M1.(a) Reagent

Acidified
$K_2Cr_2O_7$

Acidified
$KMnO_4$

I_2 / NaOH

Named
RCOOH with HCl or H_2SO_4

Named
RCOCl

Allow names including potassium permanganate
Wrong or no reagent CE = 0

1

P (ketone)
no reaction
no reaction
Yellow ppt
no reaction
no reaction

Penalise incorrect formulae or incomplete reagent, such as $K_2Cr_2O_7$ or acidified dichromate, but mark on.

1

S (2° alcohol)
(orange to) green
(purple to) colourless
no reaction
fruity or sweet smell
Misty fumes

Allow no change or nvc but penalise <u>nothing or no observation</u>
If 2 reagents added sequentially or 2 different reagents used for P and S then CE = 0

1

(b) Tollens'
silver mirror / solid

1

Fehling's / Benedicts
red ppt

1

(c) **G**
P

If not P then no marks for clip

1

5 OR five

1

(d) $C_4H_{12}Si$

Must be molecular formula
Wrong substance CE = 0 for clip

1

Any **two** from

- One or single peak OR all (four) carbon atoms are equivalent or one environment

1

- upfield from others or far away from others or far to right
- non toxic OR inert
- low boiling point or volatile or easy removed from sample

Ignore and don't credit single peak linked to 12 equivalent H or has a peak at δ = 0

but use list principle for wrong statements

1
1

(e) Figure 1 is **R**

*If not **R** cannot score M2*

M1

1

90−150 (ppm) or value in range is (two peaks for) C = C / alkene

M2

1

Figure 2 is **T**

*If not **T** cannot score M4 or M5*

M3

1

50-90 (ppm) or value in range is C—O or alcohol or ether

M4

1

two peaks (so not S which would have only one)

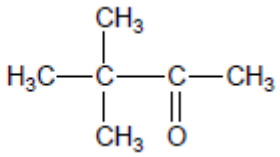
M5

1

(f)

U

$C_6H_{12}O_6$

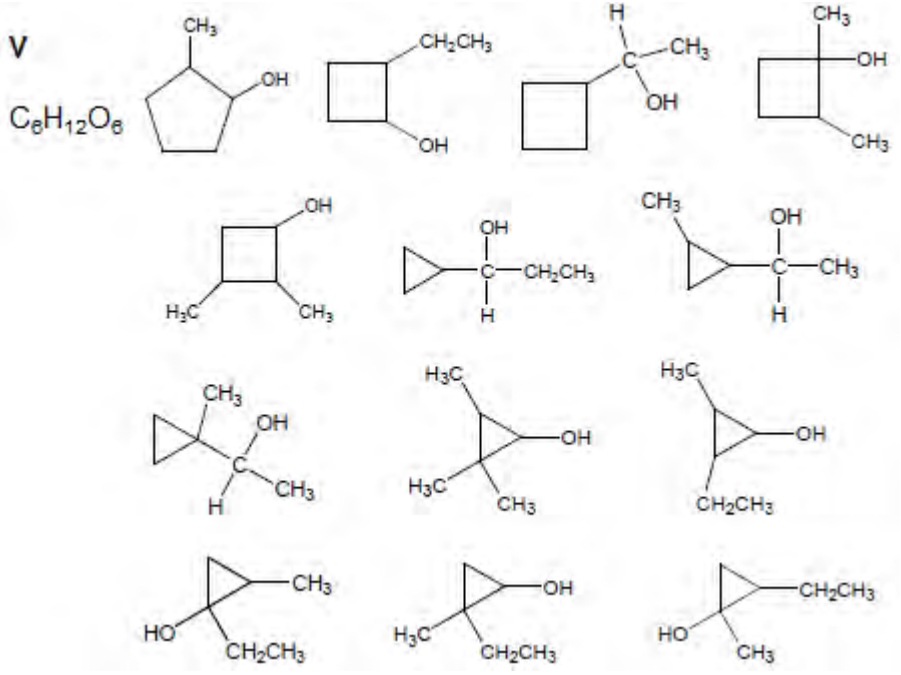


1

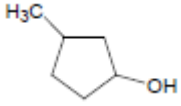
Answers include

V

$C_6H_{12}O_6$



*Not allow **S***



*because **V** must be an isomer of **S***

[17]

M2.6 / six

[1]

M3.(a) (i) Single / one (intense) peak / signal ***OR*** all H or all C in same environment ***OR*** 12 equiv H or 4 equiv C

Do not allow non-toxic or inert (both given in Q)

Any 2 from three

Ignore peak at zero

OR

Upfield / to the right of (all) other peaks ***OR*** well away from others ***OR*** doesn't interfere with other peaks

Ignore cheap

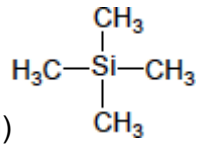
Ignore non-polar

OR

Low bp ***OR*** volatile ***OR*** can easily be removed

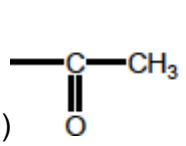
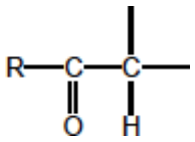
Ignore mention of solubility

2

(ii) 

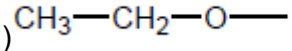
Allow $Si(CH_3)_4$

1

(b) (i)  or with sticks or 

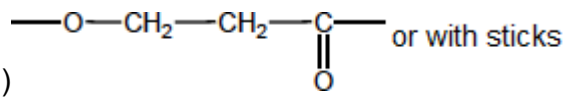
Ignore any group joined on other side of CO
Ignore missing trailing bond
Ignore charges

1

(ii)  or with sticks

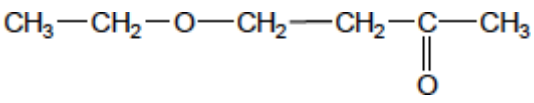
Ignore any group joined on other side of −O−
Ignore missing trailing bond
Ignore charges as if MS fragment

1

(iii)  or with sticks

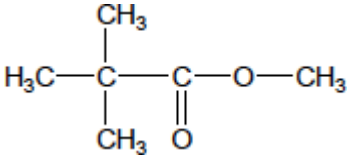
Ignore missing trailing bonds
Ignore charges as if MS fragment

1

(iv) 

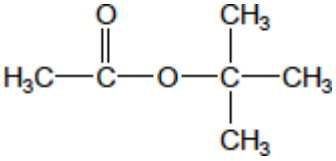
1

(c) (i) Check structure has 6 carbons



Allow $(CH_3)_3CCOOCH_3$ or $(CH_3)_3CCO_2CH_3$

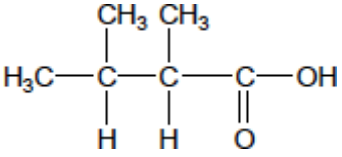
1



Allow $CH_3COOC(CH_3)_3$ or $CH_3CO_2C(CH_3)_3$

1

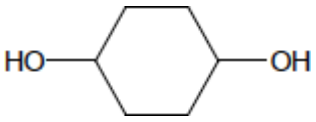
(ii) Check structure has 6 carbons



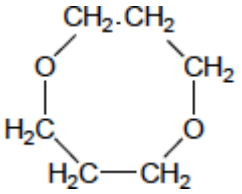
Allow $(CH_3)_2CHCH(CH_3)COOH$ or $(CH_3)_2CHCH(CH_3)CO_2H$
Penalise C_3H_7

1

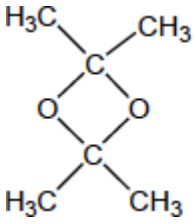
(iii) Check structure has 6 carbons



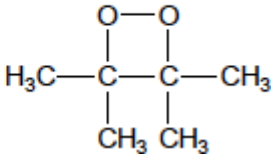
OR



Allow



OR



1

[11]

M4.(a) (i) $CDCl_3$ or CD_2Cl_2 or C_6D_6 or CCl_4

Not D_2O Allow CD_3Cl

1

(ii) 4 **or four**

1

(iii) Triplet or 3 or three

1

(iv) 1,4-dichloro-2,2-dimethylbutane

Do not penalise different or missing punctuation or extra spaces.

Spelling must be exact and order of letters and numbers as here.

1

(b) (i) 3 or three

1

(ii) 190-220 (cm^{-1})

Allow a single number within the range.

***OR** a smaller range entirely within this range.*

1

(iii) hexan**e**-2,5-dione

Do not penalise different or missing punctuation or extra spaces.

Spelling must be exact and order of letters and numbers as here.

NB so must have middle e

1

[7]

M5.IR

Extended response

Absorption at 3360 cm^{-1} shows OH alcohol present

Deduction of correct structure without explanation scores maximum of 4 marks as this does not show a clear, coherent line of reasoning.

M1

1

NMR

There are 4 peaks which indicates 4 different environments of hydrogen

Maximum of 6 marks if no structure given OR if coherent logic not displayed in the explanations of how two of OH, CH_3 and CH_2CH_3 are identified.

M2

1

The integration ratio = 1.6 : 0.4 : 1.2 : 2.4

The simplest whole number ratio is 4 : 1 : 3 : 6

M3

1

The singlet (integ 1) must be caused by H in OH alcohol

M4 **1**

The singlet (integ 3) must be due to a CH_3 group with no adjacent H

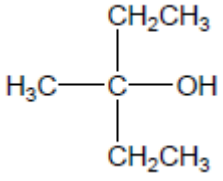
M5 **1**

Quartet + triplet suggest CH_2CH_3 group

M6 **1**

Integration 4 and integration 6 indicates two equivalent CH_2CH_3 groups

M7 **1**



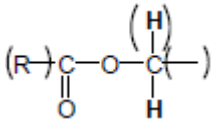
M8 **1**

[8]

M6.(a) M1 Ester **1**

If Ester 2, can score M3 only.

1

M2 peak at δ = 4.1 due to 

When marking M2 and M3, check any annotation of structures in the stem at the top of the page.

1

M3 (δ = 4.1 peak is) quartet as adjacent / next to / attached to CH_3 **1**

M4 Other spectrum quartet at δ = 2.1-2.6 (or value in this range) **1**

(b) M1 Quaternary (alkyl) ammonium salt / bromide **1**

M2 CH_3Br or bromomethane

Penalise contradictory formula and name. **1**

M3 Excess (CH_3Br or bromomethane)

Mention of acid eg H_2SO_4 OR alkali eg NaOH loses both M2 and M3. **1**

M4 Nucleophilic substitution

Can only score M3 if reagent correct.

Ignore alcohol or ethanol (conditions) or Temp. **1**

(c)

	Bromine (penalise Br but mark on)	Acidified $KMnO_4$ (Penalise missing acid but mark on)

Wrong reagent = no marks.

If bromine colour stated it must be red, yellow, orange, brown or any combination, penalise wrong starting colour. **1**

Benzene	no reaction / colour remains	no reaction / colour remains / no (visible)

	/ no (visible) change	change

Ignore 'clear', 'nothing'.
Allow colour fades slowly.
Allow 'nvc' for no visible change.

1

cyclohexene	(Bromine) decolourised	(Acidified $KMnO_4$) decolourised

1

[11]

M7.C

[1]