M1. (a) Pentan-2-one

ONLY but ignore absence of hyphens

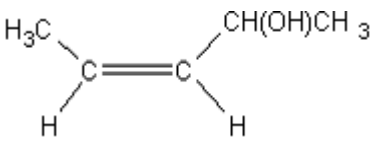
1

(b) Functional group (isomerism)

Both words needed

1

(c) (i)



Award credit provided it is obvious that the candidate is drawing the Z / cis isomer

The group needs to be $CHOHCH_3$ but do not penalise poor C–C bonds or absence of brackets around OH

Trigonal planar structure not essential

1

(ii) Restricted rotation (about the C=C)

OR

No (free) rotation (about the C=C)

1

(d)

M1 Tollens' (reagent) *(Credit ammoniacal silver nitrate OR a description of making Tollens')* *(Do not credit Ag^+, $AgNO_3$ or $[Ag(NH_3)_2^+]$ or "the silver mirror test" on their own, but mark M2 and M3)*	**M1** Fehling's (solution) / Benedict's *(Penalise $Cu^{2+}(aq)$ or $CuSO_4$ but mark M2 and M3)*
M2 silver mirror OR black solid or black precipitate	**M2** Red solid/precipitate *(Credit orange or brown solid)*

M3 (stays) colourless OR no (observed) change / no reaction	**M3** (stays) blue OR no (observed) change / no reaction

*If **M1** is blank CE = 0, for the clip*

Check the partial reagents listed and if M1 has a totally incorrect reagent, CE = 0 for the clip

Allow the following alternatives

***M1** (acidified) potassium dichromate(VI) (solution); mark on from incomplete formulae or incorrect oxidation state*

***M2** (turns) green*

M3 (stays) orange / no (observed) change / no reaction

OR

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

mark on from incomplete formulae or incorrect oxidation state

***M2** (turns) colourless*

***M3** (stays) purple / no (observed) change / no reaction*

*In all cases for **M3***

Ignore "nothing (happens)"

Ignore "no observation"

3

(e) (i) **Spectrum is for Isomer 1**

or named or correctly identified

The explanation marks in (e)(ii) depend on correctly identifying Isomer 1.

The identification should be unambiguous but candidates should not be penalised for an imperfect or incomplete name. They may say "the alcohol" or the "alkene" or the "E isomer"

1

(ii) **If Isomer 1 is correctly identified, award any two from**

- (Strong / broad) absorption / peak in the range **3230 to 3550** cm^{-1} or specified value in this range
  or **marked correctly** on spectrum
  and
  (characteristic absorption / peak for) OH group /**alcohol** group
- No absorption / peak in range **1680 to 1750** cm^{-1} or absence marked correctly on spectrum

and
(No absorption / peak for a) **C=O** group / **carbonyl** group / **carbon-oxygen double bond**

- Absorption / peak in the range **1620 to 1680** cm^{-1} or specified value in this range or marked correctly on spectrum
and

(characteristic absorption / peak for) **C=C** group / **alkene** / **carbon-carbon double bond**

If 6(e)(i) is incorrect or blank, CE=0

Allow the words ''dip'' OR ''spike'' OR ''trough'' OR ''low transmittance" as alternatives for absorption.

Ignore reference to other absorptions e.g. C-H, C-O

2

[10]

M2. (a) (i) any two from:
show a gradation/trend/gradual change in physical properties/ a specified property
differ by CH_2
chemically similar or react in the same way
have the same functional group

(penalise 'same molecular formula')

(penalise 'same empirical formula')

2

(ii) fractional distillation or fractionation

1

(iii) contains only single bonds or has no double bonds

(credit 'every carbon is bonded to four other atoms' provided it does not contradict by suggesting that this will always be H)

1

(b) (i) the molecular formula gives the actual number of atoms of each

element/type in a molecule/hydrocarbon/compound/formula

(penalise 'amount of atoms')

(penalise 'ratio of atoms')

1

(ii) $C_{14}H_{30}$ only

(penalise as a contradiction if correct answer is accompanied by other structural formulae)

1

(iii) $C_{10}H_{22} + 5½O_2 \rightarrow 10C + 11H_2O$

(or double this equation)

1

(c) (i) $½N_2 + ½O_2 \rightarrow NO$

(or double this equation)

1

(ii) Platinum or palladium or rhodium

1

(iii) $2CO + 2NO \rightarrow 2CO_2 + N_2$ or

$2NO \rightarrow N_2 + O_2$ or

(ignore extra O_2 molecules provided the equation balances)

$C + 2NO \rightarrow CO_2 + N_2$

(or half of each of these equations)

$C_8H_{18} + 25NO \rightarrow 8CO_2 + 12½N_2 + 9H_2O$

(or double this equation)

1

[10]

M3. (a)

- (Same) General formula/allow a named homologous series with its general formula
- Chemically similar/same (chemical) reactions
- Same functional group
- Trend in physical properties/eg inc bp as M_r increases
- (Molecules) increase by $CH_2/M_r = 14$

Any two points

2

(b) Fractional distillation/fractionation/chromatography

Allow GLC

1

(c) (Molecules/compounds/substances) with the same molecular formula/same number and type of atoms

Allow alkanes with same molecular formula

Allow same chemical formula in M1 = 0 but can allow M2

1

but different structural formula/different displayed formula/different arrangement of atoms/different structures

Not different positions in space

1

2,4-dimethylhexane

M2 dependent on M1

1

C_4H_9

Ignore the absence of dash and/or commas

1

(d) less surface contact/less surface area/less polarisable molecule

1

so fewer/weaker/less Van der Waals'/vdw forces

Allow more spherical or fewer points of contact

Not smaller molecule/not more compact molecule/not shorter chain

Allow converse arguments

Must be comparative answer ie not just few VDW forces

QoL

Assume 'it' refers to the branched isomer

1

[9]

M4. (a) (Different) boiling points

Ignore mp's, references to imf, different volatilities

1

(b) (i) Compound which have the same <u>molecular</u> formula

Accept same no and type of atom for M1
But If same (chemical) formula M1 = 0 but allow M2
If empirical formula CE = 0/2

1

but different structures/different structural formulae/different displayed formulae

M2 dependent on M1

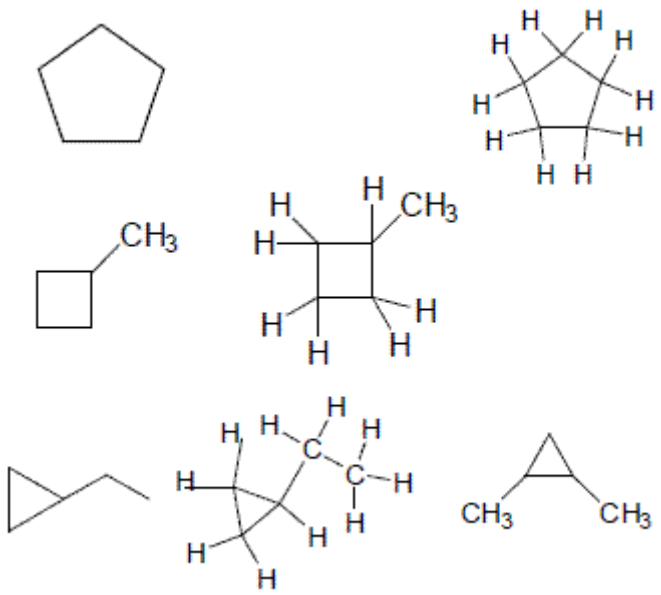
1

(ii) 3-methylbut-1-ene

only
ignore commas and hyphens

1

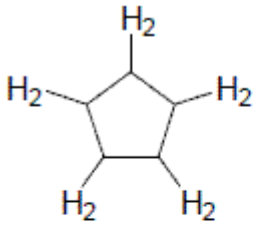
(iii)



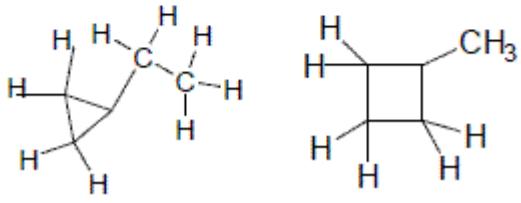
Allow any correct structure with a cyclic alkane

1

Do not allow



or



i.e with an H missing on one C

(c) $C_{13}H_{28}$

only

1

Making plastics/used to make polymers or polythene/used to make antifreeze/make ethanol/ripening fruit/any named additional polymer

*not used **as** a plastic/polymer/antifreeze*
not just 'polymers' – we need to see that they are being made

1

[6]

M5. (a) General formula;

Chemically similar;

Same functional group;

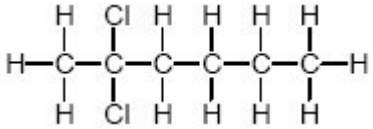
Trend in physical properties eg inc bp as M_r increases;

Contains an additional CH_2 group;

Any two points.

2 max

(b) (i)



All bonds and atoms must be shown.

1

C_3H_6Cl;

Allow any order of elements.
Do not allow EF consequential on their wrong displayed formula.

1

(ii) Same Molecular formula/ both $C_6H_{12}C_{l2}$/ same number and type of atoms;

1

Different structural formula/ different structure/ different displayed formula;

Not atoms or elements with same MF
CE=O.

Allow different C skeleton.
If same chemical formula can allow M2 only.
M2 insufficient to say atoms arranged differently.
M2 consequential on M1.

1

(c) M_r =228 for total reactants;

1

$\frac{155 \times 100}{228}$ = 67.98%;

Allow 67.98 or 68.0 or 68%.

1

(d) (i) Bp increases with increasing (molecular) size/ increasing M_r/ increasing no of electrons/increasing chain length;

Atoms CE =0.

1

Increased VDW forces (between molecules) (when larger molecule)/ bigger IMFs;

QWC
Not dipole-dipole or hydrogen bonds.
If VDW between atoms in M2 CE = 0.

1

(ii) Fractional distillation/ fractionation/ GLC/chromatography;

1

[11]

M6. (a) (i) single (C-C) bonds only/no double (C=C) bonds

1

Allow all carbon atoms bonded to four other atoms
Single C-H bonds only = 0
C=H CE

C and H (atoms) only/purely/solely/entirely

Not consists or comprises
Not completely filled with hydrogen
CH molecules = CE
Element containing C and H = CE

1

(ii) C_nH_{2n+2}

Formula only
C_xH_{2x+2}

1

(b) (i) $C_5H_{12} + 8O_2 \rightarrow 5CO_2 + 6H_2O$

Accept multiples
Ignore state symbols

1

(ii) gases produced are greenhouse gases/contribute to Global warming/effect of global warming/climate change

Allow CO_2 or water is greenhouse gas/causes global warming
Acid rain/ozone CE = 0

1

(c) carbon

Allow C
Allow soot

1

(d) (i) $C_9H_{20} \rightarrow C_5H_{12} + C_4H_8$

OR

$C_9H_{20} \rightarrow C_5H_{12} + 2C_2H_4$

Accept multiples

1

(ii) Plastics, polymers

Accept any polyalkene/haloalkanes/alcohols

1

(iii) so the bonds break ***OR*** because the bonds are strong

IMF mentioned = 0

1

(e) (i) 1,4-dibromo-1-chloropentane/1-chloro-1,4-dibromopentane

Ignore punctuation

1

(ii) Chain/position/positional

Not structural or branched alone

1

[11]