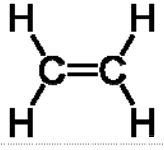
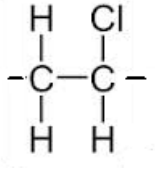
Question number	Answer	Notes	Marks
1 (a)	(refinery) gases		1
(b)	bitumen		1
(c) (i)	$C_{18}H_{38} \rightarrow C_8H_{18} + C_{10}H_{20}$ **OR** $C_{18}H_{38} \rightarrow C_8H_{18} + 2C_5H_{10}$ **OR** $C_{18}H_{38} \rightarrow C_8H_{18} + 5C_2H_4$		1
(ii)	**Any two from:** M1 over/greater supply of long chain hydrocarbons/molecules/ heavy/heavier fractions / OWTTE M2 high(er) demand/more use for short-chain/small hydrocarbons/ light/lighter fractions/ OWTTE M3 reference to a use eg the alkenes produced can be used to make polymers/plastics / eg the short-chain (saturated) hydrocarbons used as fuels	Accept reverse argument eg not enough short chain hydrocarbons Accept specific alkene and product eg ethene to make poly(ethene)/ethanol/alcohol Accept answers in terms of gasoline/petrol / fuel (for cars)	2
(d)	$C_8H_{18} + 8½O_2 \rightarrow 8CO + 9H_2O$ **M1** correct formula for CO **M2** correct balanced equation **M2** dep on **M1**	Allow multiples Accept balanced equations containing CO as well as C and/or CO_2 eg $C_8H_{18} + 6.5O_2 \rightarrow 4CO + 4C + 9H_2O$	2

Question number				Answer	Notes	Marks
2	a			cross in box C (fractional distillation)		1
	b		M1	larger molecules in crude oil	Accept longer (chains) / bigger M_r in place of larger Accept molecules in crude oil have wide range of sizes AND molecules in kerosene have similar sizes	4
			M2	more covalent bonds in crude oil (molecules) / bonds have different strengths	Accept no difference / same type of covalent bonding Reject references to double bonds in kerosene	
			M3	crude oil has higher viscosity	Accept less runny / less thick	
			M4	correct reference to other difference - eg crude oil darker colour crude oil harder to ignite crude oil burns with a smokier flame crude oil has a higher boiling point / wider range of boiling points		
					Any three points from four Accept converse statements for (molecules in) kerosene	
	c	i		C_9H_{20}	Accept $H_{20}C_9$	1
		ii		pentane		1
		iii			Ignore bond angles Ignore dot and cross diagram Ignore non-displayed formulae	1

Question number				Answer	Notes	Marks
2	d		M1 M2		M1 for 4 correct atoms joined to 2 C atoms (ignore C=C and extra atoms joined to C) Accept Cl in any position of four M2 for all 7 bonds correct provided that continuation bonds are shown but have no atoms attached Cl_2 in place of Cl but otherwise correct scores M2 but not M1 Ignore brackets and any subscript	1 1
	e	i		(in condensation polymerisation) a small molecule/H_2O/HCl is (also) formed /lost/released OR two (different) monomers / more than one product	Accept converse statement for addition polymerisation eg (only) one product formed / no atoms are lost/gained	1
					If no reference to type of polymerisation, assume that condensation is referred to	
		ii	M1	breakdown / decomposition	Ignore wear away / rot	1
			M2	by bacteria/microbes/micro-organisms	Accept biologically / naturally M2 dep on M1 or near miss	1
		iii		inert(ness)	Accept unreactive / non-polar Ignore strong bonds / long chains	1
TOTAL						**13**

Question number	Answer	Accept	Reject	Marks
3 (a)	it /gasoline is used (as a fuel) for cars ignore references to uses of fuel oil and gasoline burning better	there are more cars than ships	Any other wrong use, eg domestic heating, aeroplanes, ships, etc	1
(b) (i)	C_4H_8	$2C_2H_4$		1
(ii)	Catalyst - silica / silicon dioxide / silicon(IV) oxide / alumina / aluminium oxide	zeolite(s) / aluminosilicates		1
	Temperature – 600 – 700(°C) If more than catalyst given, all must be correct	Any temperature or any range within 600-700(°C) Equivalent temperatures in Kelvin		1

Question number	Answer	Accept	Reject	Marks
3 (c) (i)	Cracking – any two from: • continuous process • pure(r) product • fast(er) process • takes place on large(r) scale • high(er) percentage yield • 100% atom economy ignore references to cost			2
(ii)	Fermentation – any two from: • sugar is a renewable resource / uses a renewable resource • country has suitable climate/ enough land to grow sugar cane / plentiful supply of sugar (cane) • country has no / little crude oil • (ethanol produced) suitable for making alcoholic drinks / vinegar • takes place at lower temperature / uses less energy ignore references to cost		reusable resource	2
			Total	**8**

Question number	Answer	Accept	Reject	Marks
4 (a) (i)	poly(ethene)	polyethene / polythene / polyethylene		1
(ii)	cracking			1
(b) (i)	**M1** - bar labelled 9			1
	M2 - drawn to correct height			1
(ii)	(boiling point/it) increases as number of carbon atoms increases	ORA as one goes up, the other goes up positive correlation	(directly) proportional	1

Question number	Answer	Accept	Reject	Marks
4 (c)	**A / buried underground** because **Any two from:** • **M1** (plastics) do not produce carbon dioxide/carbon emissions / toxic / poisonous gases **IGNORE** harmful/dangerous/polluting gases / sulfur dioxide • **M2** (plastics) do not contribute to global warming /climate change / greenhouse effect / acid rain ● **M3** Does not pollute the soil / cause damage to the soil. **IGNORE** references to effect on wildlife/habitats / cost OR **B / burned** because • **M1** (burning) space in landfill not taken up / does not cause landfill sites to get filled up **/** will not run out of space for landfills • **M2** it provides heat **/** can be used to generate electricity IGNORE just provides energy	ORA carbon monoxide / nitrogen dioxide / hydrogen chloride / chlorine / formulae	References to ozone layer for M2 only	1 1 **OR** 1 1
			Total	7