**M1.**(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.*

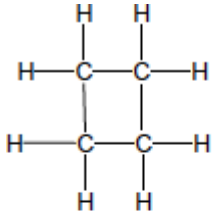
**1**

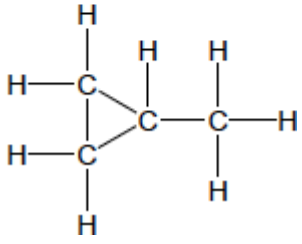
(iii) (2)-methylprop-(1)-ene

*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]

**M2.** (a) (Different) boiling points

*Ignore mp's, references to imf, different volatilities*

1

(b) (i) Compound which have the same molecular 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*

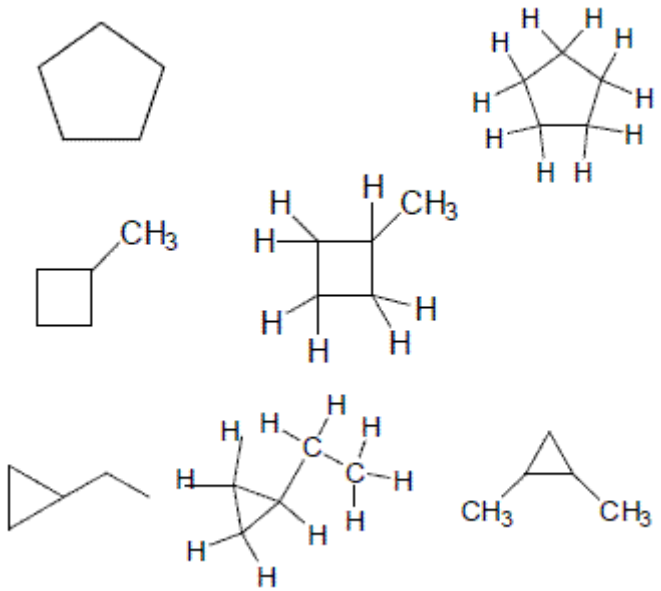
1

(ii) 3-methylbut-1-ene

*only*
*ignore commas and hyphens*

1

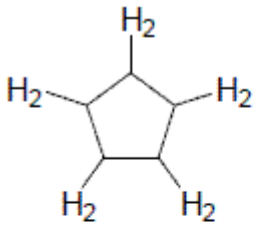
(iii)



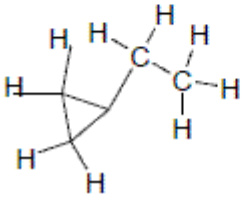
*Allow any correct structure with a cyclic alkane*

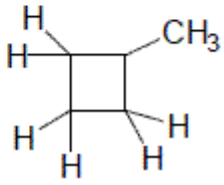
1

*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]**

**M3.**(a) (i) Crude oil / oil / petroleum

*Do not allow 'petrol'*

**1**

(ii) Fractional distillation / fractionation / fractionating

*Not distillation alone*

**1**

(b) (i) 5

*Allow five / V*

**1**

(ii) Chain (isomerism)

*Allow branched chain / chain branched / side chain (isomerism)*

*Ignore position (isomerism)*

*Do not allow straight chain / geometric / branched / function*

**1**

(c) (i) $C_{12}H_{26}$ / $H_{26}C_{12}$

*Only*

**1**

(ii) Thermal cracking

*If not thermal cracking, CE = 0/2*

*If blank mark on*

**1**

High temperature

*Allow 'high heat' for 'high temperature'*

(400°C ≤ T ≤ 900°C) or (650 K ≤ T ≤ 1200 K)

*Not 'heat' alone*

*If no T, units must be 650 – 900*

**and**

High pressure (≥ 10 atm, ≥ 1 MPa, ≥1000 kPa)

**1**

(iii) To produce substances which are (more) in demand / produce products with a high value / products worth more

*Ignore 'to make more useful substances'*

**1**

(d) (i) Corrosive or diagram to show this hazard symbol

*Ignore irritant, acidic, toxic, harmful*

**1**

(ii) $\left(\frac{120.5}{\quad} \times 100\right)(86 + 71 \quad\quad)$

=76.75(%) or 76.8(%)

*Allow answers > 3 sig figs*

**1**

(e) 2,2-dichloro-3–methylpentane

*Ignore punctuation*

*Any order*

**1**

$C_3H_6Cl$

**1**

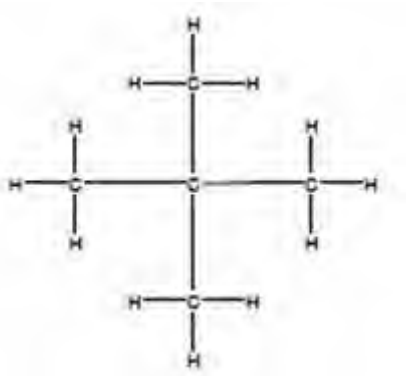
**[12]**

**M4.** (a) $C_n H_{2n+2}$

*Allow x in place of n*

**1**

(b)



Chain

*Must show every bond*

*Allow branched chain*

**2**

(c) $C_9H_{20}$

*Only*

**1**

To break the (C-C and/or C-H) bonds

*M2=0 if break C=C*

**1**

To make products which are in greater demand / higher value / make alkenes

*Not more useful products*

*Allow specific answers relating to question*

**1**

(d) $C_5H_{12} + 3O_2 \rightarrow 5C + 6H_2O$

*Allow other balanced equations which give C and CO/$CO_2$*

**1**

Causes global dimming / exacerbates asthma / causes breathing problems / makes visibility poor / smog

*Apply list principle*

*Ignore causes cancer / toxic*

**1**

(e) $\frac{106.5}{143}$ (x 100)

**1**

74.48%

*Allow 74.5%*

**1**

3

*Only*

**1**

(f) 2,3-dichloro-3-methylpentane

*Ignore punctuation*

**1**

$C_3H_6Cl$

*Only*

**1**

**[13]**

**M5.** (a) (i) $C_nH_{2n}$ / $C_xH_{2x}$

**1**

(ii) Fractional distillation / GLC / gas liquid chromatography / fractionation

*Do **not** allow cracking / distillation*

**1**

(b) (i) But-1-ene / but1ene

*Ignore hyphens and commas*

*Do **not** allow butene-1 / but-2-ene / butane / butane /alkene / $C_4H_8$ / propene / straight-chain alkene*

**1**

(ii) A structure of cyclobutane or methyl-cyclopropane

*Allow skeletal formula.*

**1**

(c) (i) $C_{15}H_{32} \rightarrow 2C_4H_8 + C_7H_{16}$

*Do not accept multiples.*

**1**

(ii) Thermal cracking

*Not catalytic cracking or cracking.*

**1**

To produce products that are in greater demand / more valuable / more expensive / more profitable

*The (unsaturated) alkene or the (unsaturated) molecule or X produced can be polymerised or can be made into plastics.*

*Ignore more useful products.*

**1**

(iii) Break (C–C or C–H) bonds

*Allow to overcome the activation energy.*

*Allow to break the carbon chain.*

*Penalise breaking wrong bonds.*

**1**

(d) (i) $\underline{H_2}$

*Only.*

**1**

(ii) Fuel / LPG

*Allow camping gas, lighter fuel, propellant, refrigerant, cordless appliances.*

*Do not allow petrol or motor fuel.*

*Ignore natural gas.*

**1**

(iii) $C_4H_{10} + 2.5O_2 \rightarrow 4C + 5H_2O$

*Accept multiples.*

**1**

(iv) $SO^2$ / sulfur dioxide

*If other sulfur oxides, mark on.*

**1**

Calcium oxide / CaO / lime / quicklime

*Allow $CaCO_3$ / allow $Ca(OH)_2$ or names.*

*Allow any solid base.*

*M2 dependent on M1.*

*Do not allow limewater.*

**1**

(v) Neutralisation

*Allow acid-base reaction.*

*Allow flue gas desulfurisation / FGD*

**1**

(e) (Molecules) are similar sizes / have similar $M_r$ / have similar number of electrons

*Chemical error CE = 0/2 if breaking bonds.*

*Allow similar number of carbon and hydrogen atoms / similar surface area / similar chain length.*

*Can accept same number of carbon atoms.*

*Do not accept same number of H atoms / same number of bonds.*

*Ignore similar amount of bonds.*

**1**

Similar van der Waals forces between molecules / similar intermolecular forces (IMF)

*Not similar incorrect IMF eg dipole-dipole*

**1**

**[16]**