Question	Answer	Marks
1(a)(i)	more than enough to react (with all the hydrocarbon); **OR** (some) oxygen remaining;	**1**
(a)(ii)	cm^3;	**1**
a)(iii)	2 : 15 : 10;	**1**
(a)(iv)	 2 : 15 : 10 : 10; C_5H_{10};	**2** 1 1
(b)(i)	$_7H_{16}$;	**1**
(b)(ii)	contains a double bond / triple bond / multiple bond; **OR** not all bonds are single bonds;	**1**
(b)(iii)	 test: aqueous bromine / bromine (water) / Br_2; result: (orange / yellow / brown) to colourless / decolourised / colour disappears;	**2** 1 1
(c)(i)	add	**1**
(c)(ii)	(kg);	**1**
(c)(iii)	 propene: CH_2; polypropene: CH_2;	**2** 1 1

Question	Answer	Marks
2(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
2(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
3(a)	*Any **two** fossil fuels from:* crude oil / petroleum; natural gas / methane; petrol / gasoline; kerosene / paraffin; diesel (oil) / gas oil; fuel oil; refinery gas / LPG; propane; butane;	**2**	**I** ethane / oil / naphtha / coal / gas **R** coke / bitumen / lubricating oil / wood
(b)	hydrog oxygen, nitrogen; *All three for 2 marks* *two for 1 mark*	**2**	H, O, N **I** H_2, O_2, N_2
(c)(i)	M1 oxygen and nitrogen (from air) react; M2 oxides of nitrogen **OR** nitrogen oxide(s) are formed; M3 nitrogen oxides formed react with water (to form acid);	**3**	**A** nitrogen combust for M1 **R** M1 if oxygen or nitrogen originate from the fuel **A** named oxide of nitrogen e.g. nitrogen dioxide **A** correct formulae **A** NO_x

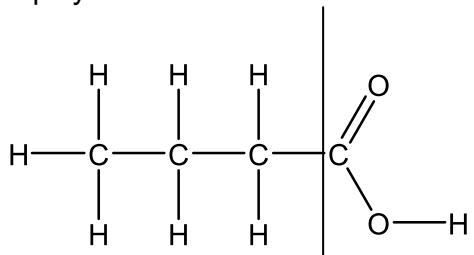
Question	Answer	Marks	Guidance
(c)(ii)	*Any **two** from:* M1 lowers pH or acidifies lakes / rivers or kills fish; M2 changes composition of soils or reduces fertility of soil or reduces crop yields deforestation or kills crops / trees / plants / leaves; M3 attacks (limestone) buildings or statues; M4 attacks metal (structures) / bridges;	**3**	**R** 'global warming / greenhouse effect' **R** 'increases pH of lakes so kills fish' for M1 **A** removes nutrients / leaches the soil **A** alternative words for 'attacks' e.g. damages / reacts with / corrode / erode for M3 and M4 **I** rusting but **A** 'enhances rusting' for M4 **I** toxicity to humans
(d)	*Any **three** from:* M1 wood burns to produce (less) carbon dioxide; M2 trees (wood) take in carbon dioxide; M3 by photosynthesis; M4 wood is carbon neutral fuel;	**3**	

Question	Answer	Marks	Guidance
4(a)(i)	*Any **one** fossil fuel from:* crude oil / petroleum / natural gas / methane / petrol / gasoline / kerosene / paraffin / diesel (oil) / gas oil / fuel oil / refinery gas / LPG / propane / butane;	1	**I** ethane / oil / naphtha / coal / gas **R** coke / bitumen / lubricating oil / wood
4(a)(ii)	(burn to) release energy; take a long time to form (from organic material);	2	If time stated 1000 years or more
4(b)(i)	/ air and sulfur (from fuel) react; (forms) sulfur (di)oxide; (sulfur dioxide) reacts with oxygen / air and water (to form sulfuric acid) **OR** sulfur trioxide reacts with water (to form sulfuric acid) **OR** sulfurous acid reacts with oxygen (to form sulfuric acid);	3	**A** correct formulae throughout **A** sulfurous acid if sulfur reacts with oxygen and water
4(b)(ii)	oxygen and nitrogen react; making oxides of nitrogen; (oxides of nitrogen) react with water (making nitric acid);	3	**A** nitrogen combust **R** if oxygen or nitrogen originate from the fuel **A** named oxide of nitrogen **A** correct formulae **A** NO_x
4(b)(iii)	add sodium hydroxide (solution) and aluminium; (warm) and ammonia made;	2	**A** zinc or Devarda's **A** description of smell of ammonia or test for ammonia

Question	Answer	Marks	Guidance
4(b)(iv)	M1 measure pH / describe how to measure pH (such as use universal indicator); M2 lower pH greater concentration of H^+; **OR** M1 add Ca, Mg, Zn, Fe; M2 faster reaction greater concentration of H^+ / faster bubbles or more hydrogen (in same time); **OR** M1 rate of reaction with (metal) carbonate; M2 faster reaction greater concentration of H^+ / faster bubbles or more carbon dioxide (in same time); **OR** M1 electrical conductivity; M2 greater conductivity greater concentration of H^+; **OR** M1 titrate with (named) alkali; M2 correct result;	**2**	**A** M2 if non specified or other metal added in M1

5 **(a) (i)** butanoic acid/butyric acid [1]

displayed formula below [2]



(1) (1)

(ii) any **three** from:
same or similar chemical properties
(same) general (molecular) formula
(consecutive members) differ by CH_2
same functional group
common methods of preparation
physical properties vary in predictable manner/show trends/gradually change
or example of a physical property variation i.e. melting point/boiling point/volatility

(iii) dissociates/ionises/splits up (into ions) [1]

partially/incompletely/slightly/not fully [1]

(donates) protons/(forms) H^+/H_3O^+(as the only positive ion) [1]

(b) (i) methyl propanoate [1]

$CH_3CH_2COOCH_3/CH_3CH_2CO_2CH_3/C_2H_5COOCH_3/C_2H_5CO_2CH_3$ [1]

(ii) methyl ethanoate [1]

(c) $3C_4H_{10} + \mathbf{5\ ½}\ O_2 \rightarrow 4C_2H_5COOH + \mathbf{3}\ H_2O$ [1]

(ii) propanol or propan-1-ol or propanal [1]

[Total: 14]

6 **(a) (i)** substance / material / compound / element / mixture (burnt) to <u>produce / release energy</u> **or** <u>heat</u> (1) [1]

(ii) Any **two** from:
coal
coke
peat
petroleum / crude oil
refinery gas / LPG
gasoline / petrol
naptha
kerosene / paraffin
diesel (oil) / gas oil
fuel oil
propane
butane [2]

(iii) wood / charcoal / animal dung / biomass / Uranium / U / plutonium / Pu (1) [1]

(b) (i) any **two** from:
water / steam / water vapour / H_2O (1)
carbon dioxide / CO_2 (1)
carbon monoxide / CO (1) [2]

(ii) any **two** from:

limited or finite resource / non-renewable / will run out / depleted (1)

greenhouse effect / gas(es) / climate change / (cause) global warming (1)

acid rain (1)

production of <u>poisonous / toxic</u> gases (1) [2]

[Total: 8]