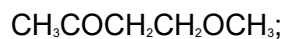


- M1.(a)** Fractional distillation (under reduced pressure) 1
- (b) BaSO₄ insoluble / remove by filtration
Do not allow answers which refer to reaction rate 1
- (c) Both contain OH group
Allow OH stretch in ir spectrum of each compound
Do not allow 'same bonds' 1
- [3]**

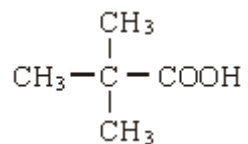
- M2.** (a) (i)
- $$\begin{array}{c} \text{H}_3\text{C} - \text{C} \\ \parallel \\ \text{O} \end{array} \text{ or RCOCH}_3;$$
- (or description in words)*
(ignore trailing bonds) 1
- (ii) H₃C—O or ROCH₃;
(allow 1 if both (i) and (ii) give CH₃- or H₃C- only) 1
- (iii) CH₂CH₂ or two adjacent methylene groups; 1
- (iv)
- $$\begin{array}{c} \text{CH}_3 - \text{C} - \text{CH}_2 - \text{CH}_2 - \text{OCH}_3 \\ \parallel \\ \text{O} \end{array}$$
- OR



1

(b) (i) OH in acids or (carboxylic) acid present

(ii)



(c)

reagent	$\text{K}_2\text{Cr}_2\text{O}_7 / \text{H}^+$	$\text{KMnO}_4 / \text{H}^+$
Y	no reaction	no reaction
Z	orange to green or turns green	purple to colourless or turns colourless

5

[9]

M3. (a) Allow 1 mark each for any correctly drawn primary, secondary and tertiary alcohol of molecular formula $\text{C}_4\text{H}_8\text{O}$

3

Tertiary alcohol cannot be oxidised

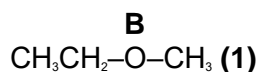
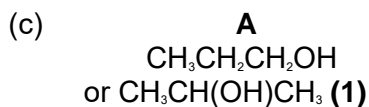
1

(b) Region $1500\text{--}400 \text{ cm}^{-1}$

1

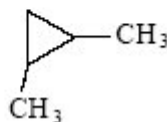
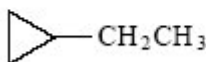
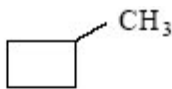
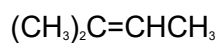
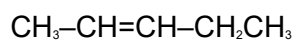
exact match to spectrum of known compound

1



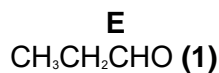
C
 one alkene e.g.

D
 one cycloalkane e.g.



(1)
 etc

(1)



6

[12]

M4. (a) Functional group (isomerism)

1

(b)

M1 Tollens' (reagent)
 (Credit ammoniacal silver nitrate OR a description of making Tollens')
 (Ignore either AgNO_3 or $[\text{Ag}(\text{NH}_3)_2]^+$ or "the silver mirror test" on their own, but mark M2 and M3)

M1 Fehling's (solution) or Benedict's solution
 (Ignore $\text{Cu}^{2+}(\text{aq})$ or CuSO_4 on their own, but mark on to M2 and M3)

M2 silver mirror

M2 Red solid/precipitate
 (Credit orange or brown solid)

OR

black solid/precipitate
 (NOT silver precipitate)

M3 (stays) colourless
 or no change or no reaction

M3 (stays) blue
 or no change or no reaction

Mark on from an incomplete/incorrect attempt at the correct

reagent, penalising M1

No reagent, CE=0

Allow the following alternatives

M1 (acidified) potassium dichromate(VI) (solution)

M2 (turns) green

M3 (stays) orange/no change

OR

M1 (acidified) potassium manganate(VII) (solution)

M2 (turns) colourless

M3 (stays) purple/no change

For M3

Ignore "nothing (happens)"

Ignore "no observation"

3

(c) (Both have) C=O **OR** a carbonyl (group)

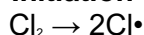
1

(d) (i) (Free-) radical substitution ONLY

Penalise "(free) radical mechanism"

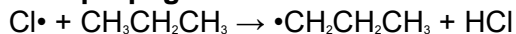
1

(ii) **Initiation**



Penalise absence of dot once only.

First propagation

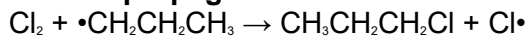


OR C_3H_8

Penalise incorrect position of dot on propyl radical once only.

Penalise $\text{C}_3\text{H}_7\cdot$ once only

Second propagation

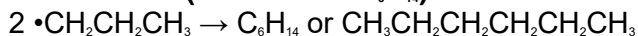


OR

$\text{C}_3\text{H}_7\text{Cl}$

Accept $\text{CH}_3\text{CH}_2\text{CH}_2\cdot$ with the radical dot above/below/to the side of the last carbon.

Termination (must make C_6H_{14})



Use of the secondary free radical might gain 3 of the four marks

4

- (e) $M_r = 44.06352$ (for propane)
 $M_r = 43.98982$ (for carbon dioxide)

Mark independently

M1 a correct value for both of these M_r values.

M2 a statement or idea that two peaks appear (in the mass spectrum)

OR

two molecular ions are seen (in the mass spectrum).

2

[12]

- M5.** (a) Secondary **OR** 2° (alcohol);

1

- (b) Spectrum is for **butanone (or formula) or butan-2-one**

The explanation marks depend on correctly identifying butanone.

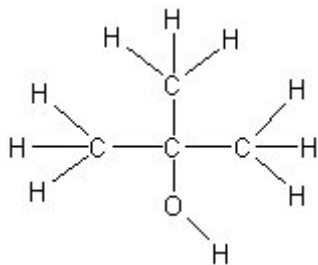
If butanone is correctly identified, award any two from

- (Strong) absorption / peak at approximately 1700 (cm⁻¹) / 1710 (cm⁻¹) / in the range 1680 – 1750 (cm⁻¹) This needs to be stated.
- (Characteristic) absorption / peak for C=O (may be shown on the spectrum in the correct place).
- No absorption / peak in range 3230 to 3550 cm⁻¹.
- No absorption / peak for an OH group.
*Look at the spectrum to see if anything is written on it that might gain credit.
Allow the words "dip" OR "spike" OR "low transmittance" as alternatives for absorption.*

1

2

- (c) Displayed structure for 2-methylpropan-2-ol

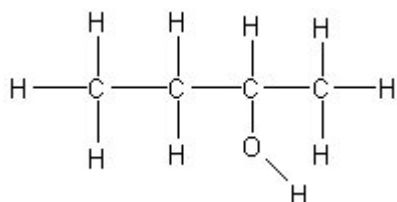


Must have **all bonds** drawn out but ignore the bond angles

1

[5]

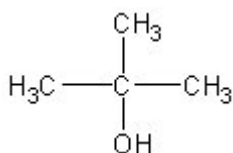
- M6.** (a) **M1**
Displayed formula for butan-2-ol



M1 displayed formula must have all bonds drawn out, including the O—H but ignore angles

Penalise "sticks"

M2 Alcohol X is



M2 structure must be clearly identifiable as 2-methylpropan-2-ol and may be drawn in a variety of ways.

M3 Alcohol Y is named (2)-methylpropan-1-ol ONLY

M3 must be correct name, but ignore structures

3

- (b) **M1** The infrared spectrum shows an absorption/peak in the range 3230 to 3550 (cm⁻¹) (which supports the idea that an alcohol is present)
In M1, allow the words "dip", "spike", "low transmittance" and "trough" as alternatives for absorption.

M2 Reference to the 'fingerprint region' or below 1500 (cm⁻¹)

M3 Match with or same as known sample/database spectra

Check the spectrum to see if alcohol OH is labelled and credit.

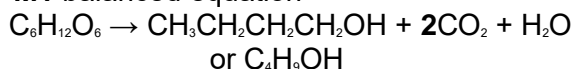
OR

M2 Run infrared spectra (of the alcohols)

M3 Find which one matches or is the same as this spectrum.

3

(c) **M1** balanced equation

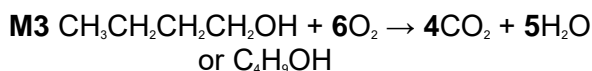


Or multiples for M1 and M3

In M1 and M3 penalise use of C₄H₁₀O or butan-2-ol once only

M2 Any one from

- excess/adequate/sufficient/correct amount of/enough/plenty/ a good supply of oxygen or air
- good mixing of the fuel and air/oxygen
*For M2, do not accept simply "oxygen" or "air" alone
Ignore reference to "temperature"*



M4 A biofuel is a fuel produced from (renewable) biological (re)source(s)

OR

(renewable) (re)source(s) from (a specified) plant(s)/fruit(s)/tree(s)

In M4

Ignore references to "carbon neutral"

Ignore "sugar" and "glucose"

4

(d) **M1** butan-1-ol is a primary or 1° (alcohol)

M2 Displayed formula (ONLY) for butanal CH₃CH₂CH₂CHO

M3 Displayed formula (ONLY) for butanoic acid CH₃CH₂CH₂COOH

M2 and M3 displayed formula must have all bonds drawn out including the O—H but ignore angles.

If butanal and butanoic acid formulae are both correctly given but not displayed, credit one mark out of two.

M4 Oxidation (oxidised) OR Redox

M5 orange to green

*Both colours required for M5
Ignore states*

5

[15]