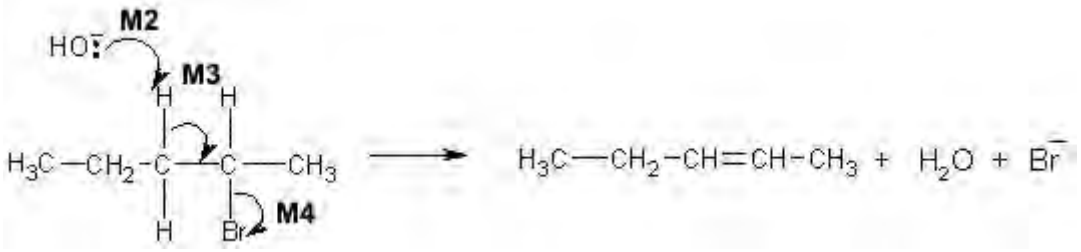
M1. (a) (i) **M1** Elimination



M2 must show an arrow from the lone pair on the oxygen of a negatively charged hydroxide ion to a correct H atom

M3 must show an arrow from a C-H bond adjacent to the C-Br bond towards the appropriate C-C bond.
Only award if a reasonable attempt has been made at the attack on the H atom of the appropriate adjacent C-H

M4 is independent provided it is from their original molecule

Award full marks for an E1 mechanism in which **M3** is on the correct carbocation.

N.B. These are double-headed arrows

For M1, accept ''Base elimination'' but no other prefix.

*Penalise **M2** if covalent KOH*

*Penalise **M4** for formal charge on C of C-Br or incorrect partial charges on C-Br*

Ignore other partial charges

Penalise once only in any part of the mechanism for a line and two dots to show a bond.

*Max any 2 of 3 marks **for the mechanism** for wrong reactant (or wrong product if shown).*

Accept the correct use of ''sticks'' for the molecule except for the C-H being attacked

4

(ii) **Structure for pent-1-ene**

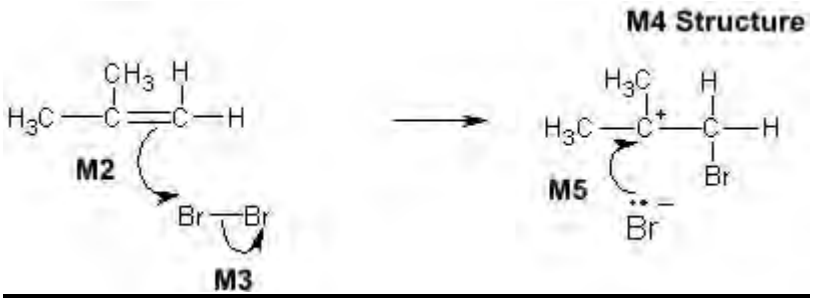
$CH_3CH_2CH_2CH=CH_2$

Penalise C_3H_7

Accept correct ''sticks''

1

(b) **M1 <u>Electrophilic addition</u>**



M2 must show an arrow from the double bond towards the Br atom of the Br-Br molecule

M3 must show the breaking of the Br-Br bond.

M4 is for the structure of the tertiary carbocation with Br on the correct carbon atom.

M5 must show an arrow from the lone pair of electrons on the negatively charged bromide ion towards the positively charged carbon atom.

N.B. These are double-headed arrows

For M1, both words required.

For the mechanism

***M2** Ignore partial negative charge on the double bond.*

***M3** Penalise partial charges on Br-Br bond if wrong way and penalise formal charges*

Penalise once only in any part of the mechanism for a line and two dots to show a bond

*<u>Max any 3 of 4 marks **for the mechanism**</u> for*

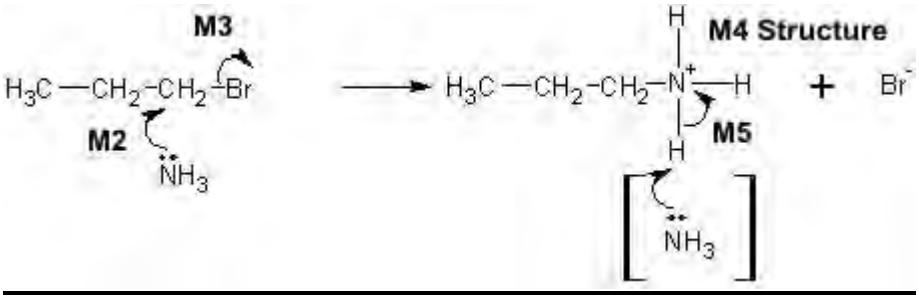
wrong organic reactant or wrong organic product (if shown) or primary carbocation.

*If HBr is used, max 2 marks **for their mechanism***

Accept the correct use of ''sticks''

5

(c) **M1 <u>Nucleophilic substitution</u>**



M2 must show an arrow from the lone pair of electrons on the nitrogen atom of an ammonia molecule to the C atom.

M3 must show the movement of a pair of electrons from the C-Br bond to the Br atom. **M3** is independent provided it is from their <u>original molecule</u>

M4 is for the structure of the alkylammonium ion, which could be a condensed formula. A positive charge must be shown on/or close to, the N atom.

M5 is for an arrow from the N-H bond to the N atom.

Award full marks for an S_N1 mechanism in which M2 is the attack of the ammonia on the intermediate carbocation.

N.B. These are double-headed arrows

*For **M1**, both words required.*

*Penalise **M2** if NH_3 is negatively charged.*

*Penalise **M3** for formal charge on C or incorrect partial charges*

The second mole of ammonia is not essential for M5; therefore ignore any species here.

Penalise once only for a line and two dots to show a bond.

*Max any 3 of 4 marks **<u>for the mechanism</u>** for wrong organic reactant (or wrong organic product if shown)*

Accept the correct use of ''sticks''

5

[15]

M2.(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

Immediately (the reagents are mixed)

1

(b) Keep 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'.

1

(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.

1

Contains hydrogen bonding

1

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

1

[15]

M3. (a) **M1** Cl_2 (provides the pale green colour)
M1 <u>requires the formula</u>

M2 NaOH reacts with the acid(s)/the HCl/the HClO/H^+
Ignore "reacts with the products"

Ignore "reacts with chloride ion"
Ignore "reacts with chlorine"

M3 <u>requires a correct answer in M2</u>
Equilibrium shifts (from left) <u>to right</u> ***OR*** wte

3

(b) **M1** A reducing agent is an <u>electron donor</u> OR (readily) <u>loses/ gives away electrons</u>

Penalise M1 if "electron pair donor"

M2 Cl_2 + **2**e^- → **2**Cl^-

For M3 and M4, **i**odide ions are stronger reducing agents than chloride ions, because

Ignore state symbols in M2 Accept no charge on the electron
Credit the electrons being lost on the RHS

M3 Relative size of ions/atomic radius/ionic radius
<u>Iodide ions</u> are <u>larger</u>/have more (electron) shells/levels than chloride ions (or converse for chloride ion) OR <u>electron(s) to be lost/outer shell/level</u> is <u>further</u> from the nucleus (or converse for chloride ion) OR greater/more shielding

For M3 insist on "<u>iodide ions</u>"

M4 Strength of attraction for <u>electron(s) being lost</u>
<u>Electron(s) lost</u> from an iodide ion is <u>less strongly held by the nucleus</u> compared with that lost from a chloride ion

M3 and M4 must be comparative and should refer to electrons.

(assume argument refers to iodide ions but accept converse argument for chloride ions)

4

(c) **M1** **2**Cl_2 + **2**H_2O → **4**HCl + O_2

Or multiples

M2 silver chloride ONLY

<u>M2 requires a name</u>

M3 The solid/precipitate would dissolve
OR is soluble
OR (It) forms a (colourless) solution

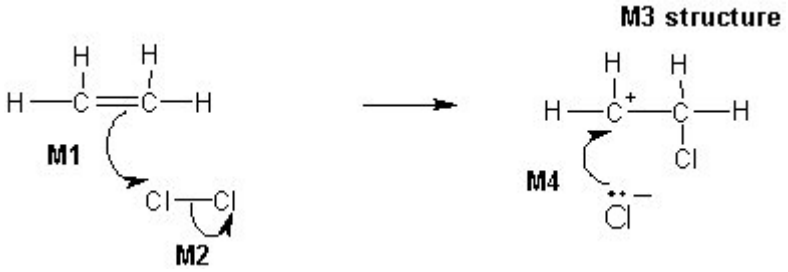
Mark M3 independently
Ignore "disappears"

3

(d) Electrophilic addition

1

Mechanism:



M2 Penalise partial charges if wrong way around, otherwise ignore

*Max 3 marks **for the mechanism** for wrong reactant and/or "sticks" (wrong reactant could be HBr or Br_2 or incorrect alkene)*

M1 must show an arrow from the double bond towards one of the Cl atoms on a Cl–Cl molecule.

M2 must show the breaking of the Cl–Cl bond.

M3 is for the structure of the carbocation with Cl substituent.

M4 must show an arrow from the lone pair of electrons on a negatively charged chloride ion towards the positively charged carbon atom.

4

[15]

M4.(a) Hydrochloric acid = **C**

1

Barium chloride = **A**

1

(b) Barium sulfate is insoluble

1

$CuSO_4 + BaCl_2 \rightarrow BaSO_4 + CuCl_2$

Accept multiples.

Accept ionic equation.

Do not penalise lack of state symbols, but if used they must be correct.

1

(c) CO_2 / Carbon dioxide

1

(d) Reagent 1 silver nitrate (solution)

Ignore lack of reference to acidifying prior to addition of silver nitrate solution.

1

Observation 1 White precipitate

1

Reagent 2 (dilute) ammonia solution / aqueous ammonia

*Do not accept addition of **ammonia** only.*

1

Observation 2 (Colourless) solution

Allow ppt dissolves.

Do not allow 'goes colourless' or 'goes clear'.

Chlorine and no visible change or solution does not become orange scores M3 and M4.

1

(e) Gloves / wash hands after use

Ignore 'eye protection'.

Do not accept 'do not ingest the chemicals', 'wipe up spillages', 'use a fume cupboard', 'wear a lab coat' (list principle).

1

[10]

M5.(a) To ensure that other (an)ions do not interfere

Accept 'to prevent other salts precipitating'.

Accept 'to remove carbonate / hydroxide (ions)'.

1

(b) Concentrated (ammonia)

'Precipitate partially soluble in dilute ammonia' scores both marks.

1

Precipitate soluble / dissolves

1

[3]