – with $HCl_{(g)}$ from concentrated hydrochloric acid.

2 For carbon dioxide – with limewater.

3 For Fe^{3+} with potassium hexacyanoferrate(II).

Mark Scheme – Experiment 2

Skill 2: Manipulation, Observing and Recording – Substance B

Procedure	Assessment Criteria	Description	Mark	Maximum Marks
1	(iv)	A white	1	2
		crystalline solid	1	
2	(iv)	Lilac flame	1	1
3	(ii)	A colourless solution	1	1
(a)	(ii)	Cream/off white	1	2
		precipitate	1	
(b)	(ii)	Precipitate does not dissolve	1	1
(c)		Precipitate dissolves	1	2
		giving a colourless solution	1	
			Total	**9**

Substance C

Procedure	Assessment Criteria	Description	Mark	Maximum Marks
1	(iv)	A green	1	2
		powdery solid/powder	1	
2	(ii)	Solid turns black	1	1
3	(iii)	Effervescence/gas evolved	1	4
		Turns limewater milky	1	
	(ii)	A green	1	
		solution formed	1	
4 (a)	(ii)	A green	1	3
		precipitate forms	1	
		Precipitate remains	1	
(b)	(ii)	A faint green precipitate forms	1	2
		Precipitate dissolves in excess	1	
	(ii)	To form a blue solution	1	1
			Total	**13**

Up to 22 observations for B and C together– scale to 6

0–1	2–4	5–8	9–11	12–14	15–18	19–22
0	1	2	3	4	5	6

Skill 2 Application of assessment criteria

Assessment Criteria	Description	Mark	Maximum Marks
(i) Use of apparatus	Fully competent	2	2
	Fairly good	1	
	Incompetent	0	
(ii), (iii), (iv) Making observations	Observations as above scaled to 6	6	6
(v) Record of observations	Immediate record, clear and neat	2	2
	Untidy, disorganised or difficult to read	1	
	Illegible	0	
		Total	**10**

Mark Scheme – Experiment 2

Skill 4: Concluding and Communicating (Qualitative)

Substance B

Procedure	Assessment Criteria (i) and (ii)	Mark	Maximum Marks
1	Not a transition metal salt	1	2
	could be a Group I or II metal salt (or other valid suggestion)	1	
2	A potassium salt	1	1
3 (a)	Halide present could be Br^-	1	1
(b)	Not Cl^-, could be Br^- or I^- present	1	1
(c)	Excludes I^-	1	2
	Br^- present	1	
Conclusion	Substance is potassium	1	2
	bromide	1	
		Total	**9**

Substance C

Procedure	Assessment Criteria (i) and (ii)	Mark	Maximum Marks
1	Transition metal salt	1	2
	Could be Cu^{2+}, Ni^{2+}, Fe^{2+} (any two)	1	
2	Could be CuO, NiO, any valid suggestion	1	1
3	Gas is CO_2	1	2
	Solid is a carbonate (accept hydrogencarbonate).	1	
4 (a)	Insoluble hydroxide formed	1	3
	Not $Cu(OH)_2$ or Cu^{2+}	1	
	Suggests $Ni(OH)_2$ or Ni^{2+}	1	
(b)	Insoluble hydroxide	1	3
	Ammine complex formed	1	
	$[Ni(NH_3)_6]^{2+}$	1	
Conclusion	Substance is nickel (II)	1	2
	carbonate	1	
		Total	**13**

Up to 22 deductions – scaled to 4

0–2	3–7	8–12	13–17	18–22
0	1	2	3	4

Experiment 2

Skill 4 – Application of Assessment Criteria

Assessment Criteria	Description	Mark	Maximum Marks
(i) and (ii)	Interpretations, conclusions and explanations as above – scaled to 4	4	4
(iii)	A concise written report justifying conclusions	1	2
	Any one uncertainty regarding conclusions	1	
(iv)	Any two **appropriate** additional tests	2	2
	Any one **appropriate** additional test	1	
	No appropriate additional tests	0	
(v)	Clear concise presentation	1	2
	Appropriate use of chemical terminology including any correct equations/formulae	1	
		Total	**10**

Notes for Teachers

Substances B and C

Skill 4: B is KBr, C is $NiCO_3$

Suggested possible additional tests.

1 Add c.H_2SO_4 to B – fumes of HBr/Br_2 evolved.

2 Dissolve B in water, pass in $Cl_{2(g)}$ – Br_2 displaced.

3 Add dil $HNO_{3(aq)}$ to C – green solution excludes Cu^{2+}.

Mark Scheme – Experiment 3

Skill 2 Manipulation, Observing and Recording

Substance D

Procedure	Assessment Criteria	Description	Mark	Maximum Marks
1	(iv)	A green/blue-green/turquoise	1	2
		crystalline solid	1	
2		Condensation on upper part of test tube (may also turn brown)	1	1
3	(iv)	Blue-green flame	1	1
4	(ii)	Blue solution	1	1
(a)	(ii)	A blue	1	3
		precipitate	1	
		Precipitate does not dissolve in excess	1	
(b)	(ii)	A white	1	2
		precipitate	1	
			Total	**10**

Substance E

Procedure	Assessment Criteria	Description	Mark	Maximum Marks
1	(iv)	A white	1	2
		crystalline solid	1	
2	(iv)	An intense orange/yellow flame	1	1
3 (a)		No immediate effervescence	1	1
(b)	(iii)	Effervescence/gas evolved on warming	1	1
(c)		Sharp/pungent/choking smell	1	1
(d) (i)	(ii)	U.I. turned orange/red	1	3
(ii)		Paper turns from purple	1	
		to brown or colourless	1	
			Total	**9**

Up to 19 observations – scale to 6

0–1	2–3	4–6	7–9	10–11	12–14	15–19
0	1	2	3	4	5	6

Skill 2 – Application of Assessment Criteria

Assessment Criteria	Description	Mark	Maximum Marks
(i) Use of apparatus	Fully competent	2	2
	Fairly good	1	
	Incompetent	0	
(ii), (iii), (iv) Making observations	Observations as above scaled to 6	6	6
(v) Record of observations	Immediate record, clear and neat	2	2
	Untidy, disorganised or difficult to read	1	
	Illegible	0	
		Total	**10**

Mark Scheme – Experiment 3

Skill 4 Concluding and Communicating (Qualitative) – Substance D

Procedure	Assessment Criteria (i) and (ii)	Mark	Maximum Marks
1	A transition metal (1) salt	1	2
	Could be iron(II), copper(II), nickel(II), any two	1	
2	Crystals contain water of crystallisation	1	1
3	Suggests a copper(II) salt/Cu^{2+}	1	1
4	Blue solution – suggests copper(II)/Cu^{2+}	1	1
(a)	Consistent with copper(II)/Cu^{2+}	1	1
(b)	Suggests chloride	1	1
Conclusion	Substance D is hydrated	1	3
	Copper(II)	1	
	-chloride	1	
		Total	**10**

Substance E

Procedure	Assessment Criteria (i) and (ii)	Mark	Maximum Marks
1	Not a transition metal salt	1	2
	could be a group I or II metal salt (or other valid suggestion)	1	
2	A sodium salt	1	1
3 (a)	Not a carbonate or	1	2
	hydrogencarbonate	1	
(b) and (c)	Any appropriate suggestion, eg acidic gas	1	1
(d) (i)	Acidic gas	1	3
	eg sulphur dioxide or	1	
	hydrogen chloride (up to two)	1	
(ii)	Sulphur dioxide	1	2
	from a sulphite	1	
Conclusion	Substance E is sodium	1	2
	sulphite	1	
		Total	**13**

Up to 23 deductions – scaled to 4

0–2	3–7	8–12	13–17	18–23
0	1	2	3	4

Experiment 3

Skill 4 – Application of Assessment Criteria

Assessment Criteria	Description	Mark	Maximum Marks
(i) and (ii)	Interpretations, conclusions and explanations as above – scaled to 4	4	4
(iii)	A concise written report justifying conclusions	1	2
	Any one uncertainty regarding conclusions	1	
(iv)	Any two **appropriate** additional tests	2	2
	Any one **appropriate** additional test	1	
	No appropriate additional tests	0	
(v)	Clear concise presentation	1	2
	Appropriate use of chemical terminology including any correct equations/formulae	1	
		Total	**10**

Notes for Teachers

Substances D and E

Skill 4

D is Copper(II) Chloride – 2 – water/$CuCl_2.2H_2O$

E is Sodium Sulphite, Na_2SO_3

1 For Cu^{2+} use dilute ammonia → ammine complex.

2 For Cl^- use dilute ammonia on AgCl precipitate.

3 For SO_2 use acidified potassium dichromate solution.

4 For SO_3^{2-} use Barium chloride solution followed by dilute hydrochloric acid.

Mark Scheme – Experiment 4

Skill 2: Manipulation, Observing and Recording – Substance X

Procedure	Assessment Criteria	Description	Mark	Maximum Marks
1	(iv)	White	1	2
		crystalline solid	1	
2	(iv)	Melts	1	7
		produces vapour/steam	1	
	(iii) (iv)	Charring smell	1	
	(iii)	Vapour turns cobalt chloride paper pink	1	
	(ii)	Darkens/forms yellow brown liquid	1	
	(iv)	Solidifies	1	
		to a brown glassy solid	1	
3	(iv)	A colourless solution	1	1
4	(ii)	U.I. paper red	1	1
5	(iii)	Immediate effervescence/colourless gas	1	2
	(iii)	Turns limewater milky/cloudy	1	
6	(ii)	Purple colour disappears/decolourised	1	4
		brown colouration at first	1	
		then turns colourless	1	
	(iii)	A few bubbles of gas	1	
7	(iv)	A sweet	1	2
		smelling compound formed	1	
			Total	**19**

Up to 19 observations – scale to 6

0–1	2–3	4–6	7–9	10–11	12–14	15–19
0	1	2	3	4	5	6

Skill 2: Application of Assessment Criteria

Assessment Criteria	Description	Mark	Maximum Marks
(i) Use of apparatus	Fully competent	2	2
	Fairly good	1	
	Incompetent	0	
(ii), (iii), (iv) Making observations	Observations as above scaled to 6	6	6
(v) Record of observations	Immediate record, clear and neat	2	2
	Untidy, disorganised or difficult to read	1	
	Illegible	0	
		Total	**10**

Mark Scheme – Experiment 4

Skill 4: Concluding and Communicating (Qualitative) – Substance X

Procedure	Assessment Criteria (i) and (ii)	Mark	Maximum Marks
2	Contains water of crystallisation	1	1
	or decomposes giving off water		
3	Ionic	1	2
	able to form hydrogen bonds with water	1	
4	About pH 2/acidic	1	2
	Contains carboxylic acid group (–COOH)	1	
5	Carbon dioxide gas produced	1	2
	A carboxylic acid	1	
6	A group present which can be oxidised	1	3
	eg –OH	1	
	or –CHO	1	
7	An ester produced	1	2
	–COOH present	1	
		Total	**12**

Conclusion: Functional groups are –COOH and –OH (or –CHO)
(Two marks available **if not already awarded**)
Up to 12 deductions – scaled to 4

0–1	2–3	4–6	7–8	9–12
0	1	2	3	4

Skill 4: Application of Assessment Criteria

Assessment Criteria	Description	Mark	Maximum Marks
(i) and (ii)	Interpretations, conclusions and explanations as above – scaled to 4	4	4
(iii)	A concise written report justifying conclusions	1	2
	Any one uncertainty regarding conclusions	1	
(iv)	Any two **appropriate** additional tests	2	2
	Any one **appropriate** additional test	1	
	No appropriate additional tests	0	
(v)	Clear concise presentation	1	2
	Appropriate use of chemical terminology including any correct equations/formulae	1	
		Total	**10**

Notes for teachers

Substance X (Citric acid/2-hydroxypropane – 1, 2, 3 – tricarboxylic acid – 1– water)

Skill 4 – Possible additional tests

1 Any further test for water, eg with anhydrous copper(II) sulphate.

2 Eliminating a phenol using iron(III) chloride solution.

3 Warming with potassium dichromate solution, ie oxidizing –OH groups.

4 Use of 2, 4-dinitrophenylhydrazine to eliminate a –CHO group.

Mark Scheme – Experiment 5: Organic test tube reactions

Skill 2: Manipulation, Observing and Recording – Substance Y

Procedure	Assessment Criteria	Observations	Mark	Maximum Marks
1	(iv)	White	1	2
		crystalline solid	1	
2	(iv)	A colourless solution formed	1	1
3		Universal Indicator paper turns red	1	1
4	(iii)	Effervescence	1	2
		colourless gas evolved	1	
6	(ii)	White	1	4
		precipitate formed	1	
		Dissolves in dilute ammonia	1	
		to give a colourless solution	1	
			Total	**10**

Substance Z

Procedure	Assessment Criteria	Observations	Mark	Maximum Marks
1	(iv)	Burns with a sooty flame	1	1
2		Colourless solution formed	1	1
3		Turns blue litmus red	1	1
4	(ii)	Bromine water turned from orange/yellow	1	2
		to colourless (or decolourised)	1	
5	(iv)	A sweet smell detected.	2	2
			Total	**7**

Up to 17 observations – scale to 6

0–1	2–3	4–6	7–8	9–11	12–13	14–17
0	1	2	3	4	5	6

Skill 2: Application of Assessment Criteria

Assessment Criteria	Description	Mark	Maximum Marks
(i) Use of apparatus	Fully competent	2	2
	Fairly good	1	
	Incompetent	0	
(ii), (iii), (iv) Making observations	Observations as above scaled to 6	6	6
(v) Record of observations	Immediate record, clear and neat	2	2
	Untidy, disorganised or difficult to read	1	
	Illegible	0	
		Total	**10**

Skill 4: Concluding and Communicating (Qualitative) – Substance Y

Procedure	Assessment Criteria (i) and (ii)	Mark	Maximum Marks
1	–		
2	Ionic/polar	1	2
	and can form hydrogen bonds with water	1	
3	Acidic compound	1	1
4	Carboxylic acid group	1	2
	reacts with carbonate to give carbon dioxide	1	
5	–		
6	Hydrolysis	1	3
	to produce halide/chloride ions	1	
	confirms chloride	1	
Conclusion	Functional groups are –COOH	1	2
	and –Cl	1	
		Total	**10**

Substance Z – Skill 4

Procedure	Assessment Criteria (i) and (ii)	Mark	Maximum Marks
1	High C content or aromatic	1	1
2	Ionic/polar	1	2
	and can form hydrogen bonds with water	1	
3	Acidic compound	1	1
4	Unsaturated or C=C bond present	1	1
5	Ester formed	1	2
	Z is an acid	1	
Conclusion	Functional groups are –COOH	1	2
	and –C=C–	1	
		Total	**9**

Up to 19 deductions – scaled to 4

0–2	3–7	8–11	12–16	17–19
0	1	2	3	4

Skill 4: Application of Assessment Criteria

Assessment Criteria	Description	Mark	Maximum Marks
(i) and (ii)	Interpretations, conclusions and explanations as above – scaled to 4	4	4
(iii)	A concise written report justifying conclusions	1	2
	Any one uncertainty regarding conclusions	1	
(iv)	Any two **appropriate** additional tests	2	2
	Any one **appropriate** additional test	1	
	No appropriate additional tests	0	
(v)	Clear concise presentation	1	2
	Appropriate use of chemical terminology including any correct equations/formulae	1	
		Total	**10**

Notes for Teachers

Substances Y and Z

Skill 4 – Possible additional tests

1 For $CO_2(g)$, with lime water.

2 Leave AgCl in sunlight.

3 Test Z with sodium carbonate solution.

4 Test a solution of Z with potassium manganate(VII) solution etc.

Y is chloroethanoic acid $CH_2ClCOOH$

Z is 3-phenyl-2-propenoic acid (cinnamic acid) $C_6H_5CH=CHCO_2H$

Mark Scheme – Experiment 6: Identification of Organic Compounds

Skill 2: Manipulation, Observing and Recording

NB: Letters (a) to (e) refer to the organic liquids

Procedure	Assessment Criteria	Observations	Mark	Maximum Marks
1	(iv)	(a) Sweet smell/pear drops	1	3
		(c) Pleasant/alcohol like	1	
		(e) Sharp/acrid/like vinegar	1	
2	(iv)	(a) Two layers form/immiscible	1	2
		(b)–(e) Soluble/solution formed/miscible	1	
3	(ii)	(a) **Not** tested.		6
		(b) Orange	1	
		precipitate	1	
		(c) No precipitate	1	
		(d) Orange	1	
		precipitate	1	
		(e) No precipitate	1	
4	(ii)	Only (b) and (d) tested. (b) Solution remains blue/no change	1	3
		(d) Red-red/brown	1	
		precipitate formed	1	
5 (i)	(iv)	Both samples, ie of (c) and (e) give a vigorous, exothermic reaction	2	6
	(iii)	Fuming gas,	1	
		hissing sound	1	
(ii)		White	1	
		solid/smoke formed	1	
6 (i)	(iii)	(c) No effervescence/gas	1	
		(e) Immediate effervescence/gas produced	1	3
(ii)		Gas extinguishes the splint.	1	
			Total	**23**

Up to 23 observations – scale to 6

0–1	2–4	5–8	9–11	12–14	15–18	19–23
0	1	2	3	4	5	6

Experiment 6

Skill 2: Application of Assessment Criteria

Assessment Criteria	Description	Mark	Maximum Marks
(i) Use of apparatus	Fully competent	2	2
	Fairly good	1	
	Incompetent	0	
(ii), (iii), (iv) Making observations	Observations as above scaled to 6	6	6
(v) Record of observations	Immediate record, clear and neat	2	2
	Untidy, disorganised or difficult to read	1	
	Illegible	0	
		Total	**10**

Mark Scheme – Experiment 6: Identification of organic compounds

Skill 4: Concluding and Communicating (Qualitative)

NB: Letters (a) to (e) refer to the organic liquids

Procedure	Assessment Criteria (i) and (ii)	Mark	Maximum Marks
1	(a) An ester/pentyl ethanoate	1	3
	(c) Ethanol	1	
	(e) Ethanoic acid	1	
2	(a) Is the ester/pentyl ethanoate	1	2
	All the others soluble in water	1	
3	(b) and (d) are either ethanal	1	2
	or propanone	1	
4	(b) is propanone	1	2
	(d) is ethanal	1	
5 (i)	Both	1	3
	compounds contain an –OH group	1	
(ii)	Gas is hydrogen chloride	1	
6 (i)	(c) is the alcohol/ethanol	1	4
	(e) is the carboxylic acid/ethanoic acid	1	
	as carbon dioxide released from the carbonate	1	
(ii)	Consistent with carbon dioxide gas	1	
Conclusions	Correct list	2	2
	Two incorrect	1	
	More than two incorrect	0	
		Total	**18**

Up to 18 deductions/conclusions – scaled to 4

0–1	2–5	6–10	11–13	14–18
0	1	2	3	4

Experiment 6

Skill 4

Assessment Criteria	Description	Mark	Maximum Marks
(i) and (ii)	Interpretations, conclusions and explanations as above – scaled to 4	4	4
(iii)	A concise written report justifying conclusions	1	2
	Any one uncertainty regarding conclusions	1	
(iv)	Any two **appropriate** additional tests	2	2
	Any one **appropriate** additional test	1	
	No appropriate additional tests	0	
(v)	Clear concise presentation	1	2
	Appropriate use of chemical terminology including any correct equations/formulae	1	
		Total	**10**

Notes for Teachers

Skill 4: Concluding and Communication (Qualitative)

1 The organic liquids should be labelled in the order shown below to fit in with the mark scheme.

(a) Pentyl ethanoate

(b) Propanone

(c) Ethanol

(d) Ethanal

(e) Ethanoic acid.

2 Possible additional tests.

(a) Tollens reagent to distinguish aldehyde from ketone.

(b) Acidified potassium dichromate solution to distinguish alcohol from acid.

(c) Lime water to detect CO_2.