M1. (a) (i) There are three pairs of equivalent carbon atoms

1

(ii) 75ppm

1

(b) (i) 4

1

(ii) 2

1

(c) Each structure can represent a pair of cis/Z and trans/E isomers
OR
Optical isomers

1

[5]

M2. (a) (i)

Reagent	Tollens	Fehlings or Benedicts	$K_2Cr_2O_7/H^+$ or acidified	$KMnO_4/H^+$	I_2/NaOH
Propanal	silver (mirror)	red ppt or goes red *(not red solution)*	goes green	goes colourless	No reaction
Propanone	no reaction	no reaction	no reaction	no reaction	Yellow (ppt)

(penalise incomplete reagent e.g. $K_2Cr_2O_7$ or $Cr_2O_7^{2-}/H^+$ then mark on)

3

(ii) propanal 3 peaks
ignore splitting even if wrong

1

propanone 1 peak

1

(b) **X** is CH_3CH_2COOH or propanoic acid if both name and formula given, both must be correct, but

1

Y is $CH_3CH(OH)CH_3$ or propan-2-ol allow propanol with correct formula

1

Mark the type of reaction and reagent/condition independently.
The reagent must be correct or close to score condition

Step 1 Oxidation

$K_2Cr_2O_7/H^+$ or other oxidation methods as above
allow $Cr_2O_7^{2-}H^+$ if penalised above (ecf)
reflux (not Tollens/Fehlings) or heat or warm

1

Step 2

reduction or nucleophilic addition	reduction or nucleophilic addition	reduction or hydrogenation	1
$NaBH_4$	$LiAlH_4$	H_2	1
in (m)ethanol or water or ether or dry	ether or dry	Ni / Pt etc	1

Step 3 esterification or (nucleophilic) addition-elimination or condensation

1

(conc) H_2SO_4 or HCl

1

warm (allow without acid reagent if **X** and **Y** given as reagents)

1

or reflux or heat

1

[15]

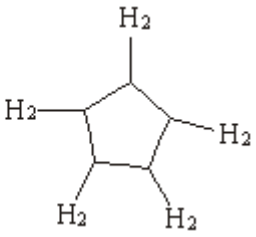
M3. (a) **A** any C_5 alkene

1

B

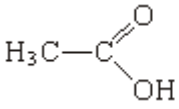
etc

penalise

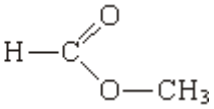


1

(b) **C**



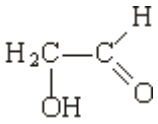
or



or CH_3COOH or $HCOOCH_3$

1

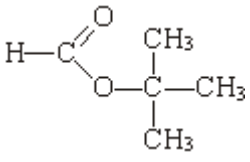
D



or $HOCH_2CHO$

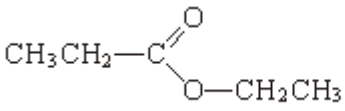
1

(c) **E**



1

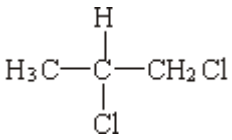
F



(allow C_2H_5)

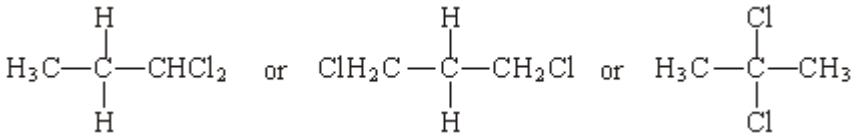
1

(d) **G**



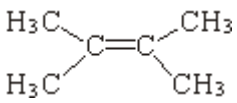
1

H



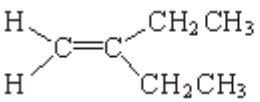
1

(e) **I**



1

J


(allow C_2H_5) **NOT** hex-3-ene

1

[10]

M4. (a) **X** (O–H) <u>(alcohols)</u>

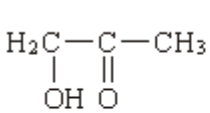
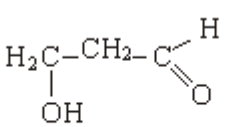
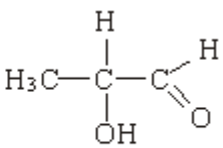
penalise acid or missing "alcohol"

1

Y C=O

allow carbonyl

1

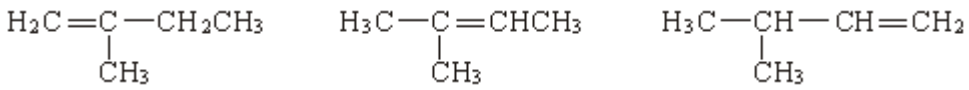




A

NOT acid

4

(b)

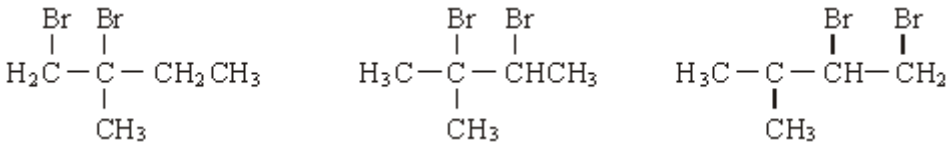


Allow conseq dibromocompounds following incorrect unbranched alkenes

NOT allow dibromocompound consequent on a duplicate alkene

NOT allow monobromocompounds if HBr added

3



3

6:3:1 either next to correct structure or to none

1

Allow a mark for identifying correct dibromocompound with three peaks even if integration ratio is wrong

1

if 6:3:1 missing or wrong, no marks for splitting

Only award a mark for splitting if it is clear which integration number it refers to

6 singlet or drawn

1

3 doublet or drawn

1

1 quartet/quadruplet or drawn

1

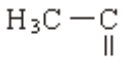
(max 10 marks)

[16]

M5.D

[1]

M6. (a) (i)


or $RCOCH_3$;

(or description in words)
(ignore trailing bonds)

1

(ii) $H_3C—O$ or $ROCH_3$;

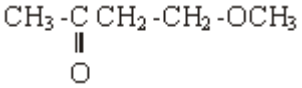
(allow 1 if both (i) and (ii) give CH_3- or H_3C– only)

1

(iii) CH_2CH_2 or two <u>adjacent</u> methylene groups;

1

(iv)



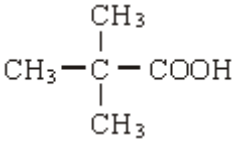
OR

$CH_3COCH_2CH_2OCH_3$;

1

(b) (i) OH <u>in acids</u> or (carboxylic) acid present

(ii)



(c)

reagent	$K_2Cr_2O_7$ /H^+	$KMnO_4$ /H^+

Y	no reaction	no reaction
Z	orange to green or turns green	purple to colourless or turns colourless

5

[9]

M7.B

[1]