OCR
RECOGNISING ACHIEVEMENT

GCE

Chemistry A

Advanced Subsidiary GCE **F322**

Chains, Energy and Resources

Mark Scheme for June 2010

Oxford Cambridge and RSA Examinations

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This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by Examiners. It does not indicate the details of the discussions which took place at an Examiners' meeting before marking commenced.

All Examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the Report on the Examination.

OCR will not enter into any discussion or correspondence in connection with this mark scheme.

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General advice to Assistant Examiners on the procedures to be used

YOU WILL BE REQUIRED TO UNDERTAKE 10 PRACTICE AND 10 STANDARDISATION SCRIPTS BEFORE STARTING TO MARK LIVE SCRIPTS.

1 The schedule of dates for the marking of this paper is very important. It is vital that you meet these requirements. If you experience problems then you must contact your Team Leader (Supervisor) without delay.

2 An element of professional judgement is required in the marking of any written paper. Candidates often do not use the exact words which appear in the detailed sheets which follow. If the science is correct and also answers the question then the mark(s) should normally be credited. If you are in doubt about the validity of any answer then consult your Team Leader (Supervisor) by phone, the messaging system within SCORIS or e-mail.

3 Correct answers to calculations always gain full credit even if no working is shown. (The 'Show your working' is to help candidates, who may then gain partial credit even if their final answer is not correct.)

4 Some questions may have a 'Level of Response' mark scheme. Any details about these will be in the Additional Guidance.

5 If an answer has been crossed out and no alternative answer has been written then mark the answer crossed out.

6 In addition to the award of 0 marks, there is a NR (No Response) option on SCORIS.

Award 0 marks

- if there is any attempt that earns no credit (including copying out the question or some crossed out working)

Award NR (No Response)

- if there is nothing written at all in the answer space
  OR
- if there is any comment which does not in any way relate to the question being asked (e.g. 'can't do', 'don't know')
  OR
- if there is any sort of mark which is not an attempt at the question (e.g. a dash, a question mark)

7 Abbreviations, annotations and conventions used in the detailed Mark Scheme.

/ = alternative and acceptable answers for the same marking point
not = answers which are not worthy of credit
reject = answers which are not worthy of credit
ignore = statements which are irrelevant
allow = answers that can be accepted
( ) = words which are not essential to gain credit
__ = underlined words must be present in answer to score a mark
ECF = error carried forward
AW = alternative wording
ora = or reverse argument

8 Annotations: the following annotations are available on SCORIS.

✓	=	correct response
✗	=	incorrect response
bod	=	benefit of the doubt
nbod	=	benefit of the doubt **not** given
ECF	=	error carried forward
^	=	information omitted
I	=	ignore
R	=	reject

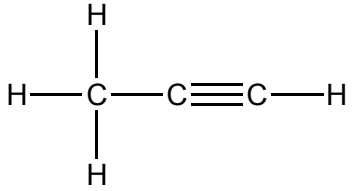
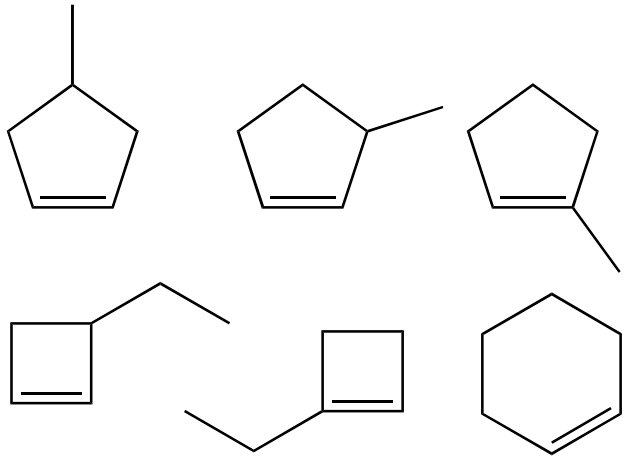
Highlighting is also available to highlight any particular points on the script.

The following questions should be annotated with ticks to show where marks have been awarded in the body of the text:
2(c)(ii), 3(b)(i), 5(d), 6(b) and **7**

9 The Comments box
The comments box will be used by your PE to explain their marking of the practice scripts for your information. Please refer to these comments when checking your practice scripts. You should only type in the comments box yourself when you have an additional object of the type described in Appendix B of the Handbook for Assistant Examiners and Subject Markers.
Please do not use the comments box for any other reason.
Any questions or comments you have for your Team Leader should be communicated by phone, SCORIS messaging system or e-mail.

10 Please send a brief report on the performance of the candidates to your Team Leader (Supervisor) by the end of the marking period. The Assistant Examiner's Report Form (AERF) can be found on the Cambridge Assessment Support Portal. This should contain notes on particular strengths displayed, as well as common errors or weaknesses. Constructive criticisms of the question paper/mark scheme are also appreciated.

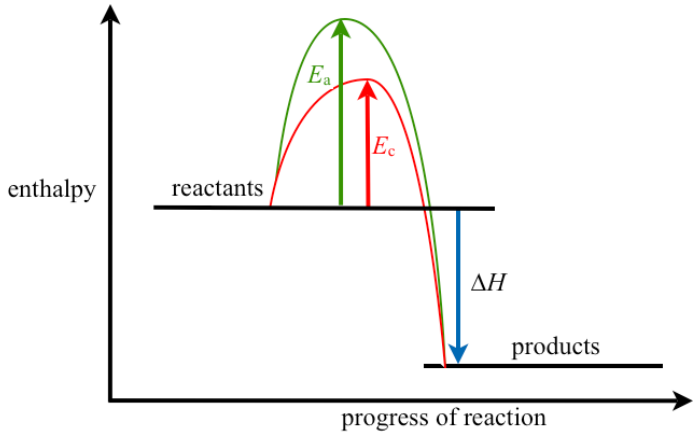
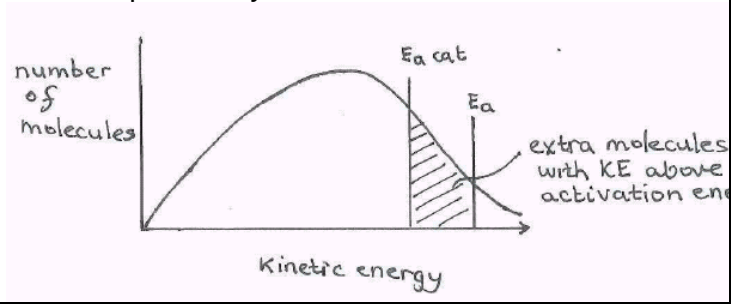
Question			Expected Answers	Marks	Additional Guidance
1	a	i	Series having same functional group and a general formula ✓	1	**ALLOW** same functional group and members vary by CH_2 **ALLOW** organic compounds with the same functional group that differ in length of their hydrocarbon chain
		ii	More surface contact **OR** bigger molecules ✓ More van der Waals' forces ✓	2	**BOTH answers need to be comparisons** **ALLOW** higher relative formula mass **OR** has more electrons **OR** longer chain length **OR** more carbon atoms **IGNORE** surface area / bigger compounds **ALLOW** stronger van der Waals' forces / stronger induced dipoles VDW forces is not sufficient More intermolecular forces is **not** sufficient **DO NOT ALLOW** breaking bonds within the chain / breaking covalent bonds **IGNORE** reference to bonds if not linked to covalent bonds
	b	i	Pent-1-yne **OR** pent-2-yne ✓	1	**ALLOW** pentyne Look for answer in the table if not on answer line but answer line takes precedence
		ii	C_nH_{2n-2} ✓	1	**ALLOW** $C_nH_{2(n-1)}$

Question			Expected Answers	Marks	Additional Guidance
1	b	iii	Correct displayed formula ✓	1	
		iv	Correct skeletal formula of cyclic hydrocarbon with formula C_6H_{10} ✓	1	Examples of correct skeletal formulae include 
	c		Energy required to break bonds = (+) 2912 ✓ Energy released to make bonds = (–)4148 ✓ Enthalpy of combustion = –1236 ✓	3	**ALLOW** full marks for correct answer with no working out **ALLOW** (2 × 415) + (837) + (2.5 × 498) **ALLOW** (4 × –805) + (2 × –464) **OR** (4 × 805) + (2 × 464) **ALLOW** ECF for calculation of enthalpy of combustion **ALLOW** 2 marks for +1236 with no working out

Question			Expected Answers	Marks	Additional Guidance
1	d	i	(Enthalpy change) when one mole of a compound ✓ is made from its elements (in their standard states) ✓ (Standard conditions are) 298 K and 100 kPa ✓	3	**IGNORE** energy required / energy released **ALLOW** (energy change) when one mole of a substance **DO NOT ALLOW** enthalpy change for one mole of products **ALLOW** 1 atmosphere pressure / 101 kPa / 10^5 Pa / 1.01×10^5 Nm^{-2} / 1000 millibars / 25 ^oC / any stated temperature in words **IGNORE** 1 mol dm^{-3} for solutions
		ii	From energy cycle Enthalpy change to get elements = −(−60) – (2 −286) / (+) 632 ✓ Enthalpy change from elements = −987 + (+227) / (−)760 ✓ Enthalpy change = −128 ✓	3	**ALLOW** full marks for −128 with no working out **ALLOW** ECF from errors in calculation **ALLOW two** marks for answer of −414 / +128 / –1392 / +1392 **ALLOW one** mark for answer of +414
	e	i	$\frac{26.0}{100.1} \times 100$ ✓ 26.0% ✓	2	First mark for 100.1 **OR** (64.1 + 36.0) **OR** (74.1 + 26.0) at **bottom** of fraction with or without × 100 **ALLOW full** marks for 26.0 or 26% with no working out **ALLOW** from two significant figures up to calculator value **ALLOW** 25.97 / 26% **NO ECF** for this part from incorrect numbers in first expression

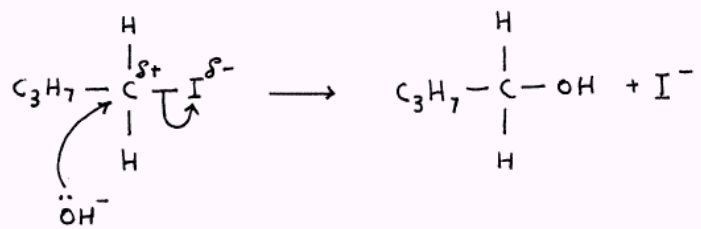
Question			Expected Answers	Marks	Additional Guidance
1	e	ii	1.56×10^4 **OR** 15600 **OR** 15601 ✓	1	**ALLOW** calculator value of 15600.62402 and any rounded value to a minimum of three significant figures
		iii	1.5×10^4 **OR** 15000 ✓	1	**ALLOW** 1.50×10^4 etc.
		iv	96.2 ✓	1	**ALLOW** ECF from **(iii)** ÷ **(ii)** **ALLOW** calculator value 96.1538461 and any rounded value to a minimum of two significant figures **ALLOW** 96.14768284 if 15601 is used **ALLOW** any value between 88 to 89 if answer to **(iii)** was calculated by dividing by 26
		v	**Any two from:** Low atom economy gives a poor sustainability **OR** low atom economy means lots of waste ✓ A use for the aqueous calcium hydroxide needs to be developed to increase atom economy ✓ Alternative process needs to be developed with high atom economy ✓	2	**ANNOTATE WITH TICKS AND CROSSES** **IGNORE** comments about percentage yield **ALLOW** ECF from **(i)** e.g. high atom economy will have good sustainability **ALLOW** find a use for the waste to increase atom economy
			Total	**23**	

Question			Expected Answers	Marks	Additional Guidance
2	a	i	Branched chain alkane of formula C_5H_{12} to C_9H_{20} e.g. 2-methylpentane, 3-methyloctane ✓	1	Must have position number **but ALLOW** methylbutane **DO NOT ALLOW** 1-methylpentane or 2-ethylpentane etc **DO NOT ALLOW** incorrect nomenclature e.g. 2-**methy**pentane etc
	b	i	Vibrate (more) ✓	1	**ALLOW** bend / stretch / oscillate **IGNORE** rotate **NOT** break / molecules vibrate
		ii	Incomplete combustion ✓	1	**ALLOW** not enough oxygen
		iii	NO for photochemical smog **OR low level** ozone ✓ CO is toxic ✓	2	**ALLOW** NO can (eventually) cause acid rain **OR** can result in respiratory irritation **OR** can (eventually) depletes high level ozone **OR** depletes ozone layer **IGNORE** greenhouse gas **ALLOW** poisonous **OR** kills **OR** lethal **ALLOW** CO reduces the capacity of blood to carry oxygen Oxygen combines with haemoglobin is insufficient **IGNORE** CO is harmful / suffocates / greenhouse gas
	c	i	Makes nitrogen **AND** carbon dioxide ✓ $2CO + 2NO \rightarrow N_2 + 2CO_2$ ✓	2	 **ALLOW** any correct multiples **IGNORE** state symbols

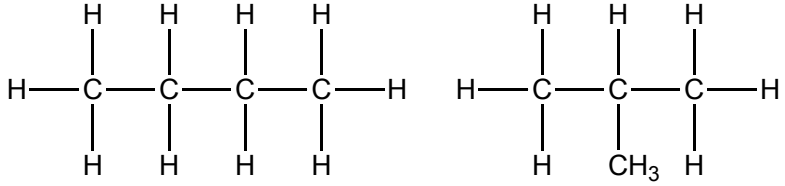
Question			Expected Answers	Marks	Additional Guidance
2	c	ii	One activation energy correctly labelled on enthalpy profile diagram ✓ Idea that activation energy is lowered ✓ Catalyst has a different reaction pathway **OR** different reaction mechanism **OR** two curves drawn on profile ✓ Correct diagram of reaction profile for exothermic reaction with product below reactants with y axis as enthalpy or energy and ΔH label – arrow should go down. Ignore a small gap between at either end of ΔH line ✓ Drawing of Boltzmann distribution – axes labelled number of molecules and energy ✓ More molecules with energy above activation energy with a catalyst ✓ More effective collisions **OR** more successful collisions ✓	7	**ANNOTATE WITH TICKS AND CROSSES** With the line/arrow no more than 1 mm from top of curve or reactant line – arrow can be double headed for activation energy **ALLOW** vertical line with no arrows **DO NOT ALLOW** arrow just pointing downwards Marks can be awarded via, reaction profile, in words or from Boltzmann  Boltzmann distribution – must start at origin and must not end up at 0 on *y*-axis i.e. must not touch *x*-axis 

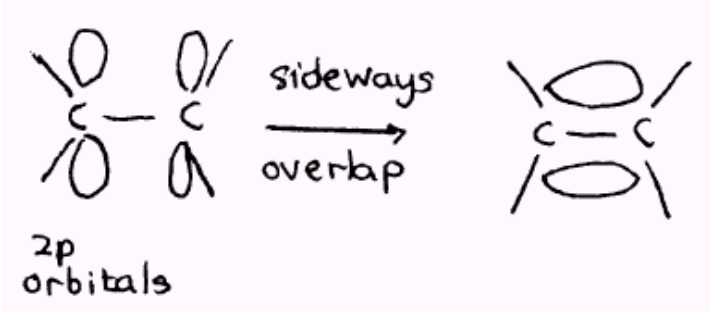
Question			Expected Answers	Marks	Additional Guidance
2	d		**Any two benefits from**:	3	**ANNOTATE WITH TICKS AND CROSSES**
			Save crude oil **OR** no risk of large scale pollution from exploitation of crude oil ✓		**ALLOW** decrease the need for fossil fuels
			Biodiesel is renewable **OR** diesel is non-renewable ✓		**ALLOW** plants are a renewable resource / crude oil non-renewable resource / biodiesel is more sustainable / diesel is not sustainable
			Use of biodiesel is (more) carbon-neutral **OR** plants take up the carbon dioxide released during combustion ✓		**ALLOW** lower carbon footprint **IGNORE** can be used by diesel powered cars with or without any conversion
			and one disadvantage		
			Land not used to grow food crops **OR** (rain)forests have to be cut down to provide land **OR** food prices may rise because less is grown ✓		**IGNORE** comments about availability / fertilisers / pesticides Destroys habitats is not sufficient
			Total	**17**	

Question			Expected Answers	Marks	Additional Guidance
3	a		Answers clockwise from top left $CH_3CH_2CH_2COOH$ ✓ $CH_3CH_2CHCH_2$ ✓ $CH_3COOCH_2CH_2CH_2CH_3$ ✓ $CH_3CH_2CH_2CHO$ ✓	4	**ALLOW** skeletal formula **ALLOW** butanoic acid **ALLOW** but-1-ene **ALLOW** butyl ethanoate **ALLOW** butanal If name and structure given both must be correct If C_3H_7 used instead of $CH_3CH_2CH_2$ penalise once and then apply ECF If wrong carbon skeleton used then penalise once then apply ECF If a hydrogen is missing then penalise once

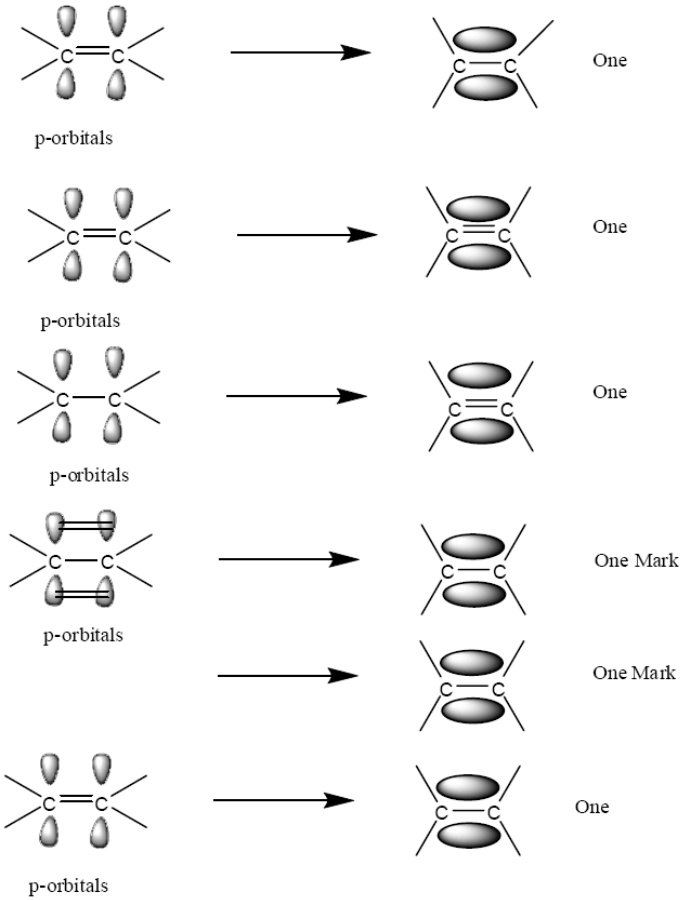
Question			Expected Answers	Marks	Additional Guidance
3	b	i	Nucleophilic substitution ✓ Heterolytic ✓ Dipole shown on C–I bond, $C^{\delta+}$ and $I^{\delta-}$ ✓ Curly arrow from OH^- to carbon atom of C–I bond ✓ Curly arrow from C–I bond to the iodine atom ✓	5	**ANNOTATE WITH TICKS AND CROSSES** **DO NOT ALLOW** fish hooks No need to show lone pair on OH^- or I^- Curly arrow must come from the negative sign or lone pair on the oxygen of the hydroxide ion  **ALLOW S_N1 mechanism** dipole shown on C–I bond, $C^{\delta+}$ and $I^{\delta-}$ ✓ curly arrow from C–I bond to the iodine atom ✓ curly arrow from OH^- to correct carbonium ion ✓
		ii	Use reflux **OR** heat for more than 20 minutes ✓ C–C*l* stronger bond (than C–I bond) **OR** C–C*l* shorter bond (than C–I bond) **OR** C–C*l* bond is harder to break **OR** needs more energy to break C–C*l* bond **OR** ora ✓	2	**ALLOW** heat stronger **OR** heat for longer **OR** heat at a higher temperature **OR** more heat Answer must refer to the C–C*l* bond or C–I bonds
			Total	**11**	

Question			Expected Answers	Marks	Additional Guidance
4	a	i	**Any two from:** Any value between 1000–1300 ✓ Any value between 2850–3100 ✓ Any value between 3200–3550 ✓	2	
		ii	Orange to green or blue ✓	1	
		iii	$CH_3CH_2OH + [O] \rightarrow CH_3CHO + H_2O$ **OR** $CH_3CH_2OH + 2[O] \rightarrow CH_3COOH + H_2O$ Correct organic product ✓ Balanced equation ✓	2	**IGNORE** any state symbols **ALLOW** CH_3COH in equation but not for the structure **ALLOW** equations with molecular formulae but not the product mark
	b	i	Absorption around 2850–3100 (cm^{-1}) so contains C—H bonds ✓ No other **important** absorptions present / no other **characteristic** absorptions ✓	2	Answer must have a reference to infrared spectrum i.e. use of cm^{-1} or data from the infrared spectrum 'Has no other peaks so no functional groups present' is **not** sufficient **BUT** There are no peaks due to functional groups is sufficient **ALLOW** peaks instead of absorption **ALLOW** no absorption due to C=O and O–H / no absorption due to carbonyl and hydroxyl
		ii	Peak furthest to right hand side is 58 / molecular ion peak is 58 / peak at highest mass ✓	1	**ALLOW** peak at *m*/*z* 58 marked on the mass spectrum / M peak is 58 / peak at 58 linked to the molecular mass **DO NOT ALLOW** highest peak but **ALLOW** 58 is the highest peak

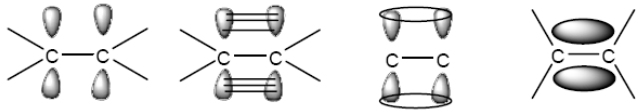
Question			Expected Answers	Marks	Additional Guidance
4	b	iii	 **BOTH** isomers correct ✓	1	If three structures are drawn then do not award mark **ALLOW** skeletal formulae / structural formulae **IGNORE** incorrect names
		iv	CH_3^+ ✓ $C_2H_5^+$ ✓ $C_3H_7^+$ / $CH_3CH_2CH_2^+$ / $(CH_3)_2CH^+$ ✓	3	Essentially marks are allocated as positive ions ✓ Formula of two fragments correct (ignore charge) ✓ **BUT** formulae of all three fragments correct (ignore charge) ✓✓
		v	$CH_3CH_2CH_2CH_3$ because there is a peak at m/z = 29 ✓	1	**ALLOW** name, displayed or skeletal structure **ALLOW** butane because there is a C_2H_5 fragment **ALLOW** butane because it gives all three fragments listed in **(iv)**
			Total	**13**	

Question			Expected Answers	Marks	Additional Guidance
5	a		**Sideways** overlap of two p orbitals on each carbon atom ✓ forms π-orbital or π-bond above and below plane of molecule ✓	2	Answers can be awarded from a labelled diagram see additional page with typical diagrams you might see  Drawings with a double bond drawn can score a maximum of one mark Drawing above with no labels scores one mark

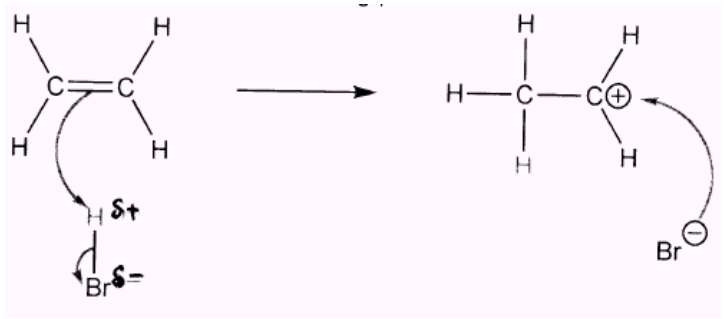
Each of the following diagrams is worth one mark. The words p-orbitals must be present to score the mark

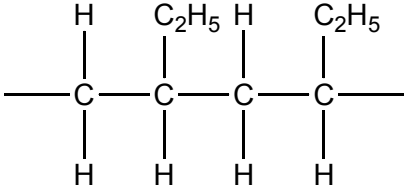


Each of the diagrams on its own scores no mark

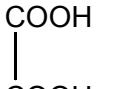
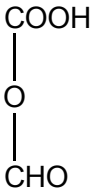


Question			Expected Answers	Marks	Additional Guidance
5	b	i	Double bond does not rotate / restricted rotation of the double bond ✓ Each carbon atom of double bond is bonded to (two) different groups ✓	2	**ALLOW** π bond does not rotate **ALLOW** each carbon atom of double bond is bonded to (two) different atoms / each end of the π-bond is bonded to different groups or atoms ✓
		ii	**C** and **E** ✓	1	

Question			Expected Answers	Marks	Additional Guidance
5	c		CH_3CH_2OH / ethanol ✓	1	**IGNORE** alcohol
	d			9	**ANNOTATE WITH TICKS AND CROSSES** **QWC** mark and **8 other** marking points
			C_4H_8 + HBr → C_4H_9Br ✓ C_2H_4 + HBr → C_2H_5Br ✓		The equation must be the overall equation not a series of steps as in a mechanism
			B makes $CH_3CH_2CH_2CH_2Br$ ✓ $CH_3CHBrCH_2CH_3$ ✓		**ALLOW** skeletal or displayed formulae **ALLOW B** makes 1-bromobutane and 2-bromo butane ✓ if marks for the structures not awarded
			QWC – number of products is linked to structure of alkene e.g. because **D** is symmetrical **OR B** is not symmetrical ✓		
			Movement of electron pair from double bond to attack hydrogen of H–Br and breaking of H–Br bond ✓ Correct dipole shown on H–Br ✓ Correct carbonium ion drawn ✓ Curly arrow from Br^- to the carbonium ion ✓		 **ALLOW** curly arrow from lone pair or minus sign of bromide ion **ALLOW** marks for the mechanism even if the wrong alkene is used e.g. for alkene **B** If two mechanisms are drawn mark the one for alkene **D**

Question			Expected Answers	Marks	Additional Guidance
5	e	i	 ✓	1	Must have at least two repeat units and the free bonds at the end All carbon–carbon bonds in the polymer chain must be shown **ALLOW** bond to ethyl group to any part of ethyl group **IGNORE** any brackets drawn
		ii	Poly(but-1-ene) ✓	1	**ALLOW** polybut-1-ene n.b. the bracket is part of the answer **DO NOT ALLOW** polybutene
	f	i	(Lots of) OH group present ✓ Can form hydrogen bonds with water ✓	2	**ALLOW** hydroxyl group present / hydroxy group Alcohol group is not sufficient
		ii	**Any two from:** Incineration to produce energy **OR** combustion to produce energy ✓ Sorting and recycling **OR** sorting and remoulding ✓ Cracked (to give monomers) **OR** as an organic feedstock ✓	2	Used as a fuel is not sufficient **IGNORE** use photodegradable or biodegradable polymers
			Total	**21**	

Question			Expected Answers	Marks	Additional Guidance
6	a		Low pressure because more (gas) molecules on right hand side of equation **OR** low pressure because ΔV = positive ✓ Low temperature because the (forward) reaction is exothermic ✓	2	**ALLOW** low pressure because more (gas) moles on right hand side of equation
	b		Increased pressure speeds up reaction / ora ✓ 900 ^{o}C increases the rate **OR** increased temperature speeds up reaction / ora ✓ Idea that high enough temperature without compromising yield **OR** idea that high enough pressure without compromising yield ✓	3	**ANNOTATE WITH TICKS AND CROSSES** **ALLOW** 'pushes gases through system'
	c	i	5.68×10^7 / 5.7×10^7 ✓	1	**ALLOW** two or more significant figures Calculator answer is 5.6812500×10^7
		ii	Used to heat the incoming gases ✓	1	**ALLOW** used to heat rest of factory **OR** sold to the national grid Provide energy to create conditions is not sufficient because one condition is pressure
			Total	**7**	

Question	Expected Answers	Marks	Additional Guidance
7	**Infrared** QWC – 1720 cm^{-1} indicates carbonyl group ✓ QWC – broad 2900 cm^{-1} indicates O–H bond in **carboxylic acid** ✓ QWC – 1080 cm^{-1} indicates C–O bond ✓ **Percentage composition** Mole ratio C : H : O = 2.23 : 2.22 : 4.44 ✓ Empirical formula is CHO_2 ✓ (mass of one mole is 90 g) so M_r is 90 ✓ QWC – molecular formula is $C_2H_2O_4$ with working out from M_r ✓ Structure is  ✓	8	**ANNOTATE WITH TICKS AND CROSSES** ✎ **QWC** –Structure linked to information at least once **ALLOW** 1720 indicates presence of aldehydes, ketones, esters, carboxylic acid, amides **ALLOW** 2900 indicates carboxylic acid **ALLOW** 1080 indicates alcohol, esters, carboxylic acids **ALLOW** 26.7/12.0. 2.22/1.0 and 71.1/16.0 **ALLOW** COOH **ALLOW two** marks for correct empirical formula with no working out **ALLOW** 0.0945/0.00105 = 90 **ALLOW** 
	Total	**8**	

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