- M1. (a) M1 AgNO₃ OR silver nitrate OR any soluble silver salt
 - **M2** remains colourless or no reaction or no (observed) change or no precipitate
 - M3 white precipitate or white solid/white suspension

An insoluble silver salt OR Tollens' OR ammoniacal silver nitrate or HCl/AgNO₃ is CE = 0 for the clip

For M1

Credit acidified (or HNO₃) silver nitrate for M1 and mark on If silver ions or incorrect formula for silver nitrate, penalise M1 but mark M2 and M3

If no reagent or incorrect reagent in M1, then no marks for M2 or M3

For M2

Ignore "nothing"

Ignore "no observation"

Ignore "clear"

Ignore "dissolves"

For M3

Ignore "cloudy solution" OR "suspension"

3

- (b) **M1** any <u>soluble</u> sulfate by name or formula e.g. sodium sulfate or sulfuric acid.
 - **M2** white precipitate or white solid/white suspension
 - M3 remains colourless or no reaction or no (observed) change or no precipitate

OR as an alternative

- M1 NaOH/KOH
- M2 remains colourless or no reaction or no (observed) change
- **M3** white precipitate or white solid/white suspension

An insoluble sulfate OR conc H_2SO_4 is CE = 0 for the clip If no reagent or incorrect reagent in M1, then no marks for M2 or M3

For the M1 soluble sulfate

If sulfate ions or incorrect formula for the chosen sulfate, penalise M1 but mark M2 and M3

For the M1 NaOH/KOH

If ammonia, then CE = 0

If hydroxide ions or incorrect formula for the chosen hydroxide, penalise M1 but mark M2 and M3

For no (observed) change in both alternatives

Ignore "nothing"

Ignore "no observation"

Ignore "clear"

Ignore "dissolves"

For the white precipitate in both alternatives

Ignore "cloudy solution" OR "suspension"

3

- (c) M1 <u>ammonia</u> (can be dilute or concentrated)
 - **M2** <u>dissolves</u> OR <u>soluble</u> OR (forms a) <u>colourless</u> solution OR goes <u>colourless</u>
 - M3 does not dissolve OR not soluble OR remains as a solid
 OR no (observed) change OR no reaction OR yellow solid remains

OR if concentrated ammonia has been used, accept yellow solid turns white.

OR as an alternative using conc sulfuric acid

M1 concentrated sulfuric acid OR c(onc) H₂SO₄

M2 misty/white fumes/gas

OR remains white

OR no change (in colour)

M3 turns <u>black</u> (solid)

OR purple fumes/gas

OR correct reference to H₂S observation (e.g. bad egg smell)

For M1

If incorrect formula or "ammonium", penalise M1 but mark

M2 and M3

If no reagent or incorrect reagent in M1, then no marks for M2 or M3

For M3

Ignore "nothing"

Ignore "no observation"

For the alternative using sulfuric acid

If dilute sulfuric acid or "aq" (alone) or the idea of concentrated not included CE = 0

If incorrect formula, penalise M1 but mark M2 and M3
If no reagent or incorrect reagent in M1, then no marks for M2 or M3

3

(d) M1 acidified potassium dichromate or K₂Cr₂O₇/H₂SO₄

OR K₂Cr₂O₇/H⁺ OR acidified K₂Cr₂O₇

- **M2** (orange to) <u>green</u> solution OR goes <u>green</u>
- **M3** (solution) remains <u>orange</u> or no reaction or no (observed) change

Alternative using KMnO₄/H₂SO₄

M1 acidified potassium manganate(VII) or KMnO₄/H₂SO₄

OR KMnO₄/H⁺ OR acidified KMnO₄

- M2 colourless solution OR goes colourless
- M3 (solution) remains <u>purple</u> or no reaction or no (observed) change

 If no reagent or incorrect reagent in M1, then no marks for

 M2 or M3

For M1

If "dichromate" or "dichromate(IV)" or incorrect formula or no acid, penalise M1 but mark M2 and M3

For M2 ignore dichromate described as "yellow" or "red"

For M3

Ignore "nothing"

Ignore "no observation"

For M1

If "manganate" or "manganate(IV)" or incorrect formula or no acid, penalise M1 but mark M2 and M3

Credit alkaline KMnO₄for possible full marks but M2 gives brown precipitate or solution goes green

M2.Add Tollens / Fehling's / Benedict's reagent / ir spectra

Accept any other chemically correct reagent and observation

Silver mirror / blue to red **OR** red precipitate (with ethanal) / peak at 1700 cm⁻¹ (in ethanal)

Must have correct test to access second mark Accept 'silver'. Do not accept 'silver solution' Give one mark for 'silver mirror test' and 'silver mirror' Accept correct answer based on n.m.r. spectra

[2]

1

1

M3. (a) (i) Hexan-1-ol1 ONLY

1

(ii) Homologous (series)

ONLY

1

(iii) <u>Displayed formula</u> for butan-2-ol

<u>All bonds</u> must be drawn out including the O–H bond Ignore bond angles

(iv) CH₃CH₂CH₂CH₂OH + [O] ← CH₃CH₂CH₂CHO + H₂O

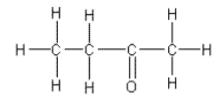
Require this whole equation as written or formulae drawn out

Penalise "sticks"

1

(v) <u>Displayed formula</u> for butanone

(credit possible enols, ethers and cyclic structures for C₄H₈O)



<u>All bonds</u> must be drawn out Ignore bond angles

1

- (b) M1 q = m c Δ T OR calculation 175 × 4.18 × 8
 - **M2** = **5852** (J) OR 5.85 (kJ) OR 5.9 (kJ) (This also scores M1)
 - **M3** 0.005 mol, therefore $\Delta H = -1170$ (kJ mol⁻¹)

OR
$$\Delta H = -1170.4$$
 (kJ mol⁻¹)

OR $\Delta H = -1200 \text{ (kJ mol}^{-1}\text{)}$

Award full marks for correct answer

In M1, do not penalise incorrect cases in the formula Ignore incorrect units in M2

Penalise M3 ONLY if correct answer but sign is incorrect OR value is in J mol⁻¹

If $m = 5 \times 10^{-3}$ OR if $\Delta T = 281$, CE and only allow one mark for correct mathematical formula for M1

If c = 4.81 (leads to 6734) penalise M2 ONLY and mark on for M3 = -1350 (-1347)

3

- (c) (i) **M1** The <u>enthalpy change</u> (or heat change at constant pressure) when <u>1 mol</u> of a compound/substance/alcohol
 - M2 is burned completely in oxygen

OR <u>burned</u> in excess oxygen

M3 with all reactants and products/all substances in standard states

OR

all reactants and products/all substances in normal states under standard conditions OR 100 kPa/1 bar and a specified T/298 K

For M3

Ignore reference to 1 atmosphere

3

(ii) M1 (could be scored by a correct mathematical expression)

M1 $\Delta H = \Sigma \Delta H_i$ (products) – $.\Sigma \Delta H_i$ (reactants)

OR a correct cycle of balanced equations

$$\mathbf{M2} = 4(-394) + 5(-286) - (-327)$$

(This also scores M1)

M3 = -2679 (kJ mol⁻¹) OR -2680 (kJ mol⁻¹)

Award 1 mark ONLY for (+) 2679 OR (+) 2680

Correct answer to calculation gains full credit Credit 1 mark if + 2679 (kJ mol⁻¹)

For other incorrect or incomplete answers, proceed as follows

- check for an arithmetic error (AE), which is either a transposition error or an incorrect multiplication; this would score 2 marks (M1 and M2)
- If no AE, check for correct method; this requires either a correct cycle with 4CO₂ and 5H₂O OR a clear statement of M1 which could be in words and scores only M1

3

(d) (i) M1 This is about the change in formula up the series

Each alcohol in the series (compared with the previous one)

increases by/has an extra CH2

OR

has one more C-C and two more C-H

M2 This is about the reaction and bond breaking/making

Combustion of each alcohol in the series breaks one

more C-C and two more C-H compared with the previous one AND forms one more mol CO₂ and one more mol H₂O

OR

A statement in which there is the idea that the <u>extra OR</u> <u>additional OR difference in number</u> of bonds <u>broken</u> <u>and formed</u> (as the series increases) <u>is the same</u> OR has the same difference in energy

N.B. If the first statement here for M2 is given, both marks score

2

(ii) For the two marks M1 and M2

heat loss or heat absorbed by the apparatus

OR

incomplete combustion/not completely burned

OR

The idea that the water may end up in the gaseous state (rather than liquid) OR reactants and/or products may not be in standard states.

2

[18]

M4. (a) to neutralise stomach acidity

OR

as an antacid

OR

eases indigestion/heartburn

Ignore milk of magnesia Credit suitable reference to indigestion/laxative/relief of constipation

1

(b) (i) an electron acceptor

OR

(readily) gains/accepts/receives electron(s)

NOT an electron pair acceptor Ignore removes/takes away/attracts electrons

1

(ii) Br₂ ONLY

Ignore "bromine"

Apply the list principle

1

(iii)
$$H_2SO_4 + 2H^+ + 2e^- \longrightarrow SO_2 + 2H_2O$$

OR

$$SO_4^{2-} + 4H^+ + 2e^- \longrightarrow SO_2 + 2H_2O$$

Ignore state symbols
Ignore absence of negative charge on electron
Or multiples of equations

1

(c) (i) (acid) catalyst

OR

catalyses (the reaction)

OR

to speed up the reaction/increase the rate (of reaction)

Ignore "provides H- ions"

Accept phonetic spelling

(ii)

- M1 must show an arrow from the double bond towards the H atom of the H O bond OR HO on a compound with molecular formula for H₂SO₄ (or accept H₂SO₃ here)
 M1 could be to an H⁺ ion and M2 an independent O H bond break on a compound with molecular formula for H₂SO₄ or H₂SO₃
- **M2** must show the breaking of the O H bond.
- M3 must show an arrow from the lone pair of electrons on the correct oxygen of the negatively charged ion towards the positively charged carbon atom.
- **M4** is for the structure of the carbocation.

NB The arrows here are double-headed

M2 Ignore partial charges unless wrong M3 NOT HSO₄-

For M3, credit <u>as shown</u> or <u>¬OSO₃H</u> ONLY with the negative charge anywhere on this ion

OR <u>correctly</u> drawn out with the negative charge placed correctly on oxygen

Max 3 marks for wrong reactant

Do not penalise the use of "sticks"

- (iii) Primary **OR** 1° (alcohol)
- (iv) <u>Displayed formula</u> for ethanoic acid, CH₃COOH

4

All the bonds must be drawn out and this includes the $\mathsf{O}-\mathsf{H}$ bond

Ignore bond angles.

[11]

1

M5.(a) (i) Green

Ignore shades of green.

1

(ii) Excess acidified potassium dichromate(VI)

1

Reflux (for some time)

1

In the diagram credit should be given for

- a vertical condenser
 - Lose M3 and M4 for a distillation apparatus.

1

an apparatus which would clearly work
 Do not allow this mark for a flask drawn on its own.
 Penalise diagrams where the apparatus is sealed.

1

(iii) Distillation

			1
(b)	Kee	ep away from naked flames Allow heat with water-bath or heating mantle. If a list is given ignore eye protection, otherwise lose this mark.	1
(c)	(i)	Tollens' or Fehling's reagents Incorrect reagent(s) loses both marks. Accept mis-spellings if meaning is clear.	1
		Silver mirror / red ppt. formed Accept 'blue to red' but not 'red' alone.	1
	(ii)	Sodium carbonate (solution) / Group II metal Allow indicator solutions with appropriate colours. Accept any named carbonate or hydrogen carbonate.	1
		Effervescence / evolves a gas Accept 'fizzes'.	

Immediately (the reagents are mixed)

(d) Propanoic acid

If this mark is lost allow one mark if there is reference to stronger intermolecular forces in the named compound. Lose M1 and M3.

Contains hydrogen bonding

1

1

Some comparison with other compounds explaining that the intermolecular forces are stronger in propanoic acid

[15]