1 (a)(i) **F** ✓

(ii) $C_6H_{14}$ ✓

(iii) $CH_2$ ✓

(b) (i) **C**, **D** and **E** ✓

same (molecular) formula/number of atoms of each element,
different structure/arrangement of atoms/displayed formula/carbon backbone
**not** "spatial" arrangement ✓

(c) (i) **C** ✓

(ii) **C** ✓

(iii) van der Waals ✓

*Any mention of van der Waal's /dispersion/London forces gets one mark*

C> A &B due to the longer chain /number of electrons **hence** the greater the number of vdW's/ surface interaction/ intermolecular forces or converse ✓

C>D & E the more branched/compact/cannot pack together as close **hence** the fewer vdW's/surface interaction/ or converse ✓

. . Penalise only once

[Total :10]

2. (a) (i) Method mark if each element is divided by its own $A_r$

| | C | . | H | : | O | |
|---|---|---|---|---|---|---|
| ÷ by $A_r$ | 5 41 | . | 13.5 | : | 1.35 | ✓ |
| ÷ by 1.35 | 4 | : | 10 | : | 1 | ✓ |

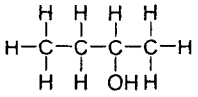
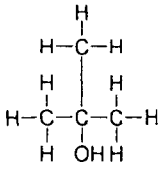
*Alternative approach is acceptable and would score both marks.*

| *C* | : | *H* | : | *O* | |
|---|---|---|---|---|---|
| $\frac{64.9 \times 74}{100}$ | : | $\frac{13.5 \times 74}{100}$ | : | $\frac{21.6 \times 74}{100}$ | |
| *48* | : | *10(9.99)* | : | *16(15.9)* | ✓ |
| *4* | : | *10* | : | *1* | ✓ |

*Divide each by its own $A_r$*

(ii) $C_4H_{10}O = 48 + 10 + 16 = 74$ ∴ molecular formula = $C_4H_{10}O$ ✓
*Must be some working as evidence as they are given $M_r = 74$ in the stem*

(b)

| structural isomer | displayed formula | name | classification | |
|---|---|---|---|---|
| 1 | | | primary | ✓ |
| 2 |  | butan-2-ol | | ✓✓ |
| 3 | | 2-methylpropan-1-ol | primary | ✓✓ |
| 4 |  | | tertiary | ✓✓ |

Any unambiguous structure gets the marks
$CH_3CH_2CHOHCH_3$ is OK
and the minimum allowed for the second is $(CH_3)_3COH$

[7]

3 (a) *If correct formulae are given instead of name do **not** penalise.*

*If both formula and name are given and they are conflicting the mark will not be awarded*

reaction 1

sodium or potassium hydroxide/ $OH^-$/hydroxide/NaOH/KOH ✓
water/(aq)/ $H_2O$ ✓

reaction 2

ammonia/$NH_3$ ✓
ethanol/ethanol+water/alc/$C_2H_5OH$ ✓

reaction 3

sodium or potassium hydroxide/ $OH^-$/hydroxide/NaOH/KOH ✓

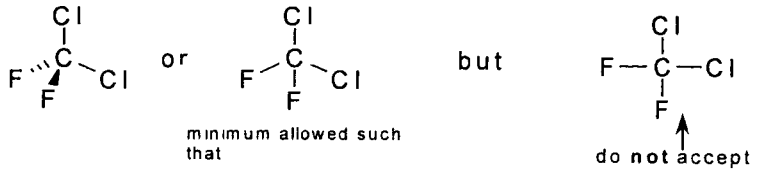
ethanol/ alc/ $C_2H_5OH$ ✓

(b) Slower: ✓

C-Cl bond > C-Br bond/ C-Cl bond is shorter/stronger than C-Br bond/ Higher activation energy with C-Cl ✓

*If faster is given .... this is incorrect and gets no mark*
*but if they give the reason for it being faster as*

*Cl is more electronegative/C-Cl is more polar this gets 1 mark* ✓*ecf*

(c)(i) 


✓

(ii) $109^o\ 28'$ (range $108 - 110^o$) ✓

(iii) Volatile/low boiling point/ unreactive/ inert/non-flammable/non-toxic ✓

(iv) each takes one (covalent)electron/ $Cl_2 \rightarrow 2Cl\bullet$ ✓

(v) Bond : C-Cl ✓

Reason. C-Cl bond weaker/longer/ C-F bond stronger/ C-F>C-Cl ✓

(vi) Cl(•) ✓

(•) $CClF_2$ ✓

If (c) (v) incorrectly identified as C-F you (vi) can be marked consequentially

[Total : 16]

4. (a) Water/ $H_2O$/cyclohexanol/$C_6H_{11}OH$/$C_6H_{12}O$ ✓
*(not $H_3PO_4$ as it boils/dehydrates @ 213 °C)*

(b) (i) 100 ✓

(ii) 0 1 mark ecf to (i) ✓

(iii) 82 *(used for $M_r$ of cyclohexene)* ✓

0.045 (*gets both marks)* ✓

(iv) $\frac{\text{moles of cyclohexene}}{\text{moles of cyclohexanol}} \times 100$ ✓

45% ✓

*Part (iv) can be marked consequentially from parts (ii) and (iii) such that*

(iii)/(ii) x 100 *gets 1 mark*

*and would get both marks if the mathematics are carried out correctly*

[Total : 7]

5. (a)(i) An Electrophile is an electron/lone pair acceptor ✓

(ii) Example anything with a + charge (except a metal ion) e.g $Cl^+$, $NO_2^+$, $H^+$ alsoaccept $Br_2$, $Cl_2$, $H_2SO_4$,HBr,$H_2$ ✓

(iii) Balanced equation for electrophilic addition,

$C_2H_4 + XY \rightarrow C_2H_4XY$/ $C_2H_4 + X_2 \rightarrow C_2H_4X_2$ ✓

(b)(i) Nucleophile is a electron/lone pair donor ✓

(ii) Example $Cl^-$, $OH^-$, $CN^-$, $NH_3$, $H_2O$, ROH ✓

(iii) Balanced equation for nucleophilic substitution,

$RX + Y^- \rightarrow RY + X^-$ / $RX + HY \rightarrow RY + HX$ ✓

typically $Y^-$ could be anyone of $Cl^-$, $OH^-$, $CN^-$
whilst HY could be anyone of $NH_3$, $H_2O$, ROH

(c)(i) Free radical has a single/unpaired electron (**not** a free electron) ✓

(ii) Example any suitable radical e.g. •Cl , $\bullet CH_3$, Br• ✓

(iii) Balanced equation for a free radical substitution.

$CH_4 + \bullet Cl \rightarrow \bullet CH_3 + HCl$ / $\bullet CH_3 + Cl_2 \rightarrow CH_3Cl + \bullet Cl$ /
$CH_4 + Cl_2$ or $2Cl\bullet \rightarrow CH_3Cl + HCl$ ✓

[Total : 9]

6. (a)(i) (will be marked as a single sub-unit worth 4 marks) There are 5 marking points with a maximum of 4. If $MnO_4^-$ used max = 3 marks

| | |
|---|---|
| **5** marking points for | **4** marks |
| **4** marking points for | **3** marks |
| **3** marking points for | **2** marks |
| **2** marking points for | **1** mark |

$Cr_2O_7^{2-}$ / dichromate/ sodium or potassium dichromate/ $Na_2Cr_2O_7$/ $K_2Cr_2O_7$ ✓

Acidified/ $H^+$/ sulphuric acid / $H_2SO_4$ ✓

reflux/heat/warm ✓

Orange ✓ to Green ✓

*Record marks in the margin as* $5 \rightarrow \underline{4}$ *or* $3 \rightarrow \underline{2}$

(ii) Reflux: ✓

to ensure complete oxidation/ avoid partial oxidation/to form the acid/to avoid distillation of aldehyde ✓

(iii) $C_7H_{16}O$ /$C_7H_{15}OH$ ✓

(iv) $C_7H_{16}O + 2[O] \rightarrow C_7H_{14}O_2 + H_2O$ ( 1mark for both products) ✓✓

Correctly balanced equation gets both marks

(v) aldehyde/$C_7H_{14}O$/ 2-ethyl-3-methylbutanal ✓

(b) (2-ethyl-3-methylbutan-2-ol is a) <u>tertiary</u> alcohol ✓

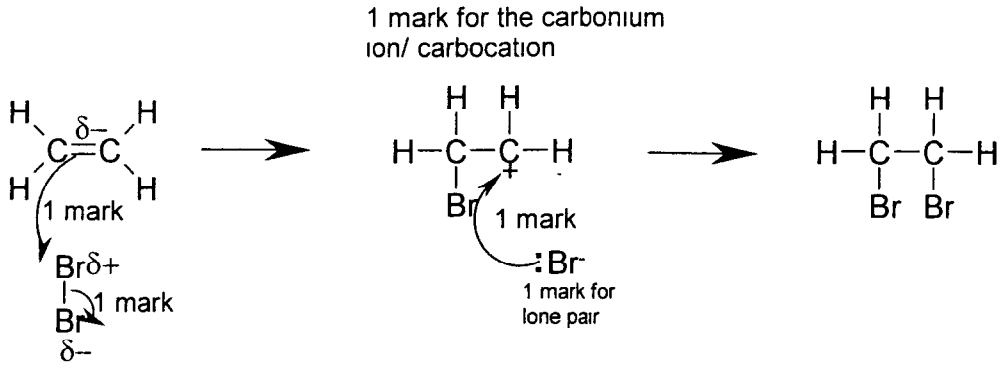
tertiary alcohols are **not** (readily) oxidised/does not react with $(H^+)/Cr_2O_7^{2-}$ ✓

[Total . 12]

7. (bromine is) decolourised ( do not accept clear) ✓

Product: 1,2-dibromoethane ✓

***Maximum of 4 marks for the mechanism***




Electrophilic addition ✓

Induced dipole in the $Br_2$/ dipoles shown correctly on the Br-Br bond ✓

curly arrow on Br-Br bond as shown/hetrolytic fission ✓

Curly arrow from the π- bond to the bromine or words to that effect ✓

Intermediate carbonium ion/ carbocation ✓

Curly arrow from $Br^-$ back to the carbonium ion/ carbocation/nucleophilic attack/$Br^-$ forms a covalent bond with the carbocation ✓

Lone pair of electrons shown on the $Br^-$ (and curly arrow from lone pair to the carbonium ion/ carbocation)/ $Br^-$ acys as a lone pair donor ✓

**[9marks; max = 6]**

1 mark for quality of written expression awarded for the description / layout of the mechanism making use of appropriate chemical terms/symbols The mark should be awarded if two or more of the following are used correctly:

- lone pair
- polarised
- hetrolytic fission/hetrolysis
- induced dipole
- curly arrows
- carbonium ion/ carbocation
- electrophilic addition ✓

If two or more chemistry marks are awarded for the mechanism I would also expect the QWC to be awarded.

Record marks for the question by counting ✓given for the chemistry as a total (max =6) followed by either ✓QWC or **x**QWC and the total for the question {chemistry + QWC} circled at the end of the question. It should look something like·

5
✓QWC

8. (a) **Cracking:**

The lighter/smaller/shorter fractions are the more useful/ in demand ✓

Heavier/longer chains cracked into shorter chains + alkene ✓

Suitable balanced equation ✓

Using heat/catalyst/ both ✓

Point of fission is variable therefore get a great variety of products ✓

Alkenes have great importance as a starting point for other products/suitable example/equation e.g. ethanol/polymers etc ✓

**Reforming:**

(Reforming converts straight chains into) ring compounds/cycloalkanes/arenes ✓

Suitable balanced equation for cycloalkane ✓
$C_6H_{14} \rightarrow C_6H_{12} + H_2$
Suitable balanced equation for arene ✓
$C_6H_{14} \rightarrow C_6H_6 + 4H_2$ / $C_6H_{12} \rightarrow C_6H_6 + 3H_2$

**Isomerisation:**

Isomerisation converts straight chains into branched chains. ✓

Suitable example. ✓

Ring compounds and/or branched chain compounds are better fuels than straight chain compounds (***not** just good fuels, there must be a comparison*)/ added to petrol to promote smoother combustion/ avoid knocking/ increase octane number or rating. ✓

**12 max = 9**

(*1 mark is available for the quality of written communication.*)
This mark should be awarded for spelling, punctuation and grammar. It will be unusual **not** to give the mark. ✓

Record marks for the question by counting ✓given for the chemistry as a total (max =9) followed by either ✓QWC or **x**QWC and the total for the question {chemistry + QWC} circled at the end of the question It should look something like:

7
✓QWC