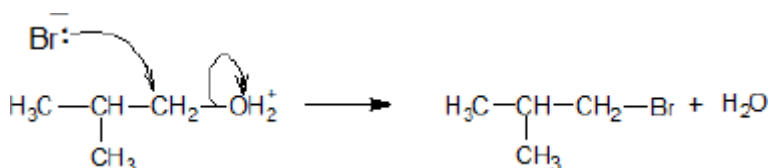


- M1.(a)** (i) **M1** double-headed curly arrow from the lone pair of the bromide ion to the C atom of the CH<sub>2</sub>

*Penalise additional arrows.*

**M2** double-headed arrow from the bond to the O atom

As follows



2

- (ii) **M1** nucleophilic substitution  
**M1** both words needed (allow phonetic spelling).

**M2** 1-bromo(-2-)methylpropane  
**M2** Require correct spelling in the name but ignore any hyphens or commas.

2

- (b) **M1** hydrolysis  
*For M1 give credit for 'hydration' on this occasion only.*

**M2** C≡N with absorption range 2220–2260 (cm<sup>-1</sup>)  
*Credit 1 mark from M2 and M3 for identifying C≡N and either O–H(acids) or C=O or C–O without reference to wavenumbers or with incorrect wavenumbers.*

**M3** O–H(acids) with absorption range 2500–3000 (cm<sup>-1</sup>)

OR

C=O with absorption range 1680–1750 (cm<sup>-1</sup>)

OR

C–O with absorption range 1000–1300 (cm<sup>-1</sup>)

*Apply the list principle to M3*

3

- (c) (i) **M1** Yield / product **OR** ester increases / goes up / gets more

**M2** (By Le Chateliers principle) the position of equilibrium is driven / shifts / moves to the right / L to R / in the forward direction / to the

product(s)

**M3 – requires a correct statement in M2**

(The position of equilibrium moves)

to oppose the increased concentration of ethanol

to oppose the increased moles of ethanol

to lower the concentration of ethanol

to oppose the change and decrease the ethanol

If no reference to **M1**, marks **M2** and **M3** can still score BUT  
if **M1** is incorrect CE=0

If there is reference to 'pressure' award **M1** ONLY.

3

(ii) **M1**

Catalysts provide an alternative route / pathway / mechanism

**OR**

surface adsorption / surface reaction occurs

For **M1**, not simply 'provides a surface' as the only  
statement.

**M1** may be scored by reference to a specific example.

**M2**

that has a lower / reduced activation energy

**OR**

lowers / reduces the activation energy

Penalise **M2** for reference to an increase in the energy of the  
molecules.

For **M2**, the student may use a definition of activation energy  
without referring to the term.

Reference to an increase in successful collisions in unit time  
alone is not sufficient for **M2** since it does not explain why  
this has occurred.

2

[12]

**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.

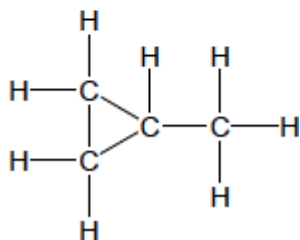
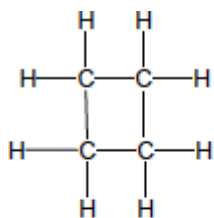
1

(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)** 2-bromo-2,3-dimethylbutane  
Ignore punctuation.

1

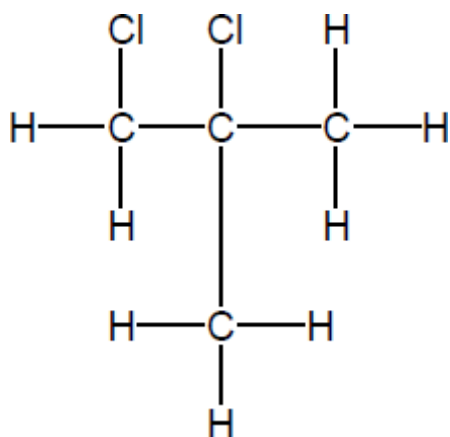
$C_nH_{2n+1}Br$  or  $C_nH_{2n+1}X$  or  $C_xH_{2x+1}Br$   
Any order.

1

Stronger / more vdw (forces) between molecules (of 1-bromohexane)  
QoL  
Allow converse arguments for Z  
Not just more IMF.  
Ignore size of molecule.

1

(b)



1

$C_2H_4Cl$   
Any order

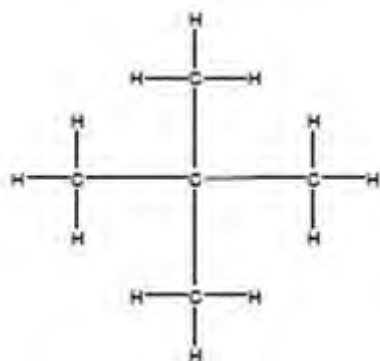
1

[5]

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

- 74.48% 1  
 Allow 74.5% 1
- 3  
 Only 1
- (f) 2,3-dichloro-3-methylpentane  
 Ignore punctuation 1
- C<sub>3</sub>H<sub>6</sub>Cl  
 Only 1

[13]

- M5.** (a) (i) C<sub>n</sub>H<sub>2n</sub> / C<sub>x</sub>H<sub>2x</sub> 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<sub>4</sub>H<sub>8</sub> / 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)  $H_2$   
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)  $\text{SO}_2$  / sulfur dioxide  
If other sulfur oxides, mark on.

1

Calcium oxide / CaO / lime / quicklime  
Allow  $\text{CaCO}_3$  / allow  $\text{Ca(OH)}_2$  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]