

- 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

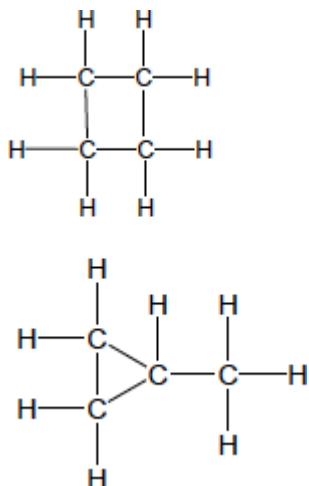
- (ii) But-2-ene
Allow but-2-ene.
Allow but 2 ene.
Ignore punctuation.

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) 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) $C_4H_{10} + 6\frac{1}{2} O_2 \longrightarrow 4CO_2 + 5H_2O$

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 $\geq 10 \text{ atm}$, $\geq 1 \text{ MPa}$ $\geq 1000 \text{ kPa}$

AND temp of $400 \text{ }^\circ\text{C} \leq T \leq 1000 \text{ }^\circ\text{C}$ or $650 \text{ K} \leq T \leq 1300 \text{ K}$

Do not allow high heat

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

1
[17]

- 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

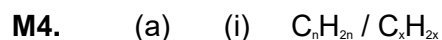
- (ii) Chain (isomerism)
Allow branched chain / chain branched / side chain (isomerism)
Ignore position (isomerism)
Do not allow straight chain / geometric / branched / function 1

- (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]



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

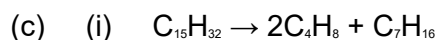
*Do not allow butene-1 / but-2-ene / butane / butane / alkene /
 C_4H_8 / propene / straight-chain alkene*

1

(ii) A structure of cyclobutane or
methyl-cyclopropane

Allow skeletal formula.

1



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) H₂
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) SO₂ / sulfur dioxide
If other sulfur oxides, mark on.

1

Calcium oxide / CaO / lime / quicklime
*Allow CaCO₃ / 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]