M1.D

[1]

M2.(a) (i) (Compounds with the) same molecular formula

Allow same number and type of atom for M1

Ignore same general formula.

1

But different structural formula / different displayed formula / different structures / different skeletal formula

M2 dependent on M1

Not different positions of atoms / bonds in space.

1

(ii) But-2-ene

Allow but-2-ene.

Allow but 2 ene.

Ignore punctuation.

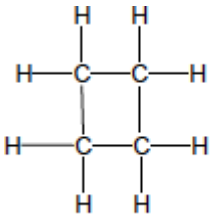
1

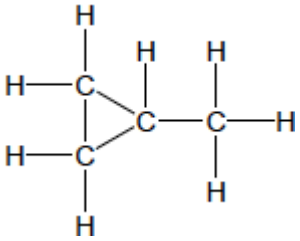
(iii) (2)-methylprop-(1)-ene

Do not allow 2-methyleprop-1-ene.

1

(iv)





Do not allow skeletal formulae.

Penalise missing H and missing C

1

(b) (i) $C_4H_8 + 2O_2 \rightarrow 4C + 4H_2O$

Accept multiples.

1

(ii) Exacerbates asthma / breathing problems / damages lungs / smog / smoke / global dimming

Ignore toxic / pollutant / soot / carcinogen.

Do not allow greenhouse effect / global warming / acid rain / ozone.

1

(c) (i) $C_{16}H_{34}$

Allow $H_{34}C_{16}$

C and H must be upper case.

1

(ii) Jet fuel / diesel / (motor) fuel / lubricant / petrochemicals / kerosene / paraffin / central heating fuel / fuel oil

Ignore oil alone.

Not petrol / bitumen / wax / LPG / camping fuel.

1

(d) (i) $C_8H_{18} + 25NO \rightarrow 8CO_2 + 12.5\ N_2 + 9H_2O$

Accept multiples.

1

(ii) Ir / iridium

OR

Pt / platinum

OR

Pd / palladium

OR

Rh / rhodium

1

[11]

M3.(a) Fractional distillation / fractionation / GLC / gas liquid chromatography

1

(b) C_4H_{10}

Need C_4H_{10} ***and*** *the reason for the mark*

Because it has a higher bp / has stronger IMF / larger molecule / longer chain / larger surface (area)

1

(c) $C_4H_{10} + 6½\ O_2 \longrightarrow 4CO_2 + 5H_2O$

Accept multiples
Ignore state symbols

1

(d) CO_2 or H_2O evolved is a greenhouse gas / CO_2 or H_2O evolved contribute to global warming / the products are greenhouse gases

Ignore climate change

1

(e) $CH_3CH_2CH_2CH_3 + 3.5O_2 \longrightarrow C_2H_2(CO)_2O + 4H_2O$

Accept multiples

Allow with or without a number 1 before the organic molecules

1

(f) (i) $C_2H_5SH + 4.5O_2 \longrightarrow 2CO_2 + 3H_2O + SO_2$

Accept multiples

1

(ii) Calcium oxide / calcium carbonate

Allow any base or alkali
Allow correct formulae

1

Neutralises the SO_2 / acid base reaction / it is a base

Can only score M2 if base or alkali used in M1
Allow M2 if blank in M1

1

(iii) Ethanol contains hydrogen bonding

Breaking covalent bonds CE = 0 / 2

Which is stronger than IMF (VDW / dipole-dipole forces) in ethanethiol / (H bonding) is the strongest IMF

Only award M2 if M1 given, but allow IMF in ethanol are stronger than in ethanethiol for maximum 1 mark

1

(g) (i) (2,2-)dimethylpropane

Ignore punctuation

1

(ii) Because molecule is smaller / less polarisable / has less surface (area) / is more spherical / molecules can't get as close to one another (to feel the vdW forces)

Allow converse answers referring to straight chain isomers
CE = 0 / 2 if breaking bonds

1

vdW intermolecular forces or vdW force between molecules are weaker or fewer

Need vdW rather than just IMF

1

(iii) 1 or one

1

(h) (i) C_9H_{20}

$H_{20}C_9$

1

(ii) Thermal (cracking)

If not thermal cracking CE = 0 / 2

1

High pressure AND high temperature

If blank mark on

Allow high P and T

1

OR

Pressure of ≥ 10 atm, ≥ 1 MPa ≥ 1000 kPa

AND temp of 400 °C ≤ T ≤ 1000 °C or 650 K ≤ T≤ 1300 K

Do not allow high heat

If no units for T, then range must be 650 − 1000

1

[17]

M4.(a) Saturated − single bonds only / no double bonds

1

Hydrocarbon − contains carbon and hydrogen (atoms) only

1

(b) $C_{16}H_{34} + 16.5O_2 \longrightarrow 16CO + 17H_2O$

Allow multiples

1

(c) (On combustion) SO_2 produced

Allow equation to produce SO_2. Ignore sulfur oxides.

1

Which causes acid rain

If formula shown it must be correct

M2 is dependent on M1. But if M1 is sulfur oxides, allow M2.

For M2 allow consequence of acid rain or SO_2.

Ignore greenhouse effect and toxic

1

(d) (i) $C_{16}H_{34} \longrightarrow C_8H_{18} + C_2H_4 + 2C_3H_6$

Allow multiples

1

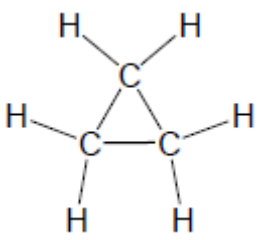
(ii) polypropene / propan(-1 or 2-)ol / propane(-1,2-)diol / isopropanol / propanone / propanal

Accept alternative names

Ignore plastic and polymer

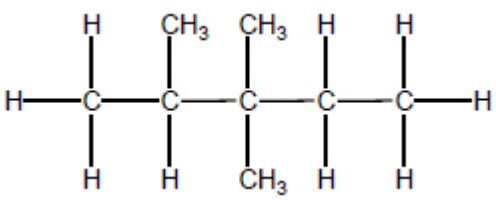
1

(iii)



1

(e)



Allow any unambiguous representation

1

(f) 2,4-dichloro-2,4-dimethylhexane

Only but ignore punctuation

1

[10]

M5.(a) Crude oil **OR** petroleum

Not petrol.

1

Fractional distillation / fractionation

Not distillation alone.

1

(b) $C_{12}H_{26} + 12.5O_2 \longrightarrow 12CO + 13H_2O$

Allow balanced equations that produce CO_2 in addition to CO.

Accept multiples.

1

(c) (i) M1 Nitrogen and oxygen (from air) react / combine / allow a correct equation

If nitrogen from petrol / paraffin / impurities CE = 0 / 2.

1

M2 at high temperatures

Allow temperatures above 1000 °C or spark.

Not just heat or hot.

M2 dependent on M1.

But allow 1 mark for nitrogen and oxygen together at high temperatures.

1

(ii) $2NO + O_2 \longrightarrow 2NO_2$

Allow multiples.

1

(iii) $4NO_2 + 2H_2O + O_2 \longrightarrow 4HNO_3$

Allow multiples.

1

(d) (i) C_nH_{2n+2}

Allow C_xH_{2x+2}

CnH2n+2

Allow CxH2x+2

1

(ii) $C_{12}H_{26} \longrightarrow C_6H_{14} + C_6H_{12}$

Only.

1

C_3H_7

Only.

1

Zeolite / aluminosilicate(s)

Ignore aluminium oxide.

1

(iii) Larger molecule / longer carbon chain / more electrons / larger surface area

1

More / stronger <u>van der Waals' forces between molecules</u>

Allow dispersion forces / London forces / temporary induced dipole-dipole forces <u>between molecules.</u>

If breaking bonds, CE = 0 / 2.

1

(e) 2,2,3,3,4,4-hexamethylhexane

Only.

Ignore punctuation.

1

Chain

Ignore branch(ed).

1

(f) Cl_2

Only.

Cl–Cl

Not CL_2 or Cl2 or CL2 or Cl^2 or CL^2.

Ignore Chlorine.

1

[16]