



EXAM PAPERS PRACTICE

Boost your performance and confidence with these topic-based exam questions

Practice questions created by actual examiners and assessment experts

Detailed mark scheme

Suitable for all boards

Designed to test your ability and thoroughly prepare you

2002

XVIII

1583

Time allowed
149 Minutes

Score

/124

Percentage

%

CHEMISTRY

**AQA
AS & A LEVEL**

Mark Scheme

3.3 Organic chemistry

- 1 (a) heated / vaporised / boiled
 passed into column / tower
 condense at different heights / liquefy at different heights
 similar molecules (size, bp, mass) condense together / (1)
 small molecules at the top and big molecules at the bottom 4
- (b) larger (1)
 reduces decomposition (1) 2
- (c) (i) hexane or valid isomers (1)
 propene (1) 2
 (ii) C₃H₆ (1) 1
- (d) CHCl₃ (1)
 C₂HBrClF₃ or correct structural formula (1)
- $$\begin{array}{c}
 \text{H} \quad \text{F} \\
 | \quad | \\
 \text{Br} - \text{C} - \text{C} - \text{F} \\
 | \quad | \\
 \text{Cl} \quad \text{F}
 \end{array}$$
- 2

[11]

2 Cracking (1)

radical mechanism (1)

Any two equations e.g. $\text{C}_{10}\text{H}_{22} \rightarrow \text{C}_2\text{H}_4 + \text{C}_8\text{H}_{18}$



$\text{C}_{10}\text{H}_{22}$ or larger alkanes: low demand/high abundance/less useful (1)

C_2H_4 or smaller alkanes: high demand/low abundance/more useful (1)

Uses: ethene to make polymers/plastics/ethanol (1)

octane or smaller alkanes - for petrol or fuels (1)

8

[8]

3

(a) pollutants: CO (1)

NO or NO_2 (1)

unburned hydrocarbons (1)

CO from incomplete combustion (1)

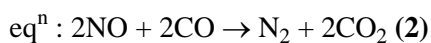


NO from $\text{N}_2 + \text{O}_2 \rightarrow 2\text{NO}$ (1)

spark (1)

max 7

removal: reaction between NO_x and CO or C_xH_y
to form harmless products (1)



one of Pt/Rh/Pd catalyst (1)

max 4

(b) Demand for heavy fraction: low or for petrol: high (1)

Supply of heavy fraction: high or of petrol: low (1)

larger Mr are less volatile/have higher bp (1)

due to stronger intermolecular forces (1)

4

[15]

4

- (a) Missing fraction = naphtha (*allow naphtha from list if not quoted separately*) (1) Order = mineral oil (lubricating oil), gas oil (diesel), kerosene (paraffin), naphtha, petrol (gasoline) (1)

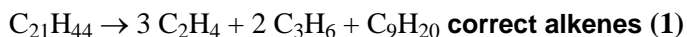
Mark order consequential on M1 (if no missing fraction given, M2 = 0) Accept correct reversed order

Negative temperature gradient on the column
or temperature of column decreases upwards (1)

Larger molecules **or** heavier fractions condense at higher temperatures **or** lower down the column **or** reference to different boiling points (*ignore mp*) (1)

4

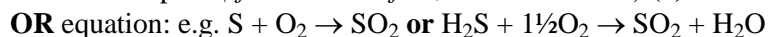
- (b) Type of mechanism = (free) radical / homolytic fission - **used in complete sentence phrase** (1)



Accept CH₂CH₂ & CH₂CHCH₃ all correct (1)

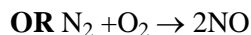
3

- (c) (i) Sulphur (containing impurities) burn to form **or forms** SO₂ **or** correct oxides of sulphur (*if oxide identified, must be correct*) (1)



Leading to acid rain (*must have specified oxides of S or burning*) **or** toxic product **or** respiratory problems (1)

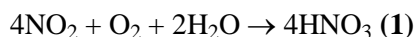
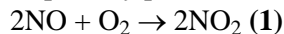
- (ii) NO formed by reaction between N₂ and O₂ from the air (1)



High combustion temperature **or** spark in engine (1)

provides E_A **or** sufficient heat / energy to break N≡N (1)

- (iii) Need to remove NO as forms acid rain **or** toxic product **or** causes respiratory problems (1)



Need to remove CO as it is poisonous (1)

Catalytic converter (1)

uses Pt / Rh / Pd / Ir (*wrong answer cancels a correct one*) (1)

Provides active sites / reduces E_A (1)

Forms N₂ + CO₂ (1)



(1)


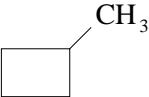
Max 10

[17]

5

- (a) (i) Gas oil or diesel (1)
- (ii) $\text{C}_{16}\text{H}_{34} \text{ (1)} \rightarrow \text{C}_8\text{H}_{18} + 2\text{C}_3\text{H}_6 + \text{C}_2\text{H}_4 \text{ eq}^n \text{ (1)}$
- (iii) To produce polymers (1) 4
- (b) (i) large surface area (1)
faster reaction (1)
- (ii) $\text{C}_8\text{H}_{18} + 25\text{NO} \rightarrow 8\text{CO}_2 + 9\text{H}_2\text{O} + 12\frac{1}{2}\text{N}_2 \text{ (2)}$ 4

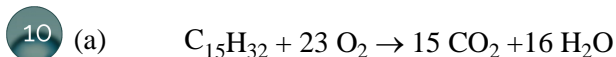
[8]

- 6
- (a) petrochemicals (1)
 Kerosine or paraffin (1)
 Power stations or ships (1) 3
- (b) (i)
$$\begin{array}{c} \text{CH}_3 \\ | \\ \text{CH}_3 - \text{C} - \text{CH}_3 \\ | \\ \text{CH}_3 \end{array} \quad (1)$$
- (ii) 2
-  or  (1)
- (c) (i) C_8H_{18} (1)
 (ii) $\text{C}_{12}\text{H}_{26}$ (1) 2
- [7]
- 7
- but-1-ene (1) [1]
- 8
- (a) (i) Kerosine or paraffin (1)
 (ii) Boiling point (1) 2
- (b) (i) $\text{C}_{19}\text{H}_{40}$ (1)
 (ii) $\text{C}_{16}\text{H}_{34} \rightarrow 2\text{C}_2\text{H}_4 + \text{C}_3\text{H}_6 + \text{C}_9\text{H}_{20}$
 or $\text{C}_{16}\text{H}_{34} \rightarrow 4\text{C}_2\text{H}_4 + 2\text{C}_3\text{H}_6 + \text{C}_2\text{H}_6$ (2) 4
- [5]

9

- (a) Crude oil is heated to vaporise it / **oil vaporised (1)**
 (Vapour passed into fractionating) tower / column (1)
 Top of tower cooler than bottom
 or **negative temperature gradient (1)**
 fractions separated by b.p
OR condensed at different temperatures OR levels
OR low boiling fractions at the top
OR at the top small molecules or light components (1) max 3
- (b) (i) Identify shortfall in supply - e.g. petrol / small molecules (1)
 Higher value products **OR more useful products (1)**
OR cracking produces more of material (problem solving)
- (ii) Motor fuels
 Aromatic hydrocarbons
 Branched alkanes / hydrocarbons
 Cycloalkanes
Any two (2)
Ignore specific fractions, alkanes, shorter alkanes, penalise alkenes, and hydrogen 4
- (c) *Catalyst:* Zeolite / aluminosilicate (1)
Conditions: High temp OR around 450 °C [300 – 600] °C **NOT heat / warm (1)**
 Slight pressure [$> 1 \text{ atm} \leq 10 \text{ atm}$ OR 1 megaPa, 1000 kPa] (1)
NOT high pressure 3

[10]

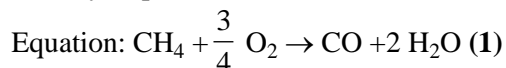


Products (1)

Balance (1)

If wrong reactant C.E

(b) Identity of product: CO or carbon monoxide (1)



Any balanced equation using CH_4 , producing CO

Not could also make C + CO_2

[4]

11 (a) (i) compounds/mixtures/alkanes/hydrocarbons/molecules with a

boiling point range/similar boiling point/similar number of carbon atoms/similar chain length;

1

(insist on “similar” rather than “same”)

(ignore references to size or M_r)

(penalise references to bond breaking/cracking as contradictions)

(ii) molecules have different boiling points/intermolecular forces/sizes/chain lengths/ M_r ;

1

(ignore references to melting points)

(credit the idea that molecules condense at different temperatures)

(iii) the column has a higher temperature at the base (*Q of L mark*)

OR

the column has a lower temperature at the top;

1

(the statement needs to be expressed in good English and show a clear understanding of the correct temperature difference)

(penalise “negative OR positive temperature gradient” without qualification to what the candidate means, otherwise ignore)

(ignore references to the boiling points of the molecules) (credit correct statements which use specific temperatures with a maximum temperature of 500 °C at the base)

- (b) (i) $\text{C}_8\text{H}_{18} + 8 \frac{1}{2} \text{O}_2 \rightarrow 8\text{CO} + 9\text{H}_2\text{O}$; 1
(or double this equation)
- (ii) correctly drawn structure of 2,2,3-trimethylpentane 1
(penalise the use of 'sticks' once on the paper, including the structures in the 2(a)(ii) and 2(c)(iii) mechanisms) (credit correctly condensed structures)
- (c) cracking produces/makes ethene/propene/alkenes/motor fuels/petrol
 OR
 cracking makes more useful products/high(er) value products
 OR
 cracking satisfies the high demand for small(er) products; 1
(ignore the idea that cracking makes or leads to plastics or polyethene) (high demand needs to be qualified)
- (d) zeolite
 OR
 aluminosilicate OR Al_2O_3 ; 1
- (e) alkene(s); 1
(credit "small or short chain alkenes")
(penalise "cycloalkenes")
(penalise additional types of compounds (e.g. branched alkanes) as a contradiction)
(do not credit examples or formulae, but ignore if these are correct and in addition to the word "alkene")

[8]

- 12 1(-)bromobutane 1
correct structure for 1-bromo-2-methylpropane 1
(C–C bonds must be clear where drawn) [2]
- 13 (a) 2-bromo-3-methylbutane
correct spelling each of bromo, methyl and butane (1)
for numbers – 2 & 3 either order (1) 2
- (b) compounds with the same molecular formula / compounds or molecules
with the same number and type of atoms
not atoms or elements instead of compounds (1)
different structural formulae / different arrangement of atoms / different
structures / different graphical (displayed) formulae / functional groups in
different places (1) 2
- [4]

14

- (a) C $22.24/12 = 1.85$ H $3.71/1 = 3.71$ Br $74.05/79.9 = 0.927$ (1)

ratio C:H:Br = 2:4:1 \therefore C₂H₄Br (1)

empirical mass = 107.9 \therefore mol formula = $215.8/107.9 \times \text{C}_2\text{H}_4\text{Br} = \text{C}_4\text{H}_8\text{Br}_2$ (1)

must use % to justify answer

or

C $(22.24/100) \times 215.8 = 47.99$ i.e. $48/12 = 4$ carbon atoms (1)

H $(3.71/100) \times 215.8 = 8.01$ i.e. $8/1 = 8$ hydrogen atoms (1)

Br $(74.05/100) \times 215.8 = 159.8$ i.e. $159.8/79.9 = 2$ bromine atoms (1)

or

C $(48/215.8) \times 100 = 22.24\%$ (1)

H $(8/215.8) \times 100 = 3.71\%$ (1)

Br $(159.8/215.8) \times 100 = 74.05\%$ (1)

3

- (b) **any two pairs of marks**

1,1-dibromo-(2-)methylpropane (1)

graphical formula to suit (CH₃)₂CHCHBr₂ (1)

1,2-dibromo-(2-)methylpropane (1)

graphical formula to suit (CH₃)₂C(Br)CH₂Br (1)

1,3-dibromo-(2-)methylpropane (1)

graphical formula to suit BrCH₂CH(CH₃)CH₂Br (1)

allow unambiguous names

mark name and structure independently

accept order of bromo / methyl reversed

penalise once for each of

numbering from wrong end and di in dibromo omitted

max 4

[7]

15

- (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 2
(penalise 'same molecular formula')
 - (penalise 'same empirical formula')
- (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 1
(penalise 'amount of atoms')
- (penalise 'ratio of atoms')

(ii) $\text{C}_{14}\text{H}_{30}$ only 1
(penalise as a contradiction if correct answer is accompanied
by other structural formulae)

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

(c) (i) $\frac{1}{2}\text{N}_2 + \frac{1}{2}\text{O}_2 \rightarrow \text{NO}$ 1
(or double this equation)

(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)
 $\text{C}_8\text{H}_{18} + 25\text{NO} \rightarrow 8\text{CO}_2 + 12\frac{1}{2}\text{N}_2 + 9\text{H}_2\text{O}$ 1
(or double this equation)

[10]

- 16
- (a) (i) fractional distillation or fractionation 1
- (ii) C_9H_{20} only 1
- (iii) $C_{11}H_{24} + 17O_2 \rightarrow 11CO_2 + 12H_2O$ 1
- (iv) $C_{11}H_{24} + 6O_2 \rightarrow 11C + 12H_2O$ 1
- (b) (1) $C_{10}H_{22} \rightarrow C_3H_6 + C_7H_{16}$ 1
- (ii) correctly drawn structure of methylpropene 1
(insist on clearly drawn C-C and C=C bonds)
- (c) Any two from 2
- o chemically similar or chemically the same or react in the same way
 - o same functional group
 - o same general formula
 - o differ by CH_2
- (penalise same molecular formula or same empirical formula)*

[8]