1 **(a) (i)** C_6H_{12} **[1]**
between 60 to 65°C **[1]**

(ii) $C_{12}H_{24}$ **[1]**
COND giving some indication of the method **[1]**

(b) add bromine water **or** potassium manganate(VII) **[1]**
<u>butene</u> it goes from brown/orange/yellow to colourless
or manganate (VII) from pink to colourless **[1]**
NOT clear
Cyclobutane it remains brown/orange/yellow **or** manganate (VII) stays pink
or no colour change **[1]**
Accept does not react
Provided colour of reagent somewhere in the answer [3] is possible

(c) (i) alcohol **[1]**

(ii) CH_3-CH_2-CHC*l*-CH_3 **[1]**

(iii) -$CH(CH_3)$-$CH(CH_3)$- **[2]**
or any equivalent diagram
[1] for repeat unit and [1] for continuat

TOTAL = 11

2 **(a) (i)** Correct equation [2]
For giving correct formula of alkane and alkene [1] only
Accept alkene and hydrogen

(ii) chlorine [1]
COND light **or** 200°C **or** heat **or** lead tetraethyl
or high temperature MAX 1000°C [1]
ignore comment 'catalyst'

(b) (i) same molecular formula [1]
different structures **or** structural formulae [1]

(ii) but-2-ene or cyclobutane [1]
corresponding structural formula [1]
NOT 2-butene

(c) butanol ignore numbers [1]
butane ignore numbers [1]
dibromobutane ignore numbers [1]

(d) (i) propene [1]

$CH_3—CH==CH_2$ [1]

(ii) Correct structure of repeat unit [1]
ignore point of attachment of ester group
COND upon repeat unit
shows continuation [1]
If chain through ester group [0] out of [2]

(iii) do not decay or non-biodegradable
shortage of sites or amount of waste per year
visual pollution
forms methane
Any TWO [2]

(iv) form poisonous **or** toxic gases **or** named gas CO, HCl HCN [1]
NOT carbon dioxide, harmful, sulphur dioxide

TOTAL = 18

Question	Answer	Marks
3(a)(i)	any three from: • (same) general (molecular) formula; • (consecutive members) differ by CH_2; • same functional group; • common (allow similar) methods of preparation; • same / similar chemical properties / (chemical) reactions;	**3**
(a)(ii)	C_nH_{2n} alkene; C_nH_{2n+2} alkane;	**1** **1**
(a)(iii)	alkanes <u>all</u> or <u>only</u> (C–C) single bonds / no double bonds / no multiple bonds; alkenes (at least one) C=C / double bond / multiple bond;	**1** **1**
(b)(i)	heat / high temperature / temperature between 450 °C and 800 °C; catalyst / named catalyst, e.g. zeolites or alumina or aluminium oxide or aluminosilicates or silica or oxides of chromium; **or** high pressure / pressure in range of 2–70 atm; **or** steam; absence of air / oxygen;	**2**
(b)(ii)	any correct equation producing an alkane and an alkene adding up to seven carbon atoms in the products;	**1**

Question	Answer	Marks
3(b)(iii)	any correct equation producing two alkenes and hydrogen, e.g. → C_2H_4 + C_5H_{10} + H_2 / C_3H_6 + C_4H_8 + H_2;	**1**
(b)(iv)	**alkenes:** more useful than alkanes / used to make polymers or plastics / used to make chemicals / petrochemicals; **or** **alkanes:** (balance the demand for different) fuels / increase petrol (fraction) or hydrogen / produce lighter fractions from heavier fractions or suitable example, e.g. naphtha to gasoline / more useful smaller molecules or more demand for smaller molecules or more demand for smaller fractions / used as fuel / used to make ammonia / used in Haber process / used in hydrogenation of vegetable oils / used to make HC*l*;	**1** **1**
(c)(i)	150 (cm^3);	**1**
(c)(ii)	100 (cm^3);	**1**
(c)(iii)	This question was discounted.	**1**

Question	Answer	Marks	Guidance
4(a)(i)	living/organism or named example e.g. yeast / cells / plants / animals / part of animal or plant e.g. muscle / humans / micro-organisms; produces / releases or gain or obtain energy / exothermic / heat; from food / named foodstuff / carbohydrate / named carbohydrate / sugar / named sugar / glucose / nutrients;	**3**	**A** 'we / us' for 'humans' **I** products / breathing / oxygen / anaerobic / aerobic
(a)(ii)	***Any 2 from 3:*** carbon dioxide / CO_2; water / H_2O; adenosine triphosphate / ATP;	**1**	**I** energy
(a)(iii)	biological catalyst or protein catalyst;	**1**	biocatalyst / living biological catalyst
(a)(iv)	**answer must include both** measuring the time and measuring a relevant quantity; **OR** alternatively measuring the time taken for something to happen; alternatives to time are: units of time / apparatus to measure time / regular intervals / how long examples of relevant quantities are: (Increase in / decrease in) amount / mass / volume / bubbles of carbon dioxide / bubbles of gas **OR** (Increase in / decrease in) mass of apparatus;	**1**	Examples: **A** time taken for lime water to turn milky **A** time taken for bubbling to stop / gas stop being evolved **A** count bubbles per minute **A** measure temperature (change) with time **R** time taken for reaction to end **R** measure carbon dioxide / gas with time (no reference to amount)
(b)(i)	tempe increase / heat increase / warmer / high temperature / exothermic / **more** yeast / yeast reproduces / yeast increases / yeast multiplies;	**1**	**R** yeast was added
(b)(ii)	**more** yeast / yeast reproduces / increases / multiplies;	**1**	yeast was added

Question	Answer	Marks	Guidance
4(b)(iii)	all glucose or reactant(s) reacted **OR** no glucose or reactant(s) left **OR** glucose or reactant(s) used up / finished / runs out / reacted completely / fully reacted; yeast (cells) dies **OR** enzymes denatured **OR** ethanol is toxic to yeast / ethanol kills yeast;	**2**	**I** glucose or reactants reacted / stopped reacting **R** enzyme dies / yeast denatures **R** yeast used up
(c)	***Any two from:*** fuel; **OR** petrol additive; **OR** solvent / tinctures; **OR** (making) perfumes; **OR** varnishes; **OR** preserving biological specimens / preserving food; **OR** essence / flavourings; **OR** antiseptic / kill bacteria (in medicine) / sterilizer; **OR** antitussive agent; **OR** (in) disinfectant / hand sanitizer; **OR** to make esters / esterification; **OR** to make ether(s); **OR** to make amines; **OR** to make carboxylic acid(s) / vinegar / ethanoic acid; **OR** thermometers; **OR** alcohol lamp / spirit burners; **OR** any other suitable use;	**2**	**I** medicine (unqualified) / chemical feedstock

Question	Answer	Marks	Guidance
4(d)			**I** fractional distillation / distillation wherever mentioned
	cracking / crack;		**I** catalytic / thermal + other conditions
	(hexane to obtain) ethene / C_2H_4 ;		Ethene / C_2H_4 can be given in either equation whether the equation is otherwise correct or not
	$C_6H_{14} \rightarrow C_2H_4 + C_4H_{10}$;		**I** state symbols **A** multiples / other equations e.g. $C_6H_{14} \rightarrow 3C_2H_4 + H_2$ $C_6H_{14} \rightarrow 2C_2H_4 + C_2H_6$ $C_6H_{14} \rightarrow C_2H_4 + C_4H_8 + H_2$ **A** any correct equations in which carbon is produced e.g. $C_6H_{14} \rightarrow 2C_2H_4 + 2C + 3H_2$
	hydration (of ethene) / hydrate / hydrated **or** add(ition of) water / add(ition of) steam / addition;		**A** additional **I** conditions / react with water
	$C_2H_4 + H_2O \rightarrow C_2H_5OH$;	**5**	**I** C_2H_6O / state symbols **A** multiples