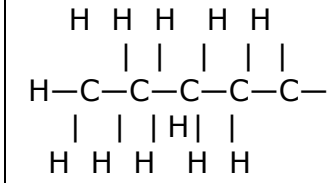
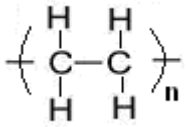
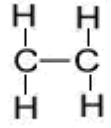
<table>
<tr><th>Question number</th><th>Answer</th><th>Notes</th><th>Marks</th></tr>
<tr><td>1 (a)</td><td>
<table>
<tr><th>Statement</th><th>Fractional distillation</th><th>Cracking</th></tr>
<tr><td>Crude oil is heated</td><td>(✓)</td><td></td></tr>
<tr><td>A catalyst may be used</td><td></td><td>✓</td></tr>
<tr><td>Alkenes are formed</td><td></td><td>✓</td></tr>
<tr><td>Decomposition reactions occur</td><td></td><td>✓</td></tr>
<tr><td>Fuels are obtained</td><td>✓</td><td>✓</td></tr>
<tr><td>Separation is the main purpose</td><td>✓</td><td></td></tr>
</table>
</td><td>1 mark for each line correct</td><td>5</td></tr>
<tr><td>(b) i</td><td>C_5H_{12}</td><td>Accept $H_{12}C_5$</td><td>1</td></tr>
<tr><td>ii</td><td>  </td><td></td><td>1</td></tr>
<tr><td>ii</td><td>C_5H_{12}</td><td>Accept $H_{12}C_5$</td><td>1</td></tr>
<tr><td>i iv</td><td>pentane</td><td></td><td>1</td></tr>
<tr><td>v</td><td>C_nH_{2n+2}</td><td>Accept x and other letters in place of n
Accept answers like $C_nH_{2n}+2$
Ignore 2(n+1)</td><td>1</td></tr>
</table>

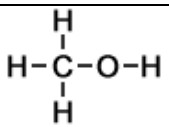
Question number	Answer	Notes	Marks
2 (c) i	(products) 2 2 (oxygen 3) 4 electrons shared between 2 (carbon) atoms 4 electron pairs between 2C and 4H atoms	 M1 and M2 independent Ignore inner electrons even if wrong Ignore number of hydrogen atoms Accept all permutations of dots and crosses Ignore intersecting circles Accept H atoms at all angles At least one C or one H atom must be labelled Max 1 if not all Max 1 if more than 2 C atoms Max 1 if wrong number of electrons in outer shell of any atom	1 1 1 1
(d) i	phosphoric acid / H_3PO_4 any value in range 250 – 350 °C	Ignore concentrated / dilute Accept value without unit Accept 523 – 623 K Marks independent	1 1
ii	20 (mol) M1 × 24 480 (dm^3)	 Accept 480 000 cm^3 If M1 incorrect but 480 is final answer, then only M3 can be awarded If no answer to amount of ethene, then 20 x 24 = 480 scores M2 and M3	1 1 1
		Total	**19**

Question number	Expected answer	Accept	Reject	Marks
2 (a) (i)	Co a (carbon to carbon) double bond / contains C=C / multiple bond IGNORE references to 'free' bond /spare bond	Can undergo addition reactions / does not contain the maximum number of hydrogen (atoms)		1
(ii)	(add) bromine (water) / Br_2 IGNORE references to any other solvent	$KMnO_4$ / potassium (per)manganate (VII) either an acid or an alkali		1
	decolourised / turns (from orange/brown to) colourless IGNORE starting colour IGNORE clear IGNORE discolour	(purple to) colourless (if acid used) (purple to) green (if alkali used)		1
	2nd mark dependent on 1st mark having been awarded, but for near miss on reagent, e.g. bromine in presence of uv, observation mark can be awarded			
	Ignore references to any products, correctly named or otherwise			

2 (b) (i)	H_2O			1
(ii)	Dehydration	Elimination		1
(c)			Any double-bonded product scores 0/2	2
	1 mark for  i.e. double to single	CH_2 - CH_2		
	1 mark for rest of formula, including extension lines, brackets and the 'n'	n as superscript	n before the brackets	
		Max 1 for skeletal formula		

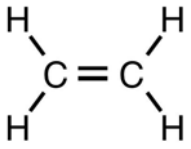
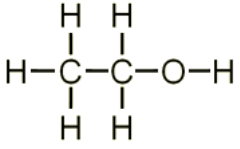
Total 7 Marks

Question number	Answer	Notes	Marks
3 a i	C (C_2H_4)		1
ii	B (colourless)		1
iii	A (dehydration)		1
b i	cracking		1
ii	(to act as a) catalyst OR to increase rate / speed up reaction	Accept (to provide an alternative route with) lower activation energy Accept decomposition / cracking in place of reaction	1
iii	cracking produces 2 or more products OR other products are formed OR identified possible product OR not all decane decomposed OR water vapour present (not just water)	Accept molecules / hydrocarbons /alkanes / alkenes in place of products Accept any hydrogen and any hydrocarbon with 8 or fewer carbon atoms (name or formula) Ignore decane decomposes / decane contains impurities Ignore references to air / oxygen / nitrogen / carbon dioxide Accept equation for cracking of decane showing two or more possible products (even if unbalanced)	1
			Total 6 marks

Question number	Answer	Notes	Marks
4 a i	sugar(s)	Accept carbohydrate(s)	1
ii	fermentation		1
iii	zymase	Accept enzyme(s) / yeast	1
iv	hydration	Accept addition	1
b i		Accept O–H in any position All atoms and bonds must be shown	1
ii	propanol/propan-2-ol/2-propanol	Reject propan-1-ol / 1-propanol	1
c	phosphoric acid / phosphoric(V) acid / H_3PO_4	Accept sulfuric acid / H_2SO_4 Ignore references to dilute Reject phosphoric(III) acid/phosphorous acid If both name and formula given, both must be correct	1
	300 (°C)	Accept a value, or any range, within the range 250-350 (°C) Accept equivalent value in other units, but unit must be given	1

4 d i		needs more oxygen (to react)	Accept needs 3 instead of 2.5 O_2 Accept reverse argument Ignore references to flammability	1
ii	M1	carbon monoxide / CO	If both name and formula given, both must be correct	1
	M2	poisonous / toxic / causes death IGNORE dangerous/harmful		1
	M3	reduces capacity of blood to carry oxygen	Accept correct reference to haemoglobin IGNORE references to suffocation/cannot breathe IGNORE blood carries no oxygen M2 & M3 can be awarded if M1 is missing or is a near miss (eg carbon dioxide)	1
4 e i		may explode / gas may leak / cylinder might break / pipe might burst / may catch fire (if gas leaks)		1
ii		$C_2H_5OH \rightarrow C_2H_4 + H_2O$	Accept CH_3CH_2OH or displayed formula Ignore state symbols Reject C_2H_6O	1

(Total for Question 4 = 14 marks)

<table>
<tr><th colspan="3">Question number</th><th>Answer</th><th>Notes</th><th>Marks</th></tr>
<tr><td>5</td><td>(a)</td><td></td><td>B (a pressure of 65 atm)</td><td></td><td>1</td></tr>
<tr><td></td><td>(b)</td><td></td><td>
<table>
<tr><th></th><th>Displayed formula</th></tr>
<tr><td>ethene</td><td>  </td></tr>
<tr><td>ethanol</td><td>  </td></tr>
</table>
</td><td>All atoms and bonds must be shown
Ignore bond angles</td><td>2</td></tr>
</table>

Question number			Answer	Notes	Marks
5	(c)		M1 (saturated because) there are only single bonds / all the bonds are single M2 (not a hydrocarbon) because it contains oxygen/another element	Accept no double bonds / no multiple bonds Accept contains an OH group / an alcohol group Accept does not contain only hydrogen and carbon	2
	(d)		Any three of the following: M1 correct statement about connection between crude oil and ethene, eg: crude oil is converted /fractionally distilled /cracked to obtain ethene M2 correct statement about connection between sugar cane or glucose and ethanol, eg: sugar/glucose is converted into ethanol / sugar/glucose fermented to make ethanol M3 correct statement about effect of crude oil being less available, eg: less ethene available /ethene more expensive / ethene production (more) difficult OR process 1 used less / less favoured / (more) expensive	Ignore references to time taken to obtain ethene or ethanol Ignore references to purity of ethene or ethanol Ignore references to global warming / finite and renewable resources	3

			M4 correct statement about effect of climate change, eg: more sugar can be fermented / more ethanol can be produced / ethanol cheaper / ethanol production easier/easy OR process 2 used more / more favoured / less expensive		
				Total for Question 4	**8**