Assessment Support Pack

Fundamental Chemistry: An Introduction — HT6V 46

SCQF level 6

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www.sqa.org.uk

Introduction

This assessment support pack has been developed primarily for the purpose of the summative assessment of learners against the requirements of the unit. It must not be used for formative assessment.

The pack may also be used:

- to help centres develop an appropriate assessment for the unit
- as exemplification of the standard of performance expected of learners achieving the unit, ie as a benchmark
- to give teachers/lecturers/assessors new ideas
- as a staff development tool

Note: if this pack is used for any of the above, the security and confidentiality of the pack must still be maintained as outlined below.

Security and confidentiality

As the primary purpose of this pack is the summative assessment of learners against national standards in SQA approved centres, it must not be released prior to examination/practical test or distributed more widely for any other purpose.

If being used for any of the four bulleted purposes above, the security and confidentiality of the pack must be maintained.

Assessment support packs are made available only to SQA approved centres and are downloaded from SQA's secure website by authorised personnel. For added security, SQA does not permit the downloading of this pack for the maintenance of paper-based libraries, stockpiling ahead of assessment events or saving to portable storage devices and laptop computers.

The assessment and marking information in this publication can be used or adapted by staff in approved SQA centres subject to the guidelines above. Adapted materials must be verified prior to use and stored securely within the presenting centre.

In addition to a centre's own security procedures, any suspected breach of the above must be reported immediately to SQA's Quality Assurance department within SQA Operations marked 'Security breach — Support Materials'.

Copyright

General information

Before using this assessment support pack centres should read the relevant unit specification which details the standard of performance expected of learners. It is important to ensure that this assessment support pack is used in a context appropriate to the unit and, if applicable, the associated group award. A copy of the unit specification can be found on SQA's website **www.sqa.org.uk**.

This assessment support pack supplements the section *Guidance on approaches to assessment of this unit* found in the unit specification's support notes. It provides an example of assessment that is valid, reliable and practicable. The assessment tasks correspond to the guidance contained in the unit specification. Centres must ensure the integrity and confidentiality of the assessment.

Although the content of this assessment support pack has been verified as a suitable assessment, centres should note that using it does not automatically guarantee successful external verification. It is the centre's responsibility to make sure that all the appropriate internal quality assurance procedures are satisfactorily followed. A valid and effective internal verification system should be in place.

Guidance on content and context for this qualification

This assessment support pack supports the assessment of the unit Fundamental Chemistry: An Introduction at SCQF level 6. Centres are required to develop the assessment in accordance with the validated unit specification.

This pack is intended for use within the National Progression Award in Scientific Technologies. The materials within this pack provide one assessment which provides a holistic assessment for outcome 1.

This pack also contains suggestions of suitable practical experiments for the assessment of outcome 2, and checklists for recording of learner performance. For further guidance on, and exemplars of, learner laboratory reports and pro formas centres are referred to the *Understanding Standards in HN Science* document.

Opportunities for developing Core and other essential skills

There may be opportunities to gather evidence towards Core Skills in *Numeracy, Problem Solving* at SCQF level 5 and *Information and Communication Technology (ICT)* at SCQF level 4.

Related publications

Before using this assessment support pack centres might find it useful to look at some of our other publications, in particular:

- Guide to Assessment
- Introduction to Assessment Arrangements
- SQA's Quality Framework: a guide for centres

Details of these and other SQA publications are available on our website. Most publications can be downloaded free of charge from our website at **www.sqa.org.uk** on the 'Publications, Sales and Downloads' section. If you require a publication to be sent to you, please telephone our Business Development and Customer Support team on 0303 333 0330 quoting the product code and, where a charge is applicable, have a purchase order number or credit card details available.

Section 1 — How to generate assessment evidence

The Scottish Qualifications Authority's system of assessment measures the evidence of a learner's attainment of knowledge, understanding and skills against a defined criterion. Assessment must allow the learner to demonstrate competence at the level of the qualification and provide an opportunity for evidence of each learner's performance to be generated and assessed. This evidence must then be judged against the standards set out in the unit specification. To achieve a unit, learners must generate the evidence required in relation to all outcomes and performance criteria. This information is found in the statement of standards in the relevant unit specification.

This assessment support pack is consistent with the statement of standards for the unit Fundamental Chemistry: An Introduction at SCQF level 6 and the following information applies when using it to generate evidence of learner achievement.

Assessment

Examples of suggested evidence to be retained will always include the assessment, marking information and learner assessment records or class assessment records, as appropriate.

Assessment	Outcome covered	Evidence to be retained
Written and/or oral evidence	**1** Describe and use the basic chemical principles associated with atomic structure, chemical formulae, acids and bases, the periodic table, and organic chemistry.	Assessment Marking information Learner assessment records (learner scripts)
Laboratory practicals	**2** Perform practical experiments related to fundamental chemistry.	Assessment Marking information Laboratory reports/pro formas/laboratory diaries Assessor observation checklist

Conditions of assessment

Outcome 1

The assessment should be unseen by the learner before the assessment event, and should be closed-book and completed under supervised conditions. Learners can only have access to the *SQA Data Booklet for Higher and Advanced Higher Chemistry* or any suitable replacement when sitting the assessment.

The assessment is to be of 90 minutes duration and should be attempted on one single occasion following delivery of outcome 1. The pass mark for the assessment is 60%. This pass mark is to be applied on a holistic basis, ie it is not necessary for learners to achieve a pass mark for each individual evidence requirement.

Outcome 2

Assessed practical experiments for outcome 2 will be monitored by an assessor who will complete observation checklists. It is envisaged that practical experiments will usually be performed individually. However, there may be some activities that are suitable to be undertaken in pairs or small groups. If this is the case then the assessor should ensure that all learners are actively involved and are able to adequately demonstrate the required skills.

Learners must report one of the three practical experiments by production of a full laboratory report. Learners may report the remaining two practical experiments by production of a full laboratory report, completion of an appropriate pro forma or a laboratory diary. Where a pro forma approach is deployed, the pro forma will not present information or assistance to the learners on how to correctly perform calculations, analyse experimental results or experimental errors. Learners will be expected to perform such activities independently on the basis of the experimental data.

For further guidance on, and exemplars of, learner laboratory reports and pro formas centres are referred to the *Understanding Standards in HN Science* document.

Quality assurance

Centres should retain assessment evidence and internal verification records. Units are subject to external verification by SQA.

Re-assessment

Time is allowed within units for assessment and re-assessment of outcomes. Where learners have not attained the standard necessary to achieve a particular outcome or outcomes, they should have the opportunity to be re-assessed. SQA's advice is that there should normally be one unit re-assessment opportunity, or in exceptional circumstances two. In some cases, learners may be required to resubmit original work which has been revised to take account of earlier weaknesses. In other cases, learners may be required to undertake a new assessment designed to assess the particular outcome(s) in which they were unsuccessful. In all cases, evidence from the original assessment should be used for formative purposes prior to re-assessment.

Opportunities for e-assessment

For all modes of delivery, assessment conditions and quality assurance arrangements must ensure that the same standard is applied for all learners.

E-assessment may be appropriate for some assessments in this unit.
By e-assessment we mean assessment which is supported by Information and Communication Technology (ICT), such as e-testing or the use of e-portfolios or social software. Centres which wish to use e-assessment must ensure that the national standard is applied to all learner evidence and that conditions of assessment as specified in the evidence requirements are met, regardless of the mode of gathering evidence. The most up-to-date guidance on the use of e-assessment to support SQA's qualifications is available at **www.sqa.org.uk/e-assessment**.

Equality and inclusion

The unit specification has been designed to ensure that there are no unnecessary barriers to learning or assessment. The individual needs of learners should be taken into account when planning learning experiences, selecting assessment methods or considering alternative evidence. Further advice can be found on our website **http://www.sqa.org.uk/assessmentarrangements**.

Section 2 — Assessment

The assessment example below can be used by centres, or alternatively centres can develop their own assessment.

The matrix provided illustrates which evidence requirements are covered by each question of the assessment.

Outcome 1 — Evidence Requirements	Questions	Marks available
♦ Describe the structure of an atom, identify types of bonding in common compounds, determine the chemical formula of compounds which contain up to three elements.	Q1, 2, 3, 4(a)	19
♦ Write and balance chemical equations derived from written descriptions.	Q7	4
♦ Explain the general trends in the periodic table.	Q4(c)	1
♦ Explain the properties of the groups in the periodic table.	Q4(b), 4(d)	3
♦ Carry out calculations involving the relationship between the number of moles and quantity of a compound.	Q5, 8	5
♦ Calculate volumes, concentrations of solutions.	Q6	2
♦ Explain the basic concepts of acidity and alkalinity.	Q9	6
♦ Identify organic functional groups and describe their main reaction types.	Q10(a), 10(d), 10(e), 11, 12, 13(a)	17
♦ Explain the concepts of isomers and homologous series.	Q10(b), 10(c), 13(b)	3

Assessment 1

Outcome covered 1

Assessment instructions

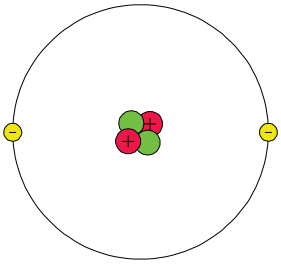
The assessment must be sat closed-book under supervised conditions. The duration of the assessment is 90 minutes and the pass mark is 60%. Learners should have access to the *SQA Data Booklet for Higher and Advanced Higher Chemistry* or any suitable replacement when sitting the assessment.

Questions **Marks**

You should have access to the *SQA Data Booklet for Higher and Advanced Higher Chemistry* or any suitable replacement while sitting this assessment, and should make reference to this as required.

1 The following diagram is a representation of an isotope of helium.

(a) Identify each of the particles within the atom. **3**



(b) State the atomic mass of this atom. **1**

2 Two atoms are described in nuclide notation below:

$$^{239}_{93}\mathrm{A} \quad ^{239}_{94}\mathrm{B}$$

(a) State how many protons element A contains. **1**

(b) State how many neutrons are present in element B. **1**

(c) Giving a reason for your answer, state whether atoms A and B are of the same element. **2**

Marks

3 A sample of bromine is found to contain two types of bromine atom, ^{79}Br and ^{81}Br.

(a) State how the two types of bromine differ. **1**

(b) State what term describes these different types of atoms. **1**

(c) Use your data booklet to find the relative atomic mass of bromine. From this information, state what can be deduced about the proportions of each type of bromine atom present in the sample. **1**

4 Different substances, elements and compounds, can have different bonding and structures.

(a) Complete the table below by stating the type of bonding present in each substance and providing a description of each structure. **8**

Substance	Bonding	Description of Structure
Sodium chloride		
Sodium		
Chlorine		
Diamond		

(b) The size of different atoms varies. State what trend in atomic size is evident moving from top to bottom in the alkali metals. **1**

(c) Atoms become smaller moving from left to right across a period. Explain why this happens. **1**

(d) Explain why it requires so much energy to remove the 4th electron from an aluminium atom compared to that required to remove the 1st, 2nd and 3rd electrons. **2**

5 Calculate the mass, in grams, of 1.8 moles of sodium fluoride (NaF). **2**

Marks

6 Calculate the molarity of a solution containing 98g of sodium hydroxide (NaOH) in 2.2 litres of water. **2**

7 Write balanced chemical equations for the following reactions.

(a) The combustion of pentane. **2**

(b) The reaction of sulphuric acid with lithium. **2**

8 Showing all working, calculate the mass of ammonia produced from reacting 70 kg of nitrogen with excess hydrogen.

The equation for the reaction is shown below:

$N_2 + 3H_2 \rightarrow 2NH_3$ **3**

9 (a) Explain why a 0.1 mol l^{-1} solution of hydrochloric acid solution has a lower pH than a 0.1 mol l^{-1} solution of ethanoic acid solution. **2**

(b) A solution of sodium hydroxide has a concentration of 0.1 mol l^{-1}. Calculate the pH of this solution. **2**

(c) A student carried out a titration reaction to determine the unknown concentration of a sulphuric acid solution. It was found that 17.80 cm^3 of 0.25 M sodium hydroxide was required to neutralise 20.00 cm^3 of the acid. Use this information to calculate the unknown concentration. Show all your working.

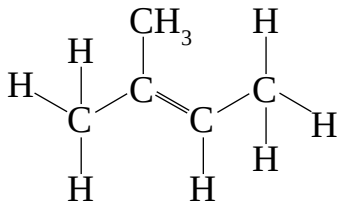
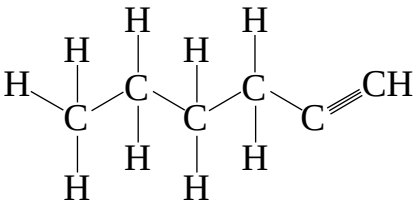
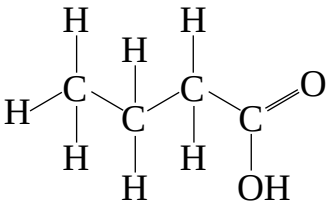
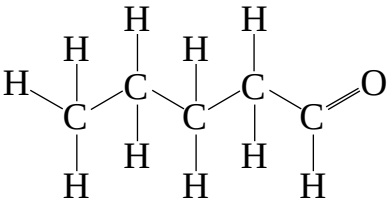
The reaction equation is shown below:

$H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$ **2**

Marks

10 The following table contains the systematic names and structures of selected molecules.

(a) Complete the table below by adding the missing molecule names and structures. **6**

Molecule	Name of molecule	Structure
A		
B	Hex – 1 – yne	
C		
D	Pent – 2 – ene	
E	Pentanal	
F	Propan – 2 – ol	

Marks

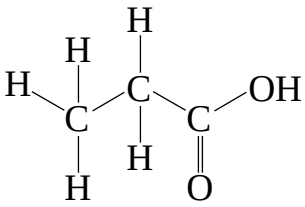
(b) Give the general formula for the homologous series that molecule B belongs to. **1**

(c) State which molecule is an isomer of molecule A. **1**

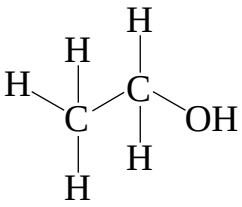
(d) Molecule A undergoes an addition reaction when reacted with bromine water. The bromine water readily decolourises. State which other molecule(s), from the table, will undergo addition reactions with bromine water. **1**

(e) Name the compound formed when molecule E is reacted with sodium borohydride. **1**

11 When an alkanoic acid and an alcohol are heated together in the presence of concentrated sulphuric acid an esterification reaction will occur. An example of both of these compounds is given below:



Propanoic Acid



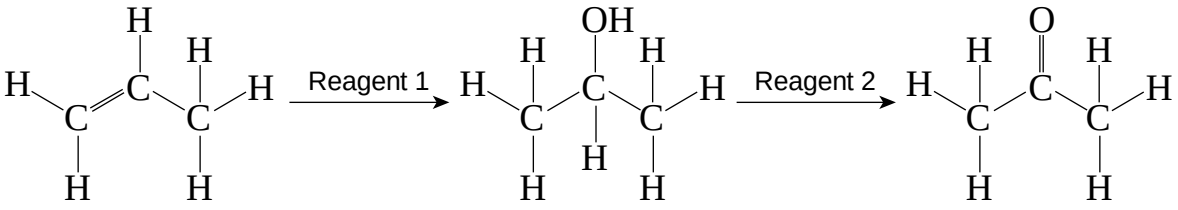
Ethanol

(a) Draw the ester that is formed when propanoic acid is reacted with ethanol. **1**

(b) Name the other product of the reaction. **1**

(c) State one use of esters. **1**

12 Propanone is a widely used solvent which can be synthesised from propene in a two-step process, shown in the equation below.



Identify reagents 1 and 2. **2**

Marks

13 An alcohol, X, on mild oxidation, gives a compound Y of molecular mass 58. Compound Y cannot be oxidised further.

(a) Draw structural formulae for X and Y. **4**

(b) State whether X is a primary, secondary or tertiary alcohol. **1**

Total marks available: 60
Pass mark: 36

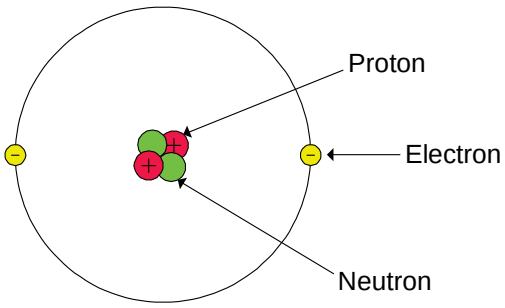
Guidance for making an assessment decision

Assessment 1

Questions **Marks**

1 The following diagram is a representation of an isotope of helium.

(a) Identify each of the particles within the atom. **3**



1 mark for each correctly named particle.

(b) State the atomic mass of this atom. **1**

4 amu. (No units necessary)

2 Two atoms are described in nuclide notation below:

$$^{239}_{93}\mathrm{A} \quad ^{239}_{94}\mathrm{B}$$

(a) State how many protons element A contains. **1**

93

(b) State how many neutrons are present in element B. **1**

145

(c) Giving a reason for your answer, state whether atoms A and B are of the same element. **2**

No **(1 mark)**, they have different atomic numbers so must be different elements (or similar answer) **(1 mark)**.

Marks

3 A sample of bromine is found to contain two types of bromine atom, ^{79}Br and ^{81}Br.

(a) State how the two types of bromine differ. **1**

They have different masses or they have different numbers of neutrons (or similar answer).

(b) State what term describes these different types of atoms. **1**

Isotopes

(c) Use your data booklet to find the relative atomic mass of bromine. From this information, state what can be deduced about the proportions of each type of bromine atom present in the sample. **1**

Relative atomic mass of bromine is 79.9 so there must be more ^{79}Br present in sample (or similar answer).

4 Different substances, elements and compounds, can have different bonding and structures.

(a) Complete the table below by stating the type of bonding present in each substance and providing a description of each structure. **8**

Substance	Bonding	Description of Structure
Sodium chloride	Ionic **(1 mark)**	Crystal lattice of alternating sodium and chloride ions **(1 mark)**
Sodium	Metallic **(1 mark)**	Array of sodium ions in 'sea' of mobile electrons **(1 mark)**
Chlorine	(Pure) Covalent **(1 mark)**	Discrete (diatomic) molecules **(1 mark)**
Diamond	(Pure) Covalent **(1 mark)**	Giant covalent network **(1 mark)**

Marks

(b) The size of different atoms varies. State what trend in atomic size is evident moving from top to bottom in the alkali metals. **1**

Size increases

(c) Atoms become smaller moving from left to right across a period. Explain why this happens. **1**

Increased nuclear charge

(d) Explain why it requires so much energy to remove the 4th electron from an aluminium atom compared to that required to remove the 1st, 2nd and 3rd electrons. **2**

1st, 2nd and 3rd electrons are in different energy level than 4th **(1 mark)**. 4th is closer to nucleus and attraction is much higher **(1 mark)**.

5 Calculate the mass, in grams, of 1.8 moles of sodium fluoride (NaF). **2**

Formula mass = 23 + 19 = 42 **(1 mark)**

Mass = mole x f.mass = 1.8 x 42 = 75.6 g **(1 mark)**

6 Calculate the molarity of a solution containing 98g of sodium hydroxide (NaOH) in 2.2 litres of water. **2**

Formula mass = 23 + 16 + 1 = 40

Moles = mass/ f. mass = 98/40 = 2.45 **(1 mark)**

Concentration = mole / volume = 2.45/2.2 = 1.11 mol l^{-1} **(1 mark)**

7 Write balanced chemical equations for the following reactions:

(a) The combustion of pentane **2**

$C_5H_{12} + 8O_2 \rightarrow 5CO_2 + 6H_2O$

1 mark for correct formulae, **1 mark** for balance.
Award 1 mark if incorrect formula for pentane is used but equation is balanced correctly.

Marks

(b) The reaction of sulphuric acid with lithium **2**

$H_2SO_4 + 2Li \rightarrow Li_2SO_4 + H_2$

1 mark for correct formulae, **1 mark** for balance.
Award 1 mark if wrong formulae are used but equation is balanced correctly.

8 Showing all working, calculate the mass of ammonia produced from reacting 70 kg of nitrogen with excess hydrogen.

The equation for the reaction is shown below:

$N_2 + 3H_2 \rightarrow 2NH_3$ **3**

Calculate moles of nitrogen = 70/28 = 2.5 moles **(1 mark)**

Calculate moles of ammonia (mole ratio) = 2 x 2.5 = 5 moles **(1 mark)**

Calculate mass = 5 x 17 = 85 kg **(1 mark)**

9 (a) Explain why a 0.1 mol l^{-1} solution of hydrochloric acid solution has a lower pH than a 0.1 mol l^{-1} solution of ethanoic acid solution. **2**

Hydrochloric acid is a strong acid so fully dissociates in solution giving 0.1 mol l^{-1} of H^+ ions **(1 mark)**.
Ethanoic acid is a weak acid so partially dissociates in solution giving less than 0.1 mol l^{-1} of H^+ ions **(1 mark)**.

(b) A solution of sodium hydroxide has a concentration of 0.1 mol l^{-1}. Calculate the pH of this solution. **2**

pOH = - log [$^-$OH] = - log 0.1 = 1 **(1 mark)**

pH = 14 – 1 = 13 **(1 mark)**

Marks

(c) A student carried out a titration reaction to determine the unknown concentration of a sulphuric acid solution. It was found that 17.80 cm^3 of 0.25 M sodium hydroxide was required to neutralise 20.00 cm^3 of the acid. Use this information to calculate the unknown concentration. Show all your working.

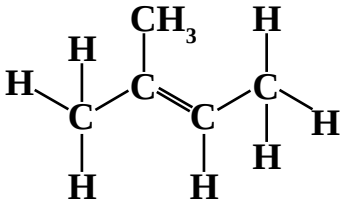
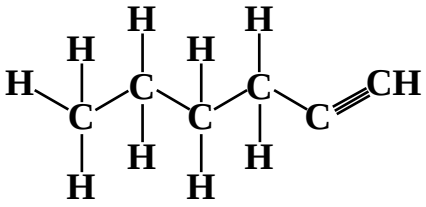
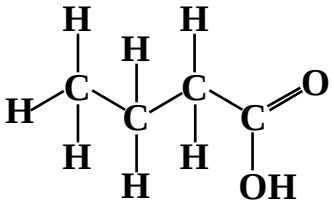
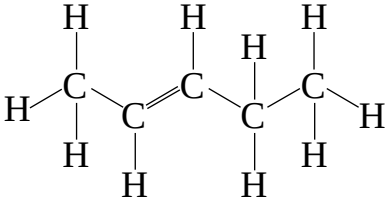
The reaction equation is shown below:

H_2SO_4 + 2NaOH → Na_2SO_4 + $2H_2O$ **2**

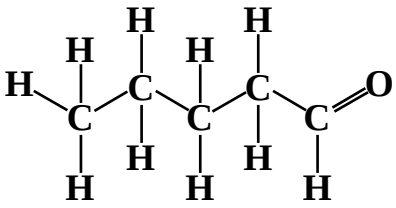
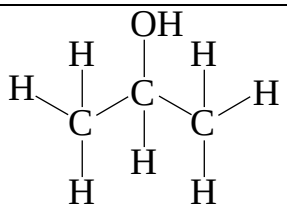
$N_1M_1V_1 = N_2M_2V_2$
$2 \times M_1 \times 20 = 1 \times 0.25 \times 17.8$ **(1 mark)**
$M_1 = 4.45/40 = 0.11$ mol l^{-1} **(1 mark)**

10 The following table contains the systematic names and structures of selected molecules.

(a) Complete the table below by adding the missing molecule names and structures. **6**

Molecule	Name of molecule	Structure
A	2 – methyl but – 2 – ene **(1 mark)**	
B	**Hex – 1 – yne**	
C	Butanoic Acid **(1 mark)**	
D	**Pent – 2 – ene**	 **(2 marks)**

Marks

Molecule	Name of molecule	Structure
E	**Pentanal**	
F	**Propan – 2 – ol**	 **(2 marks)**

Award 1 mark for a structure containing only a minor error (eg missing hydrogen).

(b) Give the general formula for the homologous series that molecule B belongs to. **1**

C_nH_{2n-2}

(c) State which molecule is an isomer of molecule A. **1**

D

(d) Molecule A undergoes an addition reaction when reacted with bromine water. The bromine water readily decolourises. State which other molecule(s), from the table, will undergo addition reactions with bromine water. **1**

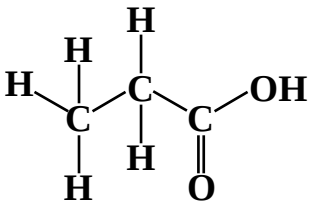
B and D (both required)

(e) Name the compound formed when molecule E is reacted with sodium borohydride. **1**

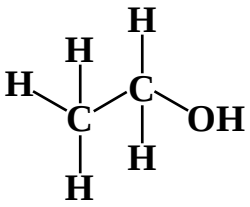
Pentan- 1- ol (numbering required)

Marks

11 When an alkanoic acid and an alcohol are heated together in the presence of concentrated sulphuric acid an esterification reaction will occur. An example of both of these compounds is given below:

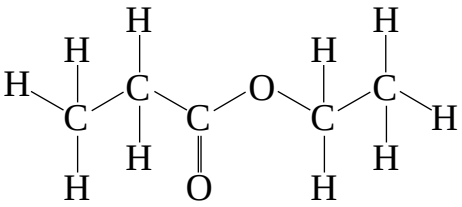


Propanoic Acid



Ethanol

(a) Draw the ester that is formed when propanoic acid is reacted with ethanol. **1**



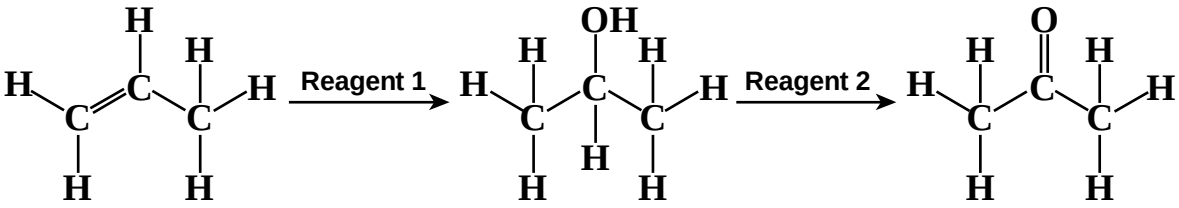
(b) Name the other product of the reaction. **1**

Water

(c) State one use of esters. **1**

Any suitable use, including as a solvent in paints and varnishes or used as fragrances, flavourings or cosmetics.

12 Propanone is a widely used solvent which can be synthesised from propene in a two-step process, shown in the equation below:



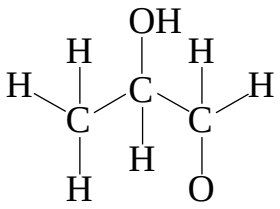
Identify reagents 1 and 2. **2**

Reagent 1 — H_2O **(1 mark)**
Reagent 2 — Any appropriate oxidising agent. For example, acidified potassium dichromate **(1 mark)**

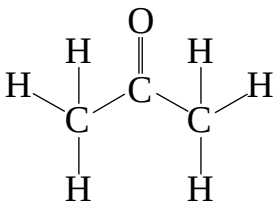
Marks

13 An alcohol, X, on mild oxidation, gives a compound Y of molecular mass 58. Compound Y cannot be oxidised further.

(a) Draw structural formulae for X and Y. **4**



X



Y

2 marks for each correct structure.
Award 1 mark for a structure containing only a minor error (eg missing hydrogen). If propan – 1 – ol is drawn, no marks can be awarded.

(b) State whether X is a primary, secondary or tertiary alcohol. **1**

Secondary

Total marks available: 60
Pass mark: 36

Assessment

Assessment 2

Outcome covered 2

Assessment instructions

Learners will be required to independently follow instructions supplied to correctly complete at least three practical experiments. A checklist will be used to record the results of the learners' practical work on three occasions.

Learners may report results by production of a full laboratory report, completion of an appropriate pro forma or a laboratory diary. At least one full laboratory report must be completed for the outcome. Where a pro forma approach is deployed, the pro forma will not present information or assistance to the learners on how to correctly perform calculations, analyse experimental results or experimental errors. Learners will be expected to perform such activities independently on the basis of the experimental data.

Further guidance on pro forma and laboratory reporting requirements, including exemplars, are available in the *Understanding Standards in HN Science* document. When referring to this document, assessors should note that for this unit learners will not be expected to provide quantification of experimental errors, or to calculate overall percentage errors. However, learners should identify and evaluate the significant experimental errors in the practical.

Learners are required to undertake three assessed practical experiments, the content of which will be related to outcome 1. Examples of suitable experiments are given below. However, this list is not prescriptive, and other practical experiments of similar complexity may be used by the centre.

Suitable practical experiments are:

- the effect of concentration on reaction rate in the iodine clock reaction
- the effect of temperature on reaction rate in the iodine clock reaction
- synthesis of 2-chlorobutane
- separation of a mixture by distillation
- acid-alkali titration

Assessed practical experiments will usually be performed individually. However, there may be some experiments that are suitable to be undertaken in pairs or small groups. If this is the case then the assessor should ensure that all learners are actively involved and are able to adequately demonstrate the required skills.

Guidance for making an assessment decision

Assessment 2

For guidance on accuracy levels required in practical experiments and on pro forma and laboratory reporting requirements, including exemplars, centres are referred to the *Understanding Standards in HN Science* document.

History of changes

Version	Description of change	Date

Acknowledgements

SQA acknowledges the valuable contribution that Scotland's educational institutes have made in the development of qualifications.

Class Unit Assessment Record

Class	HT6V 46 — Fundamental Chemistry: An Introduction		
Tutor	Outcome 1	Outcome 2	Comments
Learner's name			

Outcome 1 — Describe and use the basic chemical principles associated with atomic structure, chemical formulae, acids and bases, the periodic table, and organic chemistry.
Outcome 2 — Perform practical experiments related to fundamental chemistry.

Achieved/not achieved — (Enter A or NA in the box to indicate whether the learner has achieved or not achieved each Outcome. The comments column can be used to highlight any re-assessment that may be needed.)

Overall comments

Learner's signature _____ **Date** _____

Assessor's signature _____ **Date** _____

Internal verifier's signature _____ **Date** _____