RECOGNISING ACHIEVEMENT

Subject: Chains and Rings Code: 2812

Session: January Year: 2005

FINAL

MAXIMUM MARK	60

ADVICE TO EXAMINERS ON THE ANNOTATION OF SCRIPTS

1. Please ensure that you use the **final** version of the Mark Scheme.
   You are advised to destroy all draft versions.

2. Please mark all post-standardisation scripts in red ink. A tick (✓) should be used for each answer judged worthy of a mark. Ticks should be placed as close as possible to the point in the answer where the mark has been awarded. The number of ticks should be the same as the number of marks awarded. If two (or more) responses are required for one mark, use only one tick. Half marks (½) should never be used.

3. The following annotations may be used when marking. No comments should be written on scripts unless they relate directly to the mark scheme. Remember that scripts may be returned to Centres.

   x = incorrect response (errors may also be underlined)
   ^ = omission mark
   bod = benefit of the doubt (where professional judgement has been used)
   ecf = error carried forward (in consequential marking)
   con = contradiction (in cases where candidates contradict themselves in the same response)
   sf = error in the number of significant figures

4. The marks awarded for each part question should be indicated in the margin provided on the right hand side of the page. The mark total for each question should be ringed at the end of the question, on the right hand side. These totals should be added up to give the final total on the front of the paper.

5. In cases where candidates are required to give a specific number of answers, (e.g. 'give three reasons'), mark the first answer(s) given up to the total number required. Strike through the remainder. In specific cases where this rule cannot be applied, the exact procedure to be used is given in the mark scheme.

6. Correct answers to calculations should gain full credit even if no working is shown, unless otherwise indicated in the mark scheme. (An instruction on the paper to 'Show your working' is to help candidates, who may then gain partial credit even if their final answer is not correct.)

7. Strike through all blank spaces and/or pages in order to give a clear indication that the whole of the script has been considered.

8. An element of professional judgement is required in the marking of any written paper, and candidates may not use the exact words that appear in the mark scheme. If the science is correct and answers the question, then the mark(s) should normally be credited. If you are in doubt about the validity of any answer, contact your Team Leader/Principal Examiner for guidance.

1.

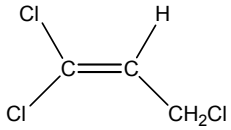
(a) (i) 24.7/12 : 2.1/1: 73.2/35.5
2.06 : 2.1 : 2.06 ✓

CHCl ✓

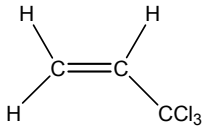
(ii) (CHCl = 12 + 1 + 35.5 =) 48.5 ✓

48.5 x 3 = 145.5 ✓
alternatively (12x3) + (1 x 3) + (35.5 x 3) = 143.5 gets both marks

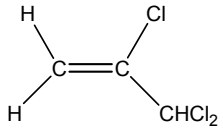
(b) (i) Any two from



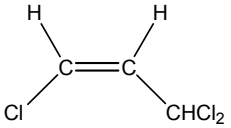
1,1,3 -trichloro



3,3,3-trichloro



2,3,3-trichloro



1,3,3 -trichloro

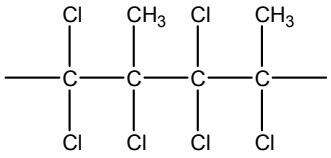
✓✓

(ii) 1,2,3-trichloropropene
(trichloropropene scores 1 mark ✓)
ignore any reference to "cis"

3 marking points:
- *correct numbers 1,2,3*
- *trichloro*
- *propene/prop-1-ene*

any two gets 1 mark ✓✓

(c) (i)



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 ✓

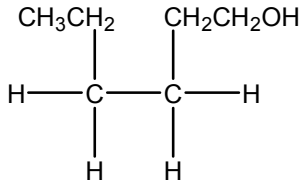
toxic fumes evolved <u>when burnt</u> ✓

HCl or Cl• or chlorinated organic compounds such as $COCl_2$ also evolved/ not Cl_2
(any reference to damaging the ozone layer loses the mark) ✓
lack of any reference to burning… penalise once only

[Total: 13]

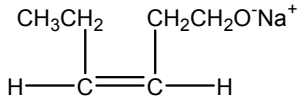
2.

(a) (i)



✓

(ii)



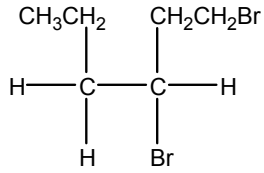
charges are not necessary

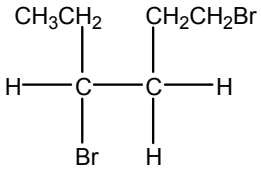
allow the alkoxide ion

✓

✓

(iii)



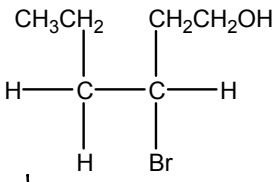


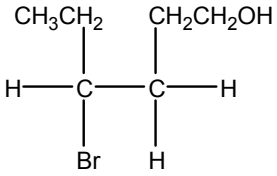
Both correct products gets 3 marks

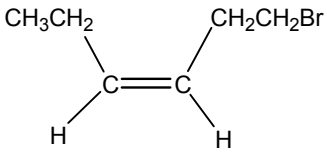
One correct product gets 2 marks

✓✓✓

If neither of the above is correct then one mark can be awarded for any of:



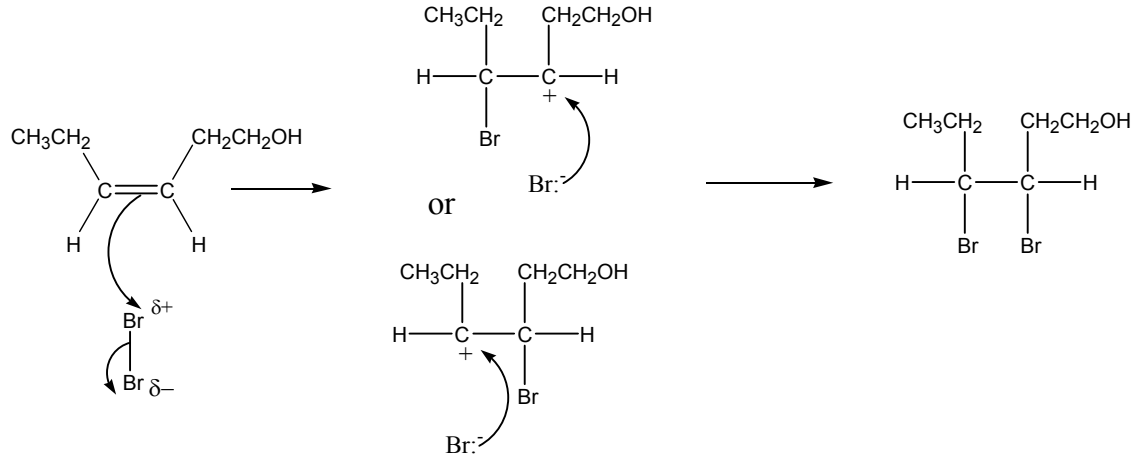




max of two marks

(b) (i) decolourises ✓

(ii)



curly arrow from C=C bond to bromine ✓

dipoles on Br_2 or curly arrow to show movement of bonded pair of electrons ✓

intermediate carbonium ion/carbocation ✓

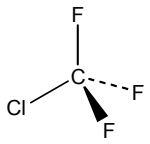
curly arrow from lone pair on the Br^- ion to carbonium ion ($Br^{\delta-}$ loses 1 mark) ✓

[Total: 10]

3. (a) (i) C_4H_{10} ✓

(ii) $C_4H_{10} + 6½O_2 \longrightarrow 4CO_2 + 5H_2O$ ✓
(CO_2 & H_2O as products ✓)

(iii) propan-2-ol ✓

(b) (i) 

require an attempt at a 3D structure and bond angles must clearly not be 90°.

require at least one 'wedge' bond or one 'dotted' bond

✓
✓

(ii) 108 –111° ✓

(iii) volatile/low boiling/gas/non-toxic/non-flammable/unreactive/liquefied under pressure/inert ✓

(iv) homolytic = bonded pair split <u>equally</u>/ each retains 1 electron ✓

fission = <u>bond</u> breaking ✓

(v) C-Cl (no mark) because it is the <u>weaker bond</u> ✓

(vi) Cl• ✓

•CF_3 (allow CF_3•) *(lack of 'dots' penalise once)* ✓

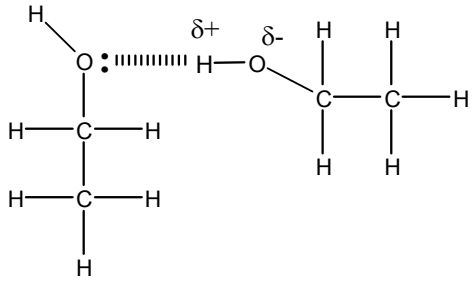
[Total: 12]

4.

(a) $C_6H_{12}O_6 \longrightarrow 2C_2H_5OH + 2CO_2$ ✓✓

(C_2H_5OH & CO_2 ✓)

(b)



dipoles ✓

hydrogen bond between O in one O-H and H in the other O-H ✓

lone pair from O involved in the H-bond /or OHO in a straight line ✓

If they show a lone pair, it must be part of the H-bond

(c) (i) (volatile components) can escape/partial oxidation ✓

ethanal is most volatile/b pt less than 60 ^oC ∴will distil out ✓

(ii) (volatile components) cannot escape/ refluxed ✓

complete oxidation will be achieved ✓

(d) $C_2H_5OH + 2[O] \longrightarrow CH_3COOH + H_2O$ ✓✓

($CH_3COOH + H_2O$ ✓)

(e) spectrum C ✓

the other two spectra contain the OH group absorption at approx 3000 cm^{-1} ✓

spectrum C only shows absorption at 1700 cm^{-1} for the C=O ✓

[Total: 14]

5.

identifies the three process as cracking, reforming, isomerisation ✓

recognises the need for high temperature or a catalyst ✓

equation for cracking ✓

equation for isomerisation ✓

state that reforming converts chains into rings/cyclic compounds ✓

equation for reforming (balanced with H_2 could score two marks) ✓

sub-section mark = 6

oil is finite/non-renewable ✓

ethanol is renewable/sustainable ✓

from plants/crops/sugar cane/sugar beet/glucose/sugar/fermentation ✓

$C_2H_5OH + 3O_2 \longrightarrow 2CO_2 + 3H_2O$ ✓

sub-section mark = 4

QWC

- organise relevant information clearly and coherently, using specialist vocabulary when appropriate (minimum of 4 from cracking/ isomerisation/ reforming/ renewable/ feedstock/ finite/fermentation/non-renewable/sustainable/etc)
- reasonable spelling, punctuation and grammar throughout ✓

[Total: 11]

1(a)

(i) compound/molecule containing hydrogen and carbon **only** ✓

(ii) $C_{10}H_{22}$ ✓

(iii) C_5H_{11} {ecf from (ii)} ✓

(b)(i) (a particle that) contains/has a single/unpaired electron ✓

(ii) UV (light) /sunlight/high temp ✓

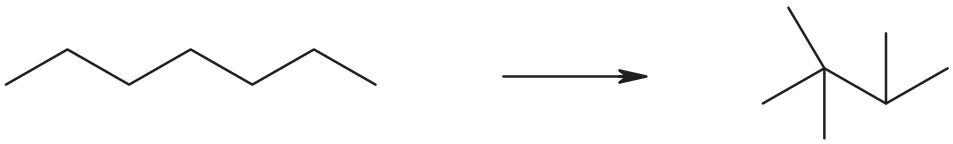
(iii) homolytic (fission)/ homolysis ✓

(iv) $C_{12}H_{26} + Cl\bullet \longrightarrow \bullet C_{12}H_{25} + HCl$ ✓
(the dot for the free radical does not have to be on the C)
$\bullet C_{12}H_{25} + Cl_2 \longrightarrow C_{12}H_{25}Cl + Cl\bullet$ ✓

(v) six ✓

(c)(i) $C_{12}H_{26} \longrightarrow 2C_2H_4 + 1C_8H_{18}$ ✓✓
(1 mark for correct formula of octane or ethene)

(ii) octane/ ecf from (c) (i) ✓

(d)(i)  ✓✓

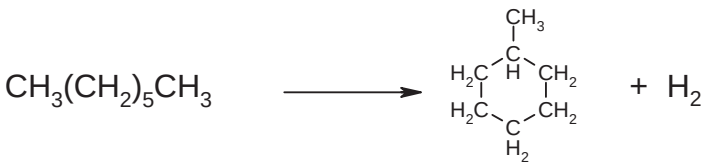
1 mark for correct reagent and 1 mark for correct product.

(ii) 1 mark for any unambiguous formula of cyclohexane ✓

1 mark for $1H_2$ but check that formula of heptane is correct/equation balanced. ✓

gets 2 marks

gets 2 marks



gets 2 marks

$C_7H_{16} \longrightarrow C_7H_{14} + H_2$ gets 1 mark

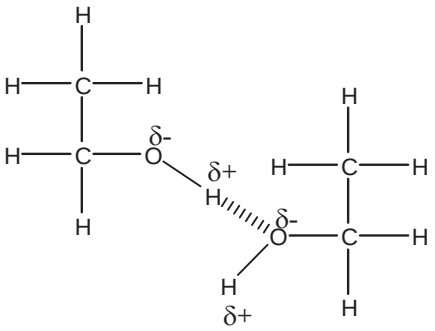
[Total : 16]

2(a)

(i) *low volatility*, = **high** boiling point/ not easy to vapourise/owtte ✓

intermolecular bonds. = bonds/forces/attractions **between** molecules ✓

(ii) type of intermolecular bond = hydrogen bond ✓



dipoles on both O-H bonds ✓

H-bond shown as a 'dashed bond' ✓

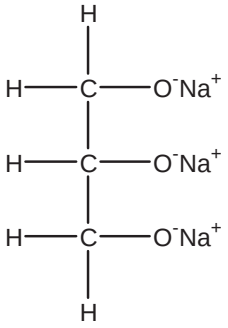
(iii) (The boiling point of glycerol will be *higher* than ethanol because there are) more OH groups ∴ <u>more H-bonds</u> ✓

(b) $C_2H_5OH + Na \longrightarrow C_2H_5O^-Na^+ + ½ H_2$ (or multiple of this) ✓✓

charges are not essential

1 mark for correct formula of sodium ethoxide & 1 mark for correct balancing

(c)



charges are not essential for both marks ✓✓

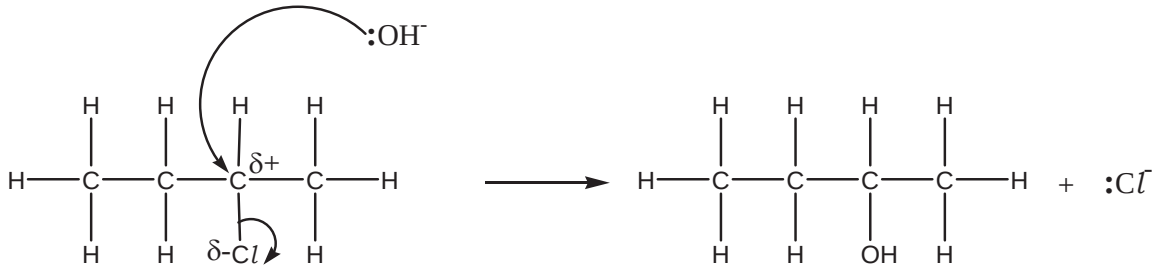
1 mark for partial reaction, 1 mark if all 3 "ONa" are shown as covalent "O-Na"

[Total : 10]

3.

(a)(i) butan-2-ol by name or by formula ✓

(ii)



curly arrow from the O of the OH^- to $C^{(\delta+)}$ ✓

curly arrow from C-Cl bond to Cl **and** correct dipoles ✓

correct products/ allow NaCl ✓

curly arrow from lone pair on $:OH^-$ ✓

[4]

S_N1 route can still score all 4 marks:

curly arrow from C-Cl bond to Cl **and** correct dipoles ✓

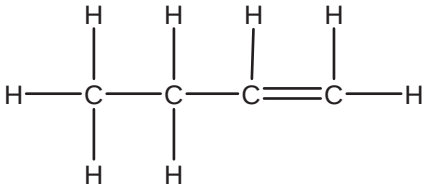
curly arrow from the O of the OH^- to C+ ion ✓

correct products/ allow NaCl ✓

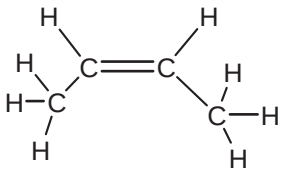
curly arrow from lone pair on $:OH^-$ ✓

(b) (i) elimination ✓

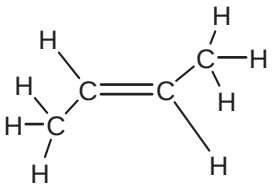
(ii)



but-1-ene ✓



cis-but-2-ene ✓

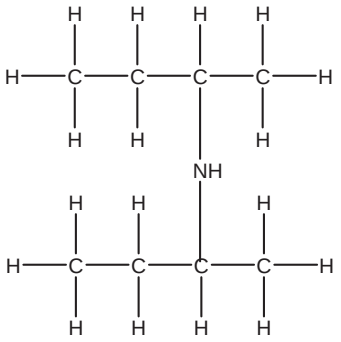


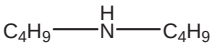
trans-but-2-ene ✓

(c) (i) ethanol ✓

(ii) $C_4H_{11}N$ ✓

(iii)





any unambiguous structure/ formula for the secondary amine ✓

[Total : 12]

4 (a)(i) alkene ✓

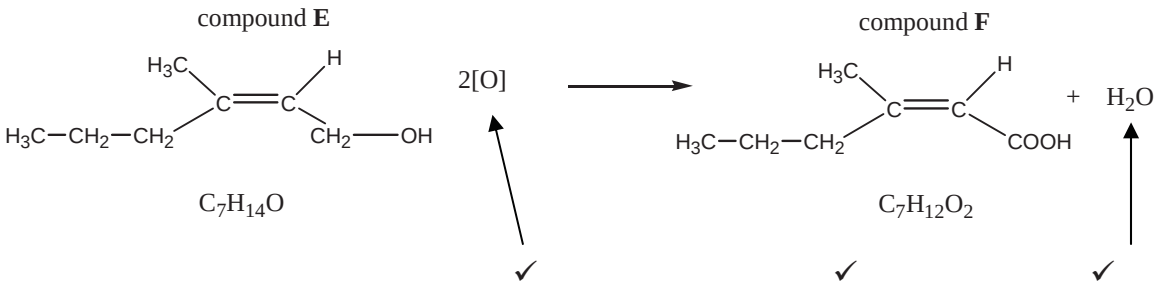
bromine ✓

decolourises ✓

(ii) 3-methylhex-2-en-1-ol/ 1-hydroxy-3-methylhex-2-ene ✓

(b) (i) H^+ ✓ $Cr_2O_7^{2-}$ ✓

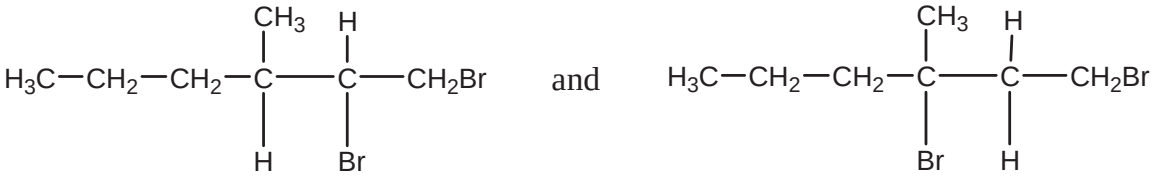
(ii)



✓ ✓ ✓

(iii) carboxylic acid would have an absorption between 1680 – 1750 cm^{-1} /1700 cm^{-1} or 2500 – 3300 cm^{-1}. ✓

(c)



1,2-dibromo-3-methylhexane 1,3-dibromo-3-methylhexane

$CH_3CH_2CH_2CH(CH_3)CHBrCH_2Br$ $CH_3CH_2CH_2CBr(CH_3)CH_2CH_2Br$

✓ ✓

[Total :12]

5

margarine

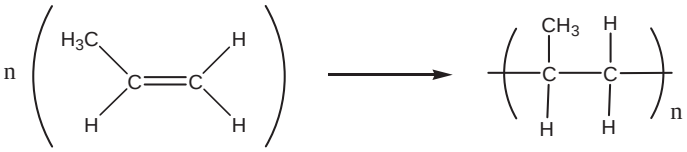
Ni catalyst ✓

hydrogen/ hydrogenated ✓

unsaturated vegetable oil/fat ✓

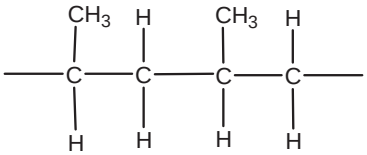
poly(propene)

equation



✓

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. ✓

[Total : 10]

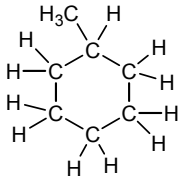
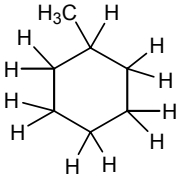
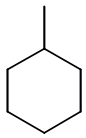
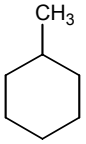
Mark Scheme 2812
January 2007

Q1

(a) separation by (differences in) boiling point ✓

(b) $C_7H_{16} \longrightarrow C_4H_{10} + C_3H_6$ ✓

(c) (i) Any of

✓

(ii) $C_7H_{16} \longrightarrow C_7H_{14} + H_2$ (or by structural formula) ✓

(d) (i) 2,2-dimethylpentane ✓

(ii) 3-methylhexane, 3,3 dimethylpentane or (3)-ethylpentane in any unambiguous form. ✓✓

(iii) 2,2,3-trimethylbutane ✓

(iv) if branched, difficult to pack/less surface interaction/less points of contact ✓
less van der Waals' forces/ less intermolecular bonds/less energy needed to boil ✓

(e) (i) (A fuel whose feedstock is obtained) from a plant/animal excrement ✓

(ii) fossil fuels are non-renewable because they take millions of years to form/
ethanol is renewable because the plant (sugar beet, cane) can be re-grown ✓

[Total: 12]

Q2

(a) (i) $C_6H_{12}O_6$ (aq) $\longrightarrow$ $2C_2H_5OH(l)$ or (aq) + $2CO_2(g)$ balanced equation ✓
state symbols can be awarded only if equation shows $C_6H_{12}O_6$, C_2H_5OH and CO_2 ✓

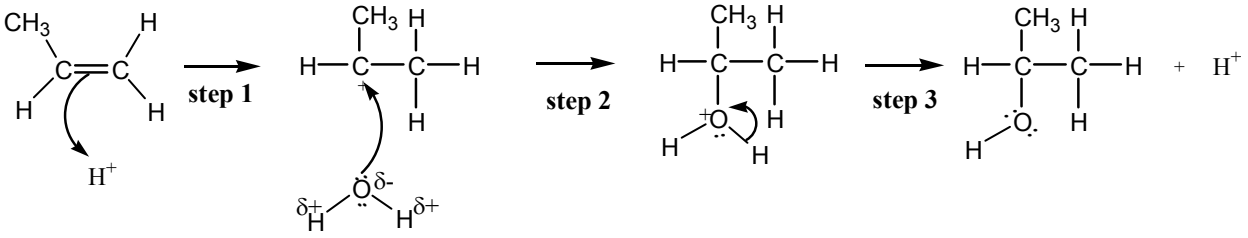
(ii) anaerobic, aqueous, temp range 25 – 40 ^oC/warm to just above room temp ✓✓

(iii) no more bubbles/gas/CO_2 ✓

(b) (i) phosphoric acid/H^+/sulphuric acid ✓

(ii) lone/electron pair of electrons acceptor ✓

(c) (i)



Step 1 curly arrow from π-bond to H^+ ✓
Step 2 curly arrow from lone pair on the $O^{\delta-}$ to C+ ✓
Step 3 curly arrow from O—H bond to O+ ✓

(ii) catalyst … no marks because it is **not** consumed/used up in the reaction/owtte ✓

(d) $CH_3CH(OH)CH_3$ + $4½O_2$ $\longrightarrow$ $3CO_2$ + $4H_2O$ ✓✓
/C_3H_8O

(1 mark if correct formula for all four chemicals and 1 mark for correct balancing)

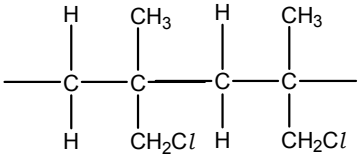
(e) ethanoic acid/ CH_3COOH/CH_3COCl ✓

[Total: 14]

Q3

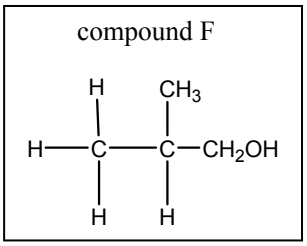
(a) 3-chloro(-2-)methylprop-1-ene/1-chloro(-2-)methylprop-2-ene ✓

(b)

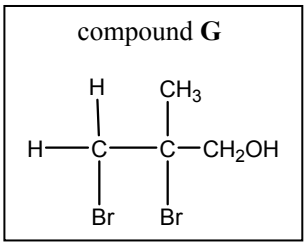


Backbone of 4 carbons and a reasonable attempt gets 1 mark. ✓✓

(c) (i)

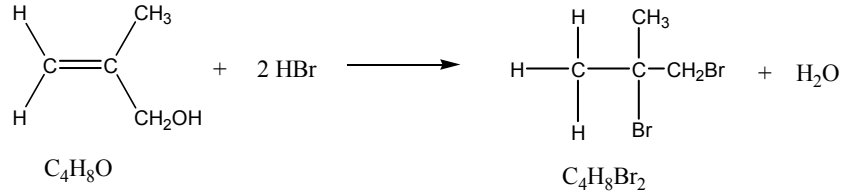


✓



✓

(ii)



C_4H_8O $C_4H_8Br_2$

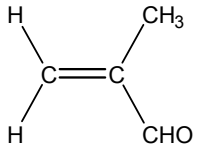
✓✓

1 mark for HBr

(iii) $Cr_2O_7^{2-}$ ✓

$H^+$and reflux ✓

(iv)



/ methylprop-2-enal ✓

(d) **infra-red**

(alcohol)**E** would show absorption 3230 – 3550 cm^{-1} ✓

(carboxylic acid) **I** would show **either** an absorption 1680 – 1750 cm^{-1} **or** 2500 – 3300 cm^{-1} ✓

I contains C=O at approx 1700 cm^{-1} but **E** doesn't get both marks ✓✓

[Total: 12]

Q4

(a) (i) uv/sunlight/high temperature (range 400 – 700 ^{o}C) ✓

(ii) $Cl_2 \longrightarrow 2Cl\bullet$ ✓

$C_4H_{10} + Cl\bullet \longrightarrow HCl + \bullet C_4H_9/C_4H_9\bullet$ ✓

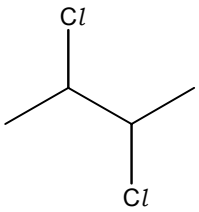
$\bullet C_4H_9/C_4H_9\bullet + Cl_2 \longrightarrow C_4H_9Cl + Cl\bullet$ ✓

(iii) any two free radicals from (a) (ii) ✓

(iv) homolytic (fission) ✓

(b) (i) 2,3-dichlorobutane ✓

(ii)



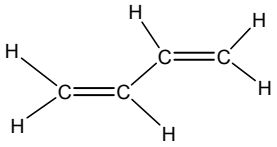
✓

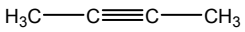
(iii) any dichlorobutane **except** 2,3-dichlorobutane. ✓

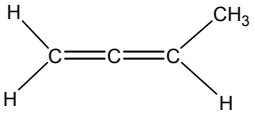
(c) (i) ethanol ✓

(ii) elimination ✓

(iii) any one from:







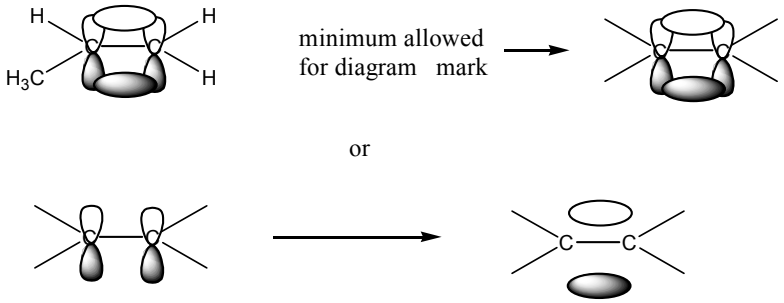
✓

[Total: 12]

Q5

Bonding: π-bond formed by overlap of (adjacent) p-orbitals/π-bond labelled on diagram ✓

diagram to show formation of the π-bond ✓



2

Shape/bond angles:

tetrahedral around the CH_3 ✓

bond angle = $109^o28^/$ (109-110^o) ✓

trigonal planar around each C in the C=C ✓

bond angle = 120^o (118-122^o) ✓

4

Cis-trans

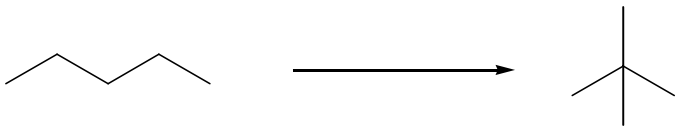
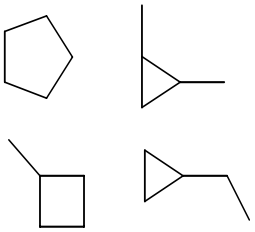
cis & trans correctly labelled eg but-2-ene ✓
require a double bond because it restricts rotation ✓
each C in the C=C double bond must be bonded to two different atoms or groups ✓

3

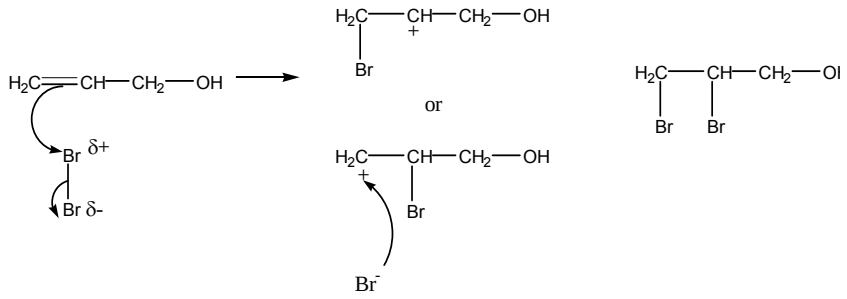
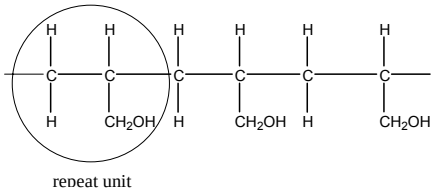
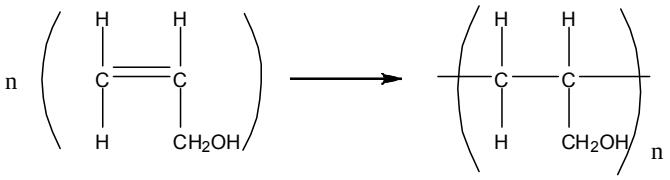
QWC Allow mark for well constructed answer and use of **three** terms like:
orbital, tetrahedral, trigonal, planar, rotation, spatial, stereoisomers, geometric ✓

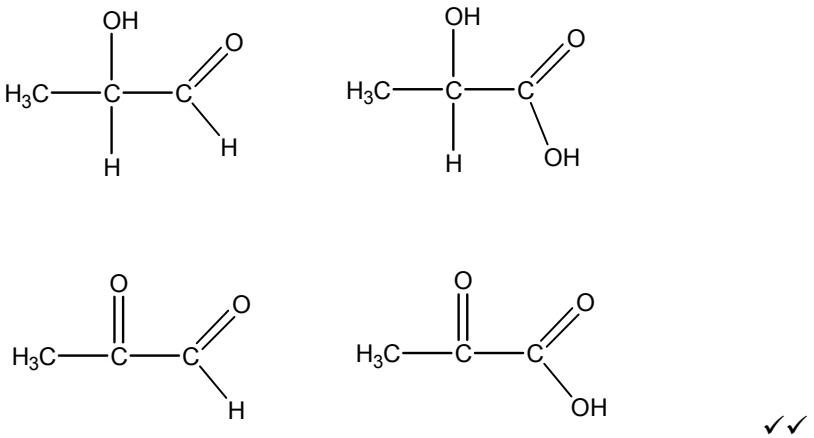
[Total: 10]

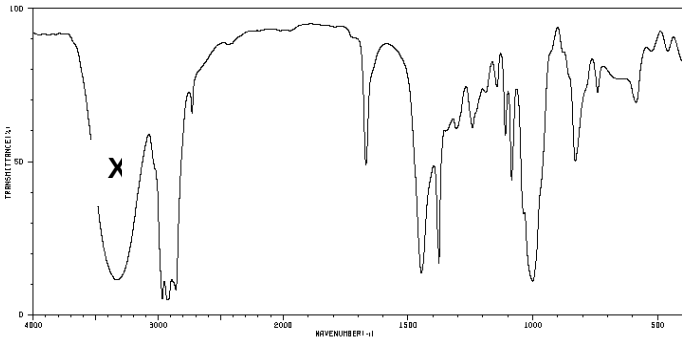
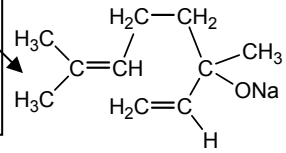
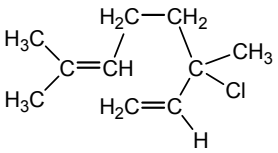
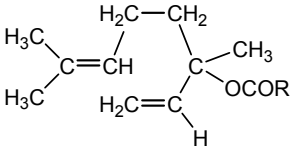
2812 Chains and Rings

Question No.			Max Mark
1a	i	boiling point increases with increased chain length/M_r ✓ more surface interaction/electrons/van der Waals/intermolecular forces ✓	**2**
	ii	boiling point decreases with increased branching ✓ less surface contact/cannot pack as close/fewer van der Waals/fewer intermolecular forces ✓	**2**
	iii	59 – 68 °C ✓	**1**
b	i	1 mark for pentane ✓and one for 2,2-dimethylpropane✓  allow 1 mark if not skeletal but both correct.	**2**
	ii	C_5H_{12} → any of:  + H_2 any of these scores both mark ✓✓ or any correct structural formula, clearly showing a cyclic compound $C_5H_{12} \longrightarrow C_5H_{10} + H_2$ ✓ scores 1 mark only pentane ⟶ cyclopentane or less without the H_2 – scores 1 mark	**2**
	iii	better fuels/burn more efficiently/increases octane rating/used as a fuel additives/reduces knocking(ignite less easily) ✓ do not allow "*easier to burn*" as this is the same as pre-ignition	**1**

Question No.			Max Mark
2a		C-H bond energy is large ✓ alkanes/C-H bonds are non-polar ✓ hence alkanes are not attracted / not attacked by nucleophiles or electrophiles ✓ 2 from 3 allow 1 mark for *"no double bond therefore will not react with electrophiles"*	**2**
b	i	(molecule/atom/particle *(not ion)* that) contains an unpaired/single/lone electron ✓ (not free electron)	**1**
	ii	homolytic/homolysis	**1**
	iii	uv/sunlight/high temperature/ >200^{o}C✓ (**not** just heat or hot or high temp + high pressure)	**1**
	iv	$CH_3CH_2CH_3 + Cl\bullet \longrightarrow CH_3CH_2CH_2\bullet + HCl$ ✓ $CH_3CH_2CH_2\bullet + Cl_2 \longrightarrow CH_3CH_2CH_2Cl + Cl\bullet$ ✓	**2**
	v	$CH_3CH_2CH_2\bullet + CH_3CH_2CH_2\bullet$ ($\longrightarrow C_6H_{14}$)/explained in words but must refer to propyl (not propane) free radicals ✓ *if correct equation ignore "propane free rads"*	**1**
c	i	$CH_3CH_2CH_3$ /$C_3H_8 + 5O_2 \longrightarrow 3CO_2 + 4H_2O$ ✓	**1**
	ii	Possibility of forming CO/ incomplete combustion/good ventilation allows complete combustion ✓	**1**

Question No.			Max Mark
3a	i	hydrogen ✓ Ni/Pt/Rh/Pd ✓	2
	ii	H_2O/steam ✓ H_3PO_4 / H_2SO_4 ✓	2
	iii	HBr/ NaBr + H_2SO_4 / NaBr + H^+ ✓	1
b		 curly arrow from π-bond to $Br^{\delta+}$ ✓ correct dipoles on Br-Br + curly arrow from Br-Br bond to $Br^{\delta-}$ ✓ correct intermediate(allow primary/secondary carbonium ion or bromonium ion) ✓ curly arrow from Br^- to C^+/ carbonium ion ✓	4
c	i	 backbone of 6 carbon atoms as shown ✓ repeat unit identified ✓ *do not penalize linkage to –CH_2OH side chain*	2
	ii	 monomer and repeat unit correctly shown ✓ correct position on the n_s✓ n $CH_2CHCH_2OH \longrightarrow (CH_2CHCH_2OH)_n$ gets both marks n $C_3H_6O \longrightarrow (C_3H_6O)_n$ gets both marks *do not penalize linkage to –CH_2OH side chain*	2
	iii	poly(prop-2-en-1-ol)/polyprop-2-en-1-ol ✓	1

3d	i	$CH_3CH_2CH_2OH + 2\,[O] \longrightarrow CH_3CH_2COOH + H_2O$ ✓✓ $C_3H_7OH + 2\,[O] \longrightarrow C_2H_5COOH + H_2O$ ✓✓ $C_3H_8O + 2\,[O] \longrightarrow C_3H_6O_2 + H_2O$ ✓✓ correct product CH_3CH_2COOH scores 1 ✓ if aldehyde is made but the equation is correctly balanced $CH_3CH_2CH_2OH + [O] \longrightarrow CH_3CH_2CHO + H_2O$ scores 1 ✓ do not allow C_3H_6O or CH_3CH_2COH	2
	iii	 ✓✓ Any two of the above. The first two have a chiral centre and if they draw two correct optical isomers with 'wedge-shaped' bonds award both marks.	2

Question No.			Max Mark
4a	C : H : O 6.5 : 11.7 : 0.65 ✓ 10 : 18 : 1 hence = $C_{10}H_{18}O$ ✓ M_R /120 + 18 +16 = 154 ✓	154 x 77.9/100 = 120 = 10 Cs 154 x 11.7/100 = 18 = 18 Hs 154 x 10.4/100 = 16 = 1 O hence = $C_{10}H_{18}O$ gets all 3 marks✓✓✓	**3**
b i	contains a (C=C) double bond/ an alkene/ C≡C/ alkyne/ unsaturated ✓		**1**
ii	uses correctly 159.8/ 160 as M_r of Br_2 ✓ 3.196 ÷ 159.8 = 0.02 mole of Br_2 ✓ 0.04 ✓ecf (used 80 instead of 160)		**2**
iii	compound must have **two** C=C double bonds/ **one** C≡C triple bond ✓		**1**
c			**1**
d i	linalool ✓		**1**
ii	It's the only tertiary alcohol/ the others would be oxidized/are primary alcohols ✓		**1**
iii	reacts with Na/ PCl_5/$SOCl_2$ /RCOCl ✓ H_2 or HCl or SO_2 ✓ correct organic product  or  or  mark ecf to d (i)		**3**

Na compound
H_2
Na alkoxide

worth 1 mark

<table>
<tr><th colspan="2">Question No.</th><th colspan="3"></th><th colspan="2">Max Mark</th></tr>
<tr><td>5</td><td>a</td><td colspan="3">There are two possible methods but marks common to both are

add Ag^+/ $AgNO_3$ ✓

warm/heat in (water bath)/ warm to a specified temp between 30 – 70 ^oC ✓

equi-molar quantities of RX/ same number of drops of RX/ same amount of RX✓

precipitate formed/goes cloudy ✓</td><td colspan="2">4</td></tr>
<tr><td></td><td></td><td>if $AgNO_3$ dissolved in ethanol ✓

must monitor rate ✓of ppt</td><td>if using NaOH must be followed by HNO_3 before adding the $AgNO_3$ ✓

must monitor amount ✓of ppt</td><td></td><td>2</td></tr>
<tr><td></td><td></td><td colspan="2">C-I is fastest and C-Cl is slowest /correct order ✓

because

C-Cl bond strongest/shortest & C-I weakest/longest/ refers to the strength of the bonding in named halogens ✓

$Ag^+ + X^- \longrightarrow AgX$ ✓

$R\text{-}X + OH^-/ H_2O \longrightarrow R\text{-}OH + X^-/ HX$ ✓</td><td></td><td>4

max = 8</td></tr>
<tr><td></td><td></td><td colspan="2">SPAG – two correct sentences in which the meaning is clear.</td><td></td><td>1</td></tr>
<tr><td colspan="6">9</td></tr>
</table>

OCR
RECOGNISING ACHIEVEMENT

GCE

Chemistry

Advanced GCE **A2 7882**

Advanced Subsidiary GCE **AS 3882**

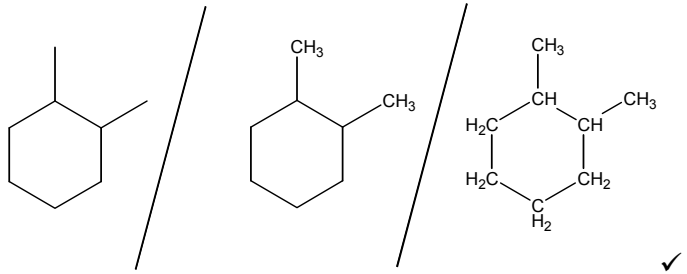
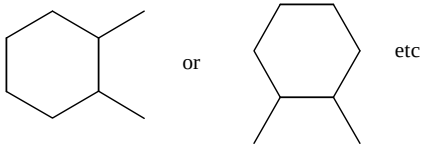
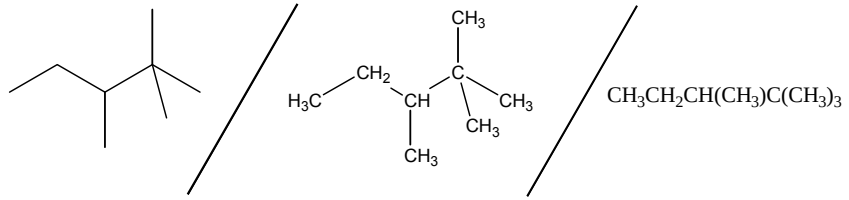
Mark Schemes for the Units

January 2009

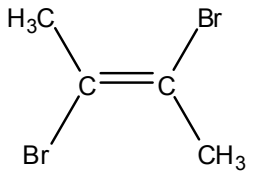
3882/7882/MS/R/09J

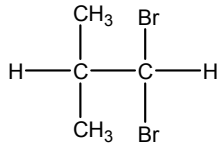
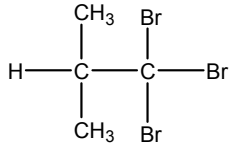
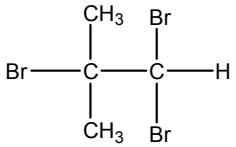
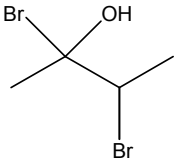
Oxford Cambridge and RSA Examinations

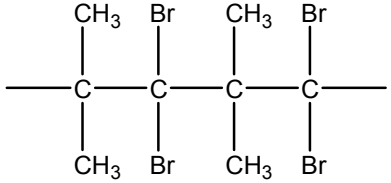
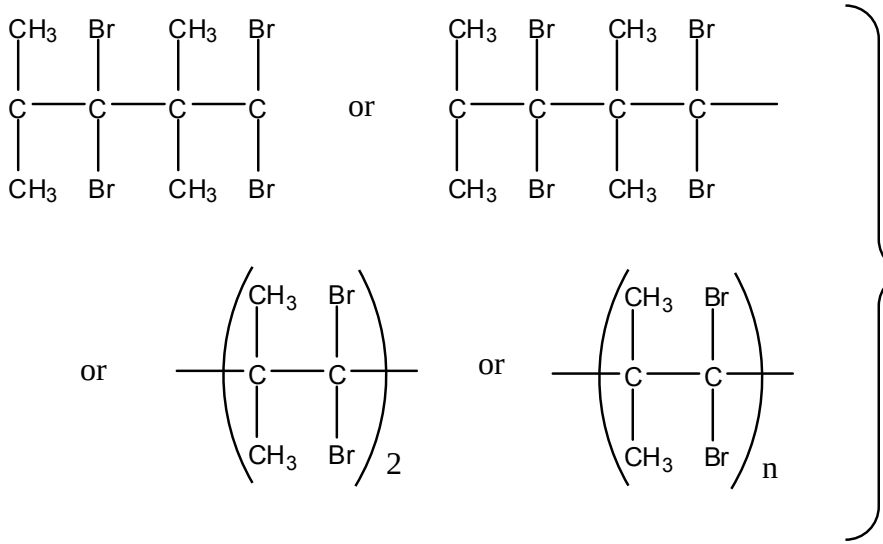
2812 Chains and Rings

Question			Expected Answers	Marks	Additional Guidance
1	(a)		compound/molecule that contains carbon & hydrogen **only** ✓	1	**allow** hydrocarbons contain carbon & hydrogen **only** **allow** molecules that contain carbon & hydrogen **only**
	(b)		$C_{14}H_{30} \longrightarrow C_8H_{18} + C_6H_{12}$ ✓	1	**allow** $CH_3(CH_2)_{12}CH_3 \longrightarrow CH_3(CH_2)_6CH_3 + C_6H_{12}$ **allow** any isomer of C_6H_{12} or any combination of alkenes that add up to C_6H_{12}.
	(c)	(i)	 ✓	1	**allow** different orientations as long as the two methyl groups are on adjacent Cs 
		(ii)	hydrogen/H_2✓	1	no other correct response
	(d)	(i)	 ✓	1	**allow** any unambiguous form of 2,2,3-trimethylpentane

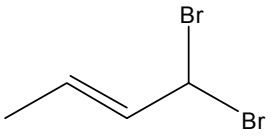
Question			Expected Answers	Marks	Additional Guidance
		(ii)	C_8H_{18} + $12½O_2$ ⟶ $8CO_2$ + $9H_2O$ ✓✓ 1 mark if all formulae are correct both marks if correctly balanced	2	**allow** $2C_8H_{18}$ + $25O_2$ ⟶ $16CO_2$ + $18H_2O$ **allow** structural, displayed or skeletal formula of C_8H_{18}.
	(e)	**(i)**	(feedstock is obtained) from plants ✓ which can be re-grown ✓	2	**allow** made from sugar cane/beet/biomass *for 1 mark* **not allow** just sugar **allow** made from sugar because it can be re-grown *for 2 marks* **not allow** just fermentation **allow** fermentation from/of plants *for first marking point*
		(ii)	CO_2 used in photosynthesis is balanced by CO_2 released in combustion/ it is carbon neutral ✓	1	**not allow** does not produce greenhouse gases **allow** doesn't emit any oxides of nitrogen/sulphur **not allow** doesn't produce toxic gases/acid rain If two statements are made and one is incorrect the mark is lost e.g. is carbon neutral and does not produce greenhouse gases *this gets ✗ con*
			Total	**10**	

Question			Expected Answers	Marks	Additional Guidance
2	(a)	i	1,1-dibromomethylpropene✓	1	**allow** 1,1-dibromo-2-methylpropene **allow** 2-methyl-1,1-dibromopropene **allow** methyl-1,1-dibromopropene **also allow** any of the above with prop-1-ene
		ii	M_r = 213.8 ✓ % = (159.8/213.8) x 100 = 74.7 ✓	2	**not allow** M_r = 214 for first mark **allow** any of: % = 75/74.74 or any correct rounding up to and including the calculator value of 74.74275023 **allow** **ecf** for correct rounding of 74.76635514 if used M_r 214 **ecf** for correctly calculating percentage from incorrect M_r 37.4% scores 1 mark
		(iii)	any dibromobut-1-ene any dibromobut-2-ene (except 2,3-dibromobut-2-ene) any dibromomethylpropene (except 1,1-dibromomethylpropene) any dibromocyclobutane any dibromomethylcyclopropane ✓	1	see page 10 at end of question for skeletal formulae of acceptable isomers Most common **incorrect** response is *trans*-2,3-dibromobut-2-ene 
	(b)	i	decolourised ✓	1	**not allow** goes clear / discoloured **allow** turns colourless/orange colour disappears **ignore** "clear" if "decolourises and goes clear" i.e. not 'CON'
		ii	electrophilic addition ✓	1	
		iii	molecular formula = $C_4H_6Br_4$ ✓ empirical formula = $C_2H_3Br_2$ ✓	2	 **allow** ecf from molecular formula $C_xH_yBr_z$

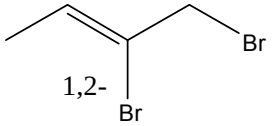
Question			Expected Answers	Marks	Additional Guidance
	(c)		 ✓ Ni/Pt ✓	2	Ignore bond linkage
	(d)	i	**B** is symmetrical ✓	1	**allow** **A** isn't symmetrical **ignore** A is asymmetric
		ii	 ✓  ✓	2	Ignore bond linkage
	e)	i	 ✓	1	**Do not allow** bond linkage to H in the OH, bond must **clearly** go to the O
		ii	reagent: steam/$H_2O_{(g)}$ ✓ conditions: phosphoric acid ✓	2	**allow** H_2O but only if temp is quoted above 100^oC **allow** sulphuric acid **not allow** acid catalyst **allow** reagent: phosphoric acid ✓ **allow** conditions: steam ✓ mention of alkali ✗ *con* acid mark

Question	Expected Answers	Marks	Additional Guidance
(f)	 backbone of 4 carbon atoms with "two end bonds" ✓ 4 CH_3s and 4 Brs attached ✓	2	 score 1 mark **allow** more than two repeat units **ignore** CH_3 bond linkage
	Total	**18**	

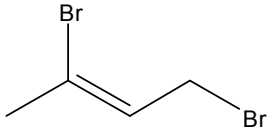
dibromobut-2-ene



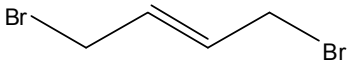
1,1-



1,2-

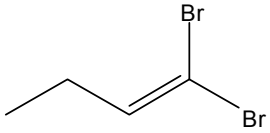


1,3-

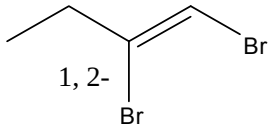


1,4-

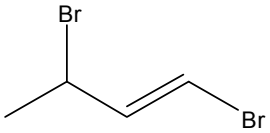
dibromobut-1-ene



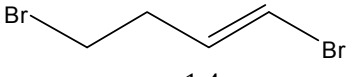
1,1-



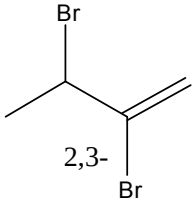
1, 2-



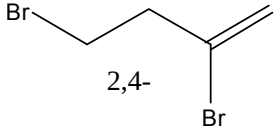
1,3-



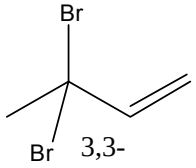
1,4-



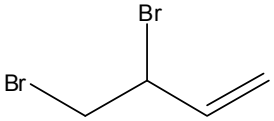
2,3-



2,4-

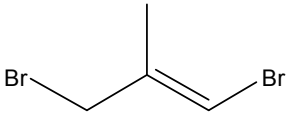


3,3-

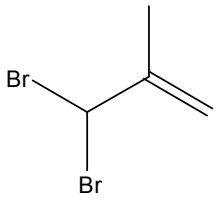


3,4-

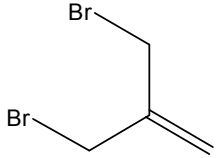
dibromomethylpropene



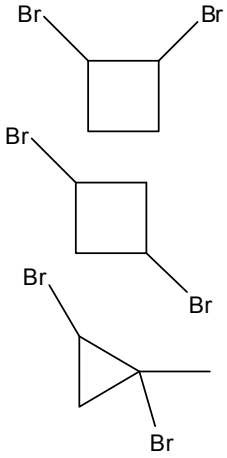
1,3-

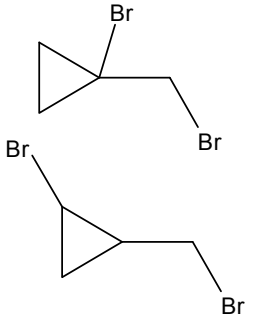


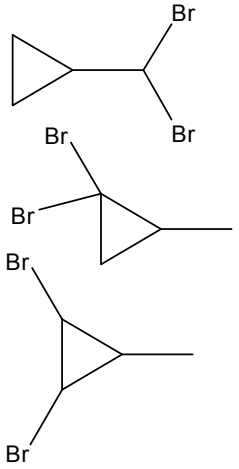
3,3-



dibromocycloalkanes

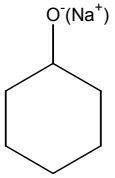
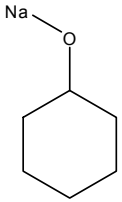
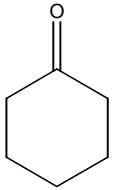
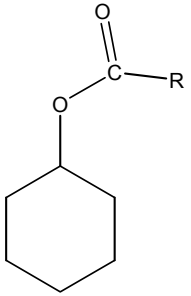
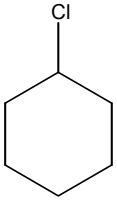
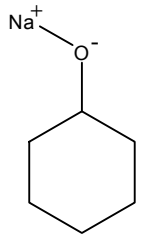


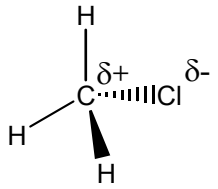
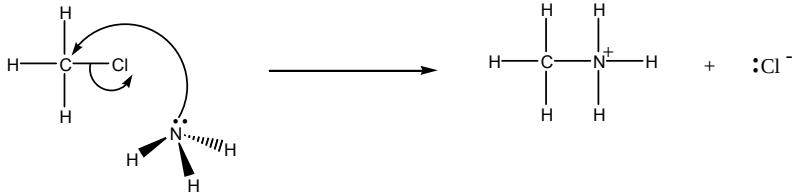




Q3a should be marked as a complete question NOT by item response

Question			Expected Answers	Marks	Additional Guidance
3	**(a)**	**i**	100 ✓	1	If incorrect ecf can be awarded for 3a(ii)
		ii	0.05 ✓	1	Check for ecf from 3a(i) if incorrect check response to part (iii) which can score all 3 marks as **ecf** to incorrect answer in (ii)
		iii	moles of cyclohexene = 1.8/82 / 0.02195 / 0.022 ✓ % yield = (0.022/0.05) x 100 = 43.9% ✓ % yield to 2 sig figs = 44% ✓	3	44% scores all 3 marks **allow** alternative method theoretical mass of cyclohexene = 0.05 x 82 = 4.1(g)✓ % yield = (1.8/4.1) x 100 = 43.9%✓ % yield to 2 sig figs = 44% ✓ **ecf** if M_r of cyclohexene is incorrect, the remaining two marks can be awarded e.c.f **ecf** % yield = (0.022/incorrect answer to (a)(ii)) x 100 for *max 3 marks* **do not allow** moles of cyclohexene rounded to 0.02 which will then lead to 40% yield. **allow** 40% will score 2 out of the 3 available marks **allow** 36% for *max 1 mark*

Question			Expected Answers				Marks	Additional Guidance
	(b)	i	(peak between) 3230–3550 (cm^{-1}) ✓ which shows presence of OH ✓				2	**do not allow** 2500–3500 (cm^{-1}) For OH **allow** peak within stated range Ignore any reference to C–O peak
		ii	Na	H^+ and $Cr_2O_7^{2-}$	RCOOH and conc H_2SO_4	PCl_5/ $SOCl_2$	1	**allow** RCOCl with observation of white fumes and product same as carboxylic acid
			bubbles/fizzes/effervesces **not allow** hydrogen gas/ gas evolved	orange to green	if RCOOH observation mark is not available	white fumes	1	If manganate(VII) used as oxidising agent then allow marks for observation (purple to colourless/green/brown) and product of cyclohexanone only
		iii	 charges not essential but **do not allow** 				1	**not allow** $C_6H_{11}ONa$ / $C_6H_{11}OOCR$/ $C_6H_{11}Cl$ product mark must be related to correct reagent. If no reagent then no product mark is possible **allow** one mark for bromocyclohexane as product if HBr used as reagent but no marks for reagent or observations **not allow** 
						Total	**10**	

Question			Expected Answers	Marks	Additional Guidance
4	(a)		 ✓ bond angle 109° 28' ✓	2	**allow** 109·5/ 109–110
	(b)	i	electron pair donor ✓	1	**allow** lone pair (of electrons) donor
		ii	 Step 1 curly arrow from lone pair on N to C ✓ curly arrow from C—Cl bond to Cl ✓	2	**not allow** any incorrect charges on reagents ✗*con 1 mark*
		iii	$CH_3Cl + 2NH_3 \longrightarrow CH_3NH_2 + NH_4Cl$ ✓	1	**allow** $CH_3Cl + 2NH_3 \longrightarrow CH_3NH_2 + NH_4^+ + Cl^-$ **not allow** $CH_3Cl + NH_3 \longrightarrow CH_3NH_2 + HCl$ **not allow** $CH_3Cl + 2NH_3 \longrightarrow CH_3NH_2 + HCl + NH_3$
		iv	methylamine/aminomethane ✓	1	**allow** even if equation in (b)(iii) is incorrect.

Question			Expected Answers	Marks	Additional Guidance
	(c)		reaction would be faster ✓ C—I bond is weaker/has lower bond enthalpy (than C—Cl bond) ✓	2	second mark is dependent on first mark *e.g. reaction is slower because C—I bond is weaker* scores no marks. **not allow** iodomethane / CH_3I has lower/weaker bond energy/enthalpy **not allow** C—I bond is longer **allow** C—I bond is longer, therefore weaker **not allow** iodine bond is weaker
			Total	**9**	

Question			Expected Answers	Marks	Additional Guidance
5	(a)		alkanes are non-polar ✓ nucleophiles/electrophiles are **attracted** to polar substances ✓ C–H bonds are strong ✓ allow max of 2 from 3	2	**allow** C–H bonds have little/no polarity/no dipoles **allow** no regions of high or low electron density **allow** nucleophiles/electrophiles/reagents are **not** attracted to non-polar substances **not allow** attacks/reacts as an alternative to attracts **allow** bonds in alkanes are strong
	(b)		Free radical substitution ✓ balanced equation $C_5H_{12} + Br_2 \rightarrow C_5H_{11}Br + HBr$ ✓ mechanism $Br_2 \longrightarrow 2Br\bullet$ ✓ $Br\bullet + C_5H_{12} \longrightarrow HBr + \bullet C_5H_{11}$ ✓ $\bullet C_5H_{11} + Br_2 \longrightarrow C_5H_{11}Br + Br\bullet$ ✓ any two free radicals to show termination step ✓ conditions: uv ✓ bond fission: homolytic fission ✓ mixed products due to: • multiple substitution of H (in C_5H_{12}) • several isomers of $C_5H_{11}Br$ • different products could be formed in termination step***** any two from three ✓✓	10	if a different alkane is used **do not allow** mark for either propagation step but the rest can be marked ecf If error in first propagation step ecf can be awarded for second propagation step **allow** any one of: $2Br\bullet \longrightarrow Br_2$ $Br\bullet + \bullet C_5H_{11} \longrightarrow C_5H_{11}Br$ $\bullet C_5H_{11} + \bullet C_5H_{11} \longrightarrow C_{10}H_{22}$ If H• formed in propagation allow ecf for a termination equation using the H• **allow** sunlight/high temperature **allow** homolysis/homolytic cleavage **do not allow** free radicals are very reactive/difficult to control ***** must be stated not just assumed if they write more than one termination step.

Question	Expected Answers	Marks	Additional Guidance
QWC	Well structured answer and uses all three of initiation, propagation and termination correctly✓	1	
	Total	**13**	