

- 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

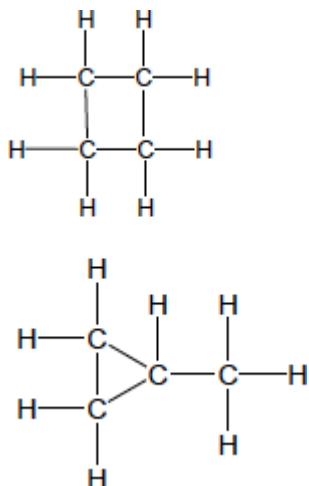
- (ii) But-2-ene  
*Allow but-2-ene.*  
*Allow but 2 ene.*  
*Ignore punctuation.*

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)  $C_{18}H_{34}$   
*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

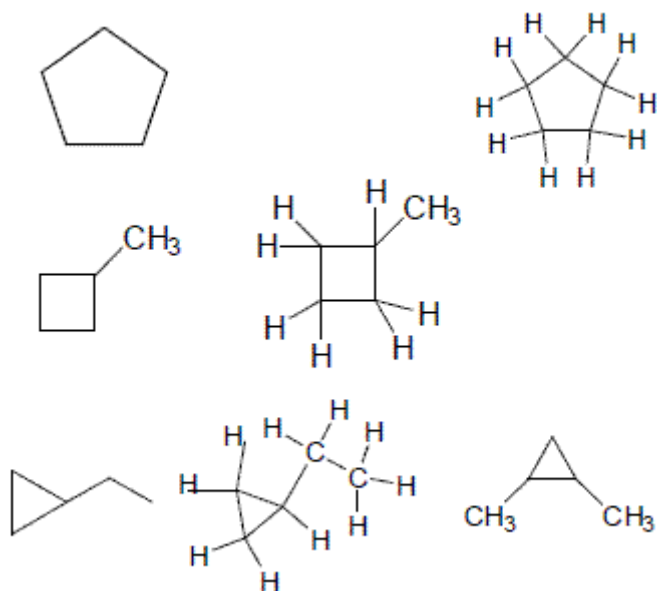
**M2.** (a) (Different) boiling points  
*Ignore mp's, references to imf, different volatilities* 1

(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

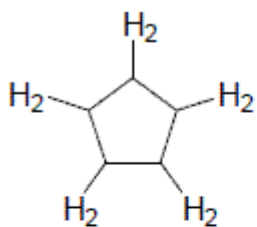
(iii)



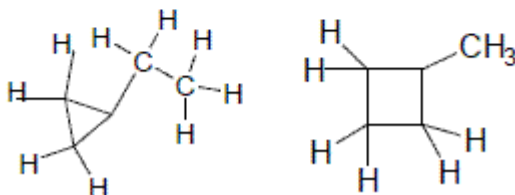
*Allow any correct structure with a cyclic alkane*

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'*  
( $400^{\circ}\text{C} \leq T \leq 900^{\circ}\text{C}$ ) or ( $650 \text{ K} \leq T \leq 1200 \text{ K}$ )  
*Not 'heat' alone*  
*If no T, units must be 650 – 900*
- and**
- High pressure ( $\geq 10 \text{ atm}$ ,  $\geq 1 \text{ MPa}$ ,  $\geq 1000 \text{ kPa}$ ) 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)  $(\underline{120.5} \times 100)(86 + 71)$

$=76.75(\%)$  or  $76.8(\%)$

*Allow answers > 3 sig figs*

1

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

*Ignore punctuation*

*Any order*

1



1

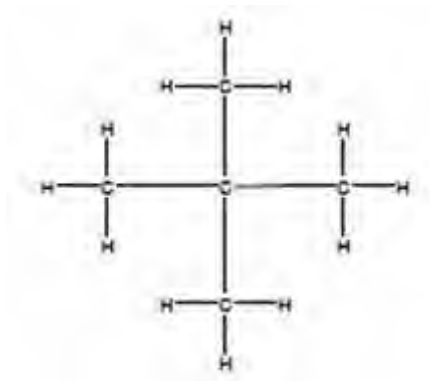
[12]

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<sub>2</sub>* 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

- 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) H<sub>2</sub>  
*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<sub>2</sub> / sulfur dioxide  
*If other sulfur oxides, mark on.* 1

Calcium oxide / CaO / lime / quicklime  
*Allow CaCO<sub>3</sub> / allow Ca(OH)<sub>2</sub> 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]