**ALKENES MS**

1. \( \text{H}_2 \)  
   Ni/Pt/Pd (catalyst)  
   1  
   1  
   [2]

2. (i) decolourises  
   (ii)  
   \[ \begin{align*}
   \text{CH}_3\text{CH}_2 & \quad \text{CH}_3\text{CH}_2\text{OH} \\
   \text{CH}_3\text{CH}_2 & \quad \text{CH}_3\text{CH}_2\text{OH} \\
   \text{H} & \quad \text{C} & \quad \text{H} \\
   \text{Br} & \quad \text{C} & \quad \text{H} \\
   \text{Br}^{\delta^+} & \quad \text{Br} \\
   \text{Br} & \quad \text{Br}^{\delta^-}
   \end{align*} \]
   curly arrow from \( \text{C}=\text{C} \) bond to bromine  
   1  
   dipoles on \( \text{Br}_2 \) or curly arrow to show movement of bonded pair of electrons  
   1  
   intermediate carbonium ion/carbocation  
   1  
   curly arrow from lone pair on the \( \text{Br}^- \) ion to carbonium ion (\( \text{Br}^{\delta^-} \) loses 1 mark)  
   1  
   [5]

3. (i) electron/lone pair acceptor  
   (ii)  
   \[ \begin{align*}
   \text{H}_3\text{C} & \quad \text{C} & \quad \text{H}_2\text{Br} \\
   \text{C}_2\text{H}_5 & \quad \text{Br} & \quad \text{C}_2\text{H}_5 \\
   \text{Br}^{\delta^+} & \quad \text{Br}^{\delta^-}
   \end{align*} \]
   curly arrow from \( \pi \)-bond to \( \text{Br}^{\delta^+} \)  
   Dipoles on the \( \text{Br}^-\text{Br} \) bond  
   \{ \text{and} \}  
   curly arrow from \( \text{Br}^-\text{Br} \) bond to \( \text{Br}^{\delta^-} \)  
   Curly arrow from \( \text{Br}^- \) to \( \text{C}^+ \)  
   1  
   1  
   1  
   [4]
4. (i) decolourises/not clear/not discolours
(ii)

\[
\begin{align*}
\text{H}_3\text{C} & \overset{\delta+}{\xrightarrow{\text{Br}}} \text{CH}_2 \\
\text{Br} & \overset{\delta-}{\xrightarrow{\text{Br}}} \\
\text{H}_3\text{C} & \overset{+}{\xrightarrow{-\text{CH}_2\text{Br}}} \\
\text{H}_3\text{C} & \overset{+}{\xrightarrow{\delta-\text{CH}_2\text{Br}}} \\
\text{H}_3\text{C} & \overset{\delta+}{\xrightarrow{-\text{CH}_2\text{Br}}} \\
\end{align*}
\]

curly arrow from C=C to Br\(^{\delta+}\)
dipole on Br-Br and curly arrow showing movement of bonded pair of electrons
correct intermediate/carbonium ion/carbocation and curly arrow from Br\(^{-}\) to C+
1, 2-dibromopropane as product

5. (a)

\[
\begin{align*}
\text{C}_2\text{H}_5 & \overset{\delta+\text{Br}}{\xrightarrow{\text{C}} \xrightarrow{\delta-\text{Br}}} \\
\text{C}_2\text{H}_5 & \overset{\delta+\text{Br}}{\xrightarrow{\text{C}} \xrightarrow{\delta-\text{Br}}} \\
\text{C}_2\text{H}_5 & \overset{\delta+\text{Br}}{\xrightarrow{\text{C}} \xrightarrow{\delta-\text{Br}}} \\
\text{C}_2\text{H}_5 & \overset{\delta+\text{Br}}{\xrightarrow{\text{C}} \xrightarrow{\delta-\text{Br}}} \\
\end{align*}
\]
curly dipoles shown correctly on the Br–Br and curly arrow from the Br–Br bond towards the Br\(^{\delta}\)
correct intermediate shown
curly arrow from the lone pair or the negative charge on the Br\(^{-}\) to the C+

(b) (i) Hs are diagonal to each other in the trans/difference clearly shown in a diagram
(ii) (the product is saturated hence) there is no restricted rotation/single bonds allow rotation/because C=C prevents rotation
6. (a) (i) phosphoric acid/H⁺/sulphuric acid 1
(ii) lone/electron pair of electrons acceptor 1

(b) (i) [Diagram of molecular structures]

Step 1  curly arrow from π-bond to H⁺ 1
Step 2  curly arrow from lone pair on the O⁻ to C⁺ 1
Step 3  curly arrow from O—H bond to O⁺ 1
(ii) catalyst … no marks because it is not consumed/used up in the reaction/owtte 1

7. (a) (i) 24.7/12 : 2.1/1: 73.2/35.5
2.06 : 2.1 : 2.06 1
CHCl 1
(ii) (CHCl = 12 + 1 + 35.5 =) 48.5 1
48.5 × 3 = 145.5 1

(b) (i) Any two from 2
1,1,3-trichloro  3,3,3-trichloro  2,3,3-trichloro  1,3,3-trichloro

(ii) 1, 2,3-trichloropropene
(trichloropropene scores 1 mark ✓)
3 marking points:
• correct numbers 1, 2,3
• trichloro
• propene/prop-1-ene
any two gets 1 mark
(c)  

(i)  

Cl Cl Cl Cl
Cl
C C C C
CH CH3 3

1 mark if backbone contains 4 carbons with 'end-bonds' and a reasonable attempt has been made e.g used the wrong isomer.... max = 1 mark

(ii) non-biodegradable  

toxic fumes evolved when burnt  

HCl or Cl• or chlorinated organic compounds such as COCl₂ also evolved when burnt

8.

H C₂H₅ H C₂H₅

C C C C

H H H H

1 mark is available if the backbone consists of 4 C atoms and a reasonable attempt has been made ✔✔
9. **margarine**

Ni catalyst

hydrogen/ hydrogenated

unsaturated vegetable oil/fat

**poly(propene)**

equation

\[ \begin{align*}
\text{n} & \left( \begin{array}{c}
\text{H} \\
\text{C} \\
\text{H} \\
\text{H} \\
\end{array} \right) \\
& \rightarrow \\
\text{n} & \left( \begin{array}{c}
\text{CH}_3 \\
\text{C} \\
\text{H} \\
\text{H} \\
\end{array} \right)
\end{align*} \]

two repeat units

(Ziegler) catalyst / high temp/heat/use of an initiator

**Problems with disposal**

non-biodegradable/don’t decompose/not broken down by bacteria etc

when burnt produces toxic fumes

**Future methods of disposal**

recycling (to produce new polymers)

incineration for energy (production)

cracking/owtte (to produce useful organic molecules)

use gas scrubbers to reduce toxic fumes

*any two*

*max = 9*

**QWC**

Answer is well organised/structure and using at least three of:

catalyst, hydrogenation, addition polymerisation, Ziegler, incineration, feedstock, recycling, non-biodegradable, initiator, monomer, unsaturated.

in the correct context.

10
10. (a) 3-chloro(-2-)methylprop-1-ene/1-chloro(-2-)methylprop-2-ene

(b) 

Backbone of 4 carbons and a reasonable attempt gets 1 mark.

11. **Bonding:** \( \pi \)-bond formed by overlap of (adjacent) p-orbitals/\( \pi \)-bond labelled on diagram

diagram to show formation of the \( \pi \)-bond

Shape/bond angles:

tetrahedral around the CH\(_3\)

bond angle = 109°28′ (109-110°)

trigonal planar around each C in the C=C

bond angle = 120° (118-122°)

**Cis-trans**

* cis & trans correctly labelled eg but-2-ene

* require a double bond because it restricts rotation

* each C in the C=C double bond must be bonded to two different atoms or groups

**QWC**

Allow mark for well constructed answer and use of **three** terms like: orbital, tetrahedral, trigonal, planar, rotation, spatial, stereoisomers, geometric