

Introduction to Organic Chemistry Test: Answers

1. (a) (i) Molecule/compound/consists/composed/made up of hydrogen and carbon only **(1)**

(ii) C_nH_{2n+2} **(1)**

(iii) C_6H_{14} only **(1)**

Do not credit structures alone or in addition.

3

(b) Chemically similar / react in same way / same chemistry

Differ by CH_2

gradation in physical properties OR specified trend e.g. b.p.

same functional group

Any 2, 2 marks 1 + 1

Not same molecular formula

2

(c) (i) Same molecular formula **(1)**

NOT same Mr

different structural formula / structures **(1)**

(or atoms arranged in different way)

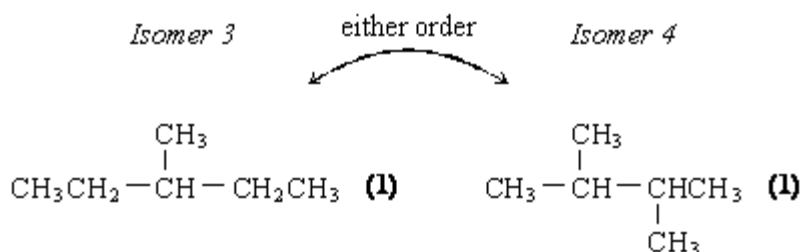
NOT different spatial arrangements

Only credit M2 if M1 correct

(ii) 2-methylpentane **(1)**

2,2-dimethylbutane **(1)**

(iii)



OR correct condensed / structural formula

Penalise "sticks" once

Penalise absence of vertical bonds once

penalise badly drawn bonds once (vertical between H atoms)

6

- (d) (i) M1 % by mass of H = 7.7(0)% **(1)**
 M2 mol H = 7.70 / 1 = 7.70
 mol C = 92.3 / 12 = 7.69 **(1)**

M3 (ratio 1:1 ∴) CH

Credit variations for M2 e.g. $78 \times \frac{77}{100} = 6$

and $\frac{78}{12} \times \frac{92.3}{100} = 6$

Correct answer = 3 marks

- (ii) (CH has empirical mass of 13 and $\frac{78}{13} = 6$ ∴) C₆H₆ **(1)**
Correct answer 1 mark

4

[15]

2. (a) % O = 21.6 % **(1)**

If % O not calculated only M2 available

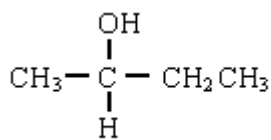
C $\frac{64.9}{12}$	H $\frac{13.5}{1}$	O $\frac{21.6}{16}$ (1)
= 5.41	= 13.5	= 1.35

Ratio: 4 : 10 : 1 (∴ C₄H₁₀O) **(1)**

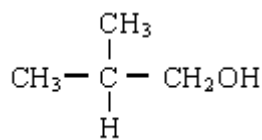
If arithmetic error in any result lose M3

If percentage composition calculation done zero

3



(1)



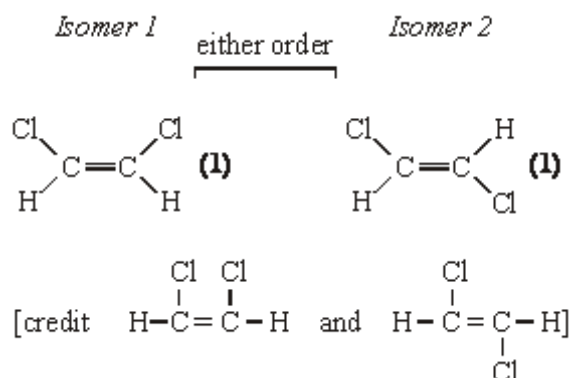
(1)

- (ii) *Isomer 3* *Isomer 4*
Penalise missing bonds / incorrect bonds once per paper

2

[5]

3. (i)

(ii) restricted rotation OR no rotation OR cannot rotate **(1)**

3

[3]

4. (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) $\text{C}_{14}\text{H}_{30}$ only*(penalise as a contradiction if correct answer is accompanied by other structural formulae)*

1

(iii) $\text{C}_{10}\text{H}_{22} + 5\frac{1}{2}\text{O}_2 \rightarrow 10\text{C} + 11\text{H}_2\text{O}$ *(or double this equation)*

- 1
- (c) (i) $\frac{1}{2}\text{N}_2 + \frac{1}{2}\text{O}_2 \rightarrow \text{NO}$
(or double this equation) 1
- (ii) Platinum or palladium or rhodium 1
- (iii) $2\text{CO} + 2\text{NO} \rightarrow 2\text{CO}_2 + \text{N}_2$ or
 $2\text{NO} \rightarrow \text{N}_2 + \text{O}_2$ or
 (ignore extra O_2 molecules provided the equation balances)
 $\text{C} + 2\text{NO} \rightarrow \text{CO}_2 + \text{N}_2$
 (or half of each of these equations)
 $\text{C}_8\text{H}_{18} + 25\text{NO} \rightarrow 8\text{CO}_2 + 12\frac{1}{2}\text{N}_2 + 9\text{H}_2\text{O}$
 (or double this equation) 1
- [10]**
5. 1(-)bromobutane 1
- correct structure for 1-bromo-2-methylpropane
 (C-C bonds must be clear where drawn) 1
- [2]**
6. (a) Correct structure for $\text{CF}_2\text{BrCF}_2\text{Br}$ drawn out
 (penalise "Fl" for fluorine) 1
- (b) (i) 2-bromo-2-chloro-1,1,1-trifluoroethane
 OR 1-bromo-1-chloro-2,2,2-trifluoroethane
 (insist on all numbers, but do not penalise failure to
 use alphabet)
 (accept "flourine" and "cloro" in this instance) 1
- (ii) 197.4 only
 (ignore units) 1
- (iii) $(57/197.4 \times 100) = 28.9\%$ OR 28.88%
 (credit the correct answer independently in part (d)(iii), even if
 (d)(ii) is blank or incorrectly calculated, but mark
consequential on part (d)(ii), if part (d)(ii) is incorrectly

calculated, accepting answers to 3sf or 4sf only
(penalise 29% if it appears alone, but not if it follows a correct answer)
(do not insist on the % sign being given)
(the percentage sign is not essential here, but penalise the use of units e.g. grams)

1

[4]

7. (a) Single bonds only /no double or multiple bonds;

1

Contains carbon and hydrogen only;

C and H only

not C and H molecules

1

Alkanes;

1

- (b) (1) Fractions or hydrocarbons or compounds have different boiling points/ separation depends on bp;

Ignore mp and vdw

1

(2) bp depends on size/ M_r / chain length;

If refer to bond breaking/cracking/ blast furnace/oxygen/air 2 max

1

(3) Temp gradient in tower or column / cooler at top of column or vice versa;

QWC

1

(4) Higher bp / larger or heavier molecules at bottom (of column) or vice versa;

Not increasing size of fraction

Not gases at top

1

- (c) Large molecules or compounds or long chain hydrocarbons (broken) into smaller molecules or compounds or smaller chain hydrocarbons;

QWC

1

- Zeolite or aluminosilicate (catalyst); 1
- $C_{14}H_{30} \rightarrow C_8H_{18} + C_6H_{12}$;
Only 1
- Smaller chain molecules are in more demand or have higher value or vice versa;
Insufficient to say more useful/have more uses 1
- (d) $C_8H_{18} + 8\frac{1}{2} O_2 \rightarrow 8CO + 9H_2O$;
Allow multiples 1
- Rh/ Pd/Pt/Ir or in words;
Penalise contradiction of name and symbol 1
- $2CO + 2NO \rightarrow 2CO_2 + N_2$ / $2CO + O_2 \rightarrow 2CO_2$;
Allow multiples 1
- (e) car less powerful/ car stops/ reduced performance/ won't run smoothly/ can't accelerate;
Not incomplete combustion or bad effect on engine
Not doesn't go as far. 1
- Test it (before sale) /Quality control etc; 1
- (f) (compounds with) same molecular formula / same no and type of atoms;
Not atoms/elements with same molecular formula.
If same chemical formula, can allow M2 1
- And different structure/ structural formula;
M2 consequential on M1
Allow displayed formula for M2 1
- 2,2,4-trimethylpentane;
Only (but allow numbers in any order) 1

8. (a) General formula;

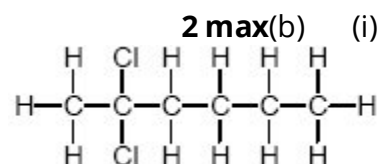
Chemically similar;

Same functional group;

Trend in physical properties eg inc bp as M_r increases;

Contains an additional CH_2 group;

Any two points.



All bonds and atoms must be shown.

1

$\text{C}_3\text{H}_6\text{Cl}$;

Allow any order of elements.

Do not allow EF consequential on their wrong displayed formula.

1

(ii) Same Molecular formula/ both $\text{C}_6\text{H}_{12}\text{Cl}_2$ / 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

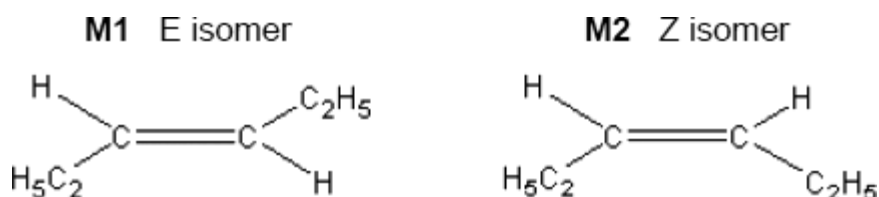
(ii) Fractional distillation/ fractionation/ GLC/chromatography;

1

[11]

9.

(i)



Award 1 mark if both correct stereoisomers but in the wrong places

Accept no other alkenes.

Be reasonably lenient on the bonds to ethyl (or to CH_2CH_3) since the question is about E and Z positions but penalise once only if connection is clearly to the CH_3 of CH_2CH_3

Accept linear structures

2

(ii) **M1** (Compounds / molecules with) the same structural formula
Penalise **M1** if "same structure"

M2 with atoms/bonds/groups arranged differently in space
Ignore references to "same molecular formula" or "same empirical formula" or any reference to "displayed formula"

OR

atoms/bonds/groups that have different spatial arrangements / different orientation.

Mark independently

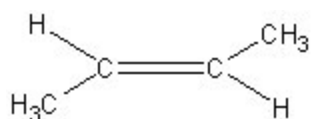
2

[4]

10. (a) Contains a C=C **OR** a double bond

1

(b)



Award credit provided it is obvious that the candidate is drawing the trans isomer.

Do not penalise poor C-C bonds

Trigonal planar structure not essential

1

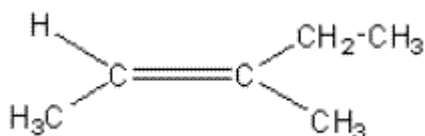
[2]

11. (i) **3-bromo-3-methylpentane ONLY**

Must be correct spelling but ignore hyphens and commas

1

- (ii) Structure of (E)-3-methylpent-2-ene



The arrangement of groups around the double bond must be clear with the ethyl group attached in the correct order. Ignore bond angles.

Accept C₂H₅ for ethyl

Be lenient on C-C bonds. The main issue here is whether they have drawn an (E) isomer.

Accept "sticks" for C-H bonds and correct skeletal formula

1

[2]

12. D

[1]

13. A

[1]

14. B

[1]