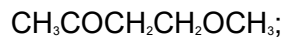


- M1.(a)** Fractional distillation (under reduced pressure) 1
- (b) BaSO<sub>4</sub> insoluble / remove by filtration  
*Do not allow answers which refer to reaction rate* 1
- (c) Both contain OH group  
*Allow OH stretch in ir spectrum of each compound*  
*Do not allow 'same bonds'* 1
- [3]**

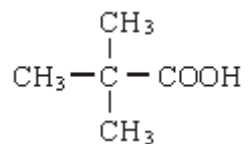
- M2.** (a) (i)
- $$\begin{array}{c} \text{H}_3\text{C} - \text{C} \\ \parallel \\ \text{O} \end{array} \text{ or RCOCH}_3;$$
- (or description in words)*  
*(ignore trailing bonds)* 1
- (ii) H<sub>3</sub>C—O or ROCH<sub>3</sub>;  
*(allow 1 if both (i) and (ii) give CH<sub>3</sub>- or H<sub>3</sub>C- only)* 1
- (iii) CH<sub>2</sub>CH<sub>2</sub> 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	$\text{K}_2\text{Cr}_2\text{O}_7 / \text{H}^+$	$\text{KMnO}_4 / \text{H}^+$
<b>Y</b>	no reaction	no reaction
<b>Z</b>	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

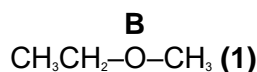
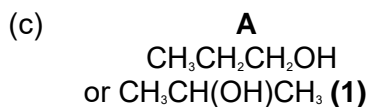
1

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

1

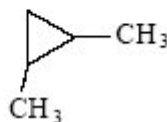
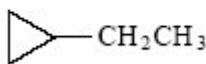
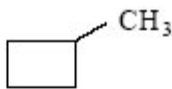
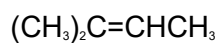
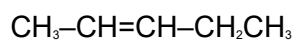
exact match to spectrum of known compound

1



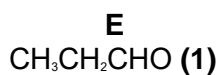
**C**  
 one alkene e.g.

**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  $\text{AgNO}_3$  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  $\text{CuSO}_4$  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)

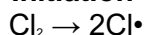
1

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

*Penalise "(free) radical mechanism"*

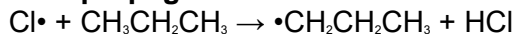
1

(ii) **Initiation**



*Penalise absence of dot once only.*

**First propagation**

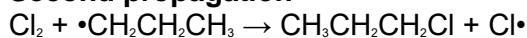


OR  $\text{C}_3\text{H}_8$

*Penalise incorrect position of dot on propyl radical once only.*

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

**Second propagation**

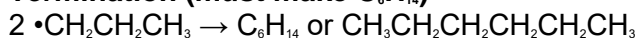


**OR**



*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  $\text{C}_6\text{H}_{14}$ )**



*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<sup>-1</sup>) / 1710 (cm<sup>-1</sup>) / in the range 1680 – 1750 (cm<sup>-1</sup>) 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<sup>-1</sup>.

1

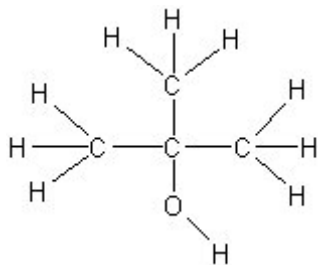
- No absorption / peak for an OH group.

*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.*

2

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

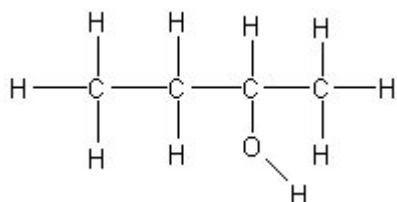


Must have **all bonds** drawn out but ignore the bond angles

1

[5]

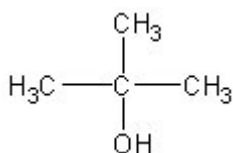
- M6.** (a) **M1**  
Displayed formula for butan-2-ol



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<sup>-1</sup>) (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<sup>-1</sup>)

**M3** Match with or same as known sample/database spectra

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

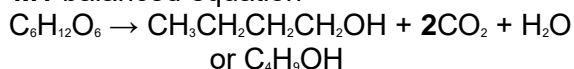
**OR**

**M2** Run infrared spectra (of the alcohols)

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

3

(c) **M1** balanced equation

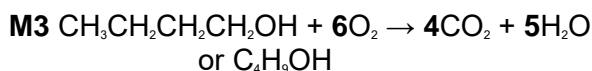


*Or multiples for M1 and M3*

*In M1 and M3 penalise use of C<sub>4</sub>H<sub>10</sub>O 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 CH<sub>3</sub>CH<sub>2</sub>CH<sub>2</sub>CHO

**M3** Displayed formula (ONLY) for butanoic acid CH<sub>3</sub>CH<sub>2</sub>CH<sub>2</sub>COOH

*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]