A-Level Chemistry

Alkanes

Mark Scheme

Time available: 65 minutes
Marks available: 61 marks

1.

(a) Single bonds <u>only</u> /no double or multiple bonds;

1

Contains carbon and hydrogen <u>only</u>;

C and H <u>only</u>
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 <u>tower or column</u> / cooler at top of <u>column</u> 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) <u>Large</u> molecules or compounds or long chain hydrocarbons (broken) into <u>smaller</u> 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) $C_8H_{18} + 8½ O_2 \rightarrow 8CO + 9H_2O$;

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

Greenhouse gas/ absorbs infrared radiation;

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 <u>chemical</u> 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

[20]

2. (a) (i) any two from:
show a <u>gradation/trend/gradual change</u> 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 <u>number of atoms of each element/type</u> 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]

3. (a) Crude oil is heated to vaporise it / **oil vaporised (1)**
(Vapour passed into fractionating) <u>tower / column</u> **(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)**
Type of mechanism: Carbocation / heterolytic fission **(1)**
Conditions: High temp OR around 450 °C [300 – 600] °C **NOT heat / warm (1)**
Slight pressure [> 1 atm ≤ 10 atm **OR 1 megaPa, 1000 kPa] (1)**

NOT high pressure

4

[11]

4. (a) **Step 1**

M1 fractional distillation

1

M2 separated into mixtures of compounds with similar boiling points / similar sized molecules

***M2** to separate naphtha from other compounds; to separate compounds by chain length / size / boiling point*

1

Step 2

M3 (thermal) cracking

***M3** not catalytic cracking*

1

M4 to make alkenes / propene **/** shorter molecules

1

Step 3

M5 (addition) polymerisation

***M5** not condensation polymerisation 1*

1

M6 molecules joined together or to produce long chain molecule

For each step the two marks are independent

1

(b) no polar bonds (in chain) / non-polar

Do not allow if only C-H bonds mentioned as non polar

1

(c) to prevent build-up of waste (in landfill) OR they can be broken down by natural processes

1

[8]

5. (a) 2,2,4-trimethylpentane

This answer only but ignore punctuation

1

(b) M1 (fractional or simple) distillation

Incorrect process in M1 CE=0

If M1 blank, mark on for M2 and M3 (ignore boiling, condensing)

1

M2 idea that isooctane / the one with the lower boiling point boils (first) (or reaches top of column first)

Ignore reference to octane boiling and being collected at higher temperature

If temperature referred to, should be between 99 and 124°C

"it" refers to isooctane

M2 – allow vaporises/evaporates first

1

M3 idea that isooctane <u>condenses / liquefies</u> and <u>collected</u>

Penalise M2 and M3 if octane boils first

In M2 and M3 – if no specific reference to individual alkanes, could score one mark for M2 + M3 combined if M2 and M3 both otherwise correct

M2 and M3 must refer to a laboratory apparatus (not to an industrial process)

1

(c) $C_8H_{18} + 12½O_2 \longrightarrow 8CO_2 + 9H_2O$

Accept multiples; ignore state symbols

Accept any correct structural representation of isooctane

1

(d) M1 Alternative route/mechanism/pathway

1

M2 With lower <u>activation energy</u>

Accept E_a for activation energy

1

(e) $2CO + 2NO \longrightarrow 2CO_2 + N_2$

Accept multiples; ignore state symbols

1

(f) M1 to reduce amount of metals needed / small amount of metal needed

Relates to low amount of metal

1

M2 Increase / maximise / produce large surface area or to give catalyst a larger surface area: volume ratio or so that high(er) proportion of atoms/metal is on surface

Is related to large surface area

1

(g) M1 bromine (water or in organic solvent or CCl_4) / Br_2 (aq) / Br_2

No reagent or an incorrect reagent (e.g. bromide), CE=0;

Penalise Br (or incorrect formula of other correct reagent) but mark on for M2

It must be a whole reagent and/or correct formula

If oxidation state given in name, it must be correct

If 'manganate' or 'manganate(IV)' or incorrect formula, penalise M1 but mark on

Ignore 'acidified'

1

M2 (orange/yellow to) colourless / decolourised / loses its colour

Ignore goes clear

Ignore brown/red, but penalise other incorrect colours

1

Alternatives:

M1 = potassium manganate(VII), M2 = colourless

M1 = <u>conc</u> sulfuric acid, M2 = brown

M1 = iodine, M2 = colourless

[12]