



GCE

Chemistry A

Mark Scheme

Mark Scheme

Question			Answer	Mark	Guidance
1	(a)	(i)	$\text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2 \rightarrow 6\text{CO}_2 + 6\text{H}_2\text{O}$ ✓	1	IGNORE state symbols
		(ii)	<p>Bond breaking absorbs energy AND bond forming releases energy ✓</p> <p>More energy released than absorbed ✓</p>	2	<p>ALLOW bond breaking is endothermic AND bond forming is exothermic</p> <p>DO NOT ALLOW bond forming requires energy</p> <p>The second marking point is dependent on the correct identification of the energy changes during bond breaking and bond making</p> <p>ALLOW exothermic change transfers more energy than endothermic change</p> <p>OR bond forming transfers more energy than bond breaking</p> <p>OR '(the sum of the) bond enthalpies in the products is greater than the (sum of the) bond enthalpies in the reactants'</p> <p>OR '(the sum of the) bond enthalpies of the bonds made is greater than (the sum of) the bond enthalpies of the bonds broken'</p> <p>IGNORE reference to strong and weak bonds</p> <p>IGNORE reference to number of bonds broken or made</p> <p>IGNORE enthalpy of products is less than enthalpy of reactants</p>
	(b)	(i)	<p>(Enthalpy change) when one mole of a substance ✓</p> <p>is completely combusted OR burns in excess oxygen ✓</p>	2	<p>ALLOW energy released</p> <p>DO NOT ALLOW energy required</p> <p>ALLOW element OR compound OR molecule</p> <p>DO NOT ALLOW one mole of atoms</p> <p>ALLOW reacts fully with oxygen</p>
		(ii)	<p>Would make carbon dioxide and water instead</p> <p>OR activation energy (too) high</p> <p>OR rate is (too) slow</p> <p>OR do not react together ✓</p>	1	<p>ALLOW will make other compounds (containing carbon and hydrogen or carbon, oxygen and hydrogen)</p> <p>ALLOW reaction cannot be carried out experimentally</p> <p>IGNORE heat is lost to the surroundings</p>

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1	(b)	(iii)	(+)2801 ✓ + (-)394 × 6 + (-)286 × 6 OR (-)4080 ✓ -1279 ✓	3	IGNORE sign IGNORE sign ALLOW full marks for -1279 with no working out ✓✓✓ Unit not needed ALLOW ECF enthalpy change of combustion of carbon dioxide and water – enthalpy of combustion of glucose ALLOW for 2 marks: +1279 cycle wrong way around OR +151 OR +691 one value not × 6 OR -6881 OR +6881 wrong sign for 2801 or 4080 OR +2121 ✓✓ correct cycle but not × 6 ALLOW for 1 mark: -151 OR -691 cycle wrong way around and one value not × 6 OR -2121 cycle wrong way around and not × 6 OR -3481 OR +3481 ✓ wrong sign and not × 6 Note: There may be other possibilities
			Total	9	

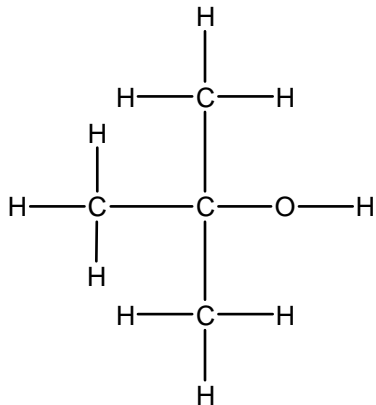
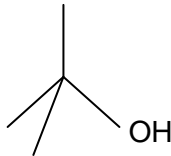
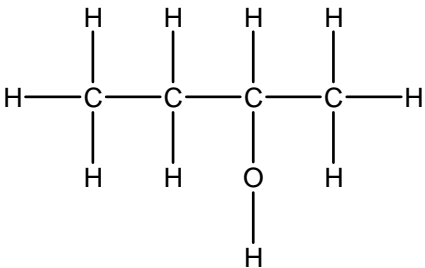
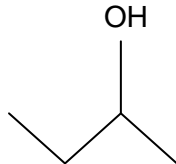
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2	(a)	(i)	$C_nH_{2n+1}OH$ ✓	1	ALLOW $C_nH_{2n+2}O$
		(ii)	$C_{13}H_{28}O$ ✓	1	ALLOW $C_{13}H_{27}OH$
	(b)		group of atoms OR part of a molecule ✓ that give a compound its (characteristic set of) reactions ✓	2	ALLOW part of an alcohol IGNORE part of a compound ALLOW that determines its chemical properties OR that gives the compound its reaction ALLOW that determines its homologous series
	(c)	(i)	Alkanes have van der Waals' intermolecular forces ✓ Alcohols have hydrogen bonds (and van der Waals' forces) ✓ Hydrogen bonds are stronger (than van der Waals' forces) OR ORA ✓	3	ANNOTATE ANSWER WITH TICKS AND CROSSES ALLOW reference to specific compounds e.g. comparing methane and methanol vdW force is not sufficient here Third marking point is dependent on the correct intermolecular forces being described BUT ALLOW hydrogen bonds are stronger than intermolecular forces in alkanes
		(ii)	Methylpropan-1-ol has weaker van der Waals' forces (than butan-1-ol) OR ORA ✓ Methylpropan-1-ol has less surface contact (than butan-1-ol) OR ORA OR Methylpropan-1-ol has more branching (than butan-1-ol) OR ORA ✓	2	ALLOW methylpropan-1-ol has fewer van der Waals' forces (than butan-1-ol) IGNORE reference to more surface area / molecules are closer ALLOW methylpropan-1-ol is branched and butan-1-ol is not IGNORE 'methylpropan-1-ol is branched' with no comparison

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2	(d)	(i)	$\text{CH}_3\text{OH} + 1\frac{1}{2}\text{O}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O} \checkmark$ $\text{CH}_3\text{OH} + \text{O}_2 \rightarrow \text{CO} + 2\text{H}_2\text{O} \checkmark$	2	ALLOW CH_4O for incomplete combustion ALLOW $\text{CH}_3\text{OH} + \frac{1}{2}\text{O}_2 \rightarrow \text{C} + 2\text{H}_2\text{O}$ ALLOW $2\text{CH}_3\text{OH} + 1\frac{1}{2}\text{O}_2 \rightarrow \text{C} + \text{CO} + 4\text{H}_2\text{O}$ ALLOW correct multiples of these equations IGNORE state symbols
		(ii)	insufficient supply of oxygen OR limited amount of air OR poorly ventilated \checkmark	1	
		(iii)	Feedstock (in manufacture of organic compounds) OR manufacture of biodiesel OR manufacture of esters. \checkmark	1	ALLOW manufacture of a named organic compound that can be made from methanol ALLOW antifreeze, screenwash
	(e)		$\text{CH}_3\text{CH}_2\text{CH}_2\text{COOH} \checkmark$ BUT $\text{C}_4\text{H}_9\text{OH} + 2[\text{O}] \rightarrow \text{CH}_3\text{CH}_2\text{CH}_2\text{COOH} + \text{H}_2\text{O} \checkmark\checkmark$	2	One mark is for the correct structure of the product One mark is for the equation ALLOW $\text{CH}_3\text{CH}_2\text{CH}_2\text{CO}_2\text{H}$ DO NOT ALLOW $\text{C}_4\text{H}_8\text{O}_2$, $\text{C}_3\text{H}_7\text{COOH}$, $\text{C}_4\text{H}_7\text{OOH}$ for the structure mark but ALLOW for the equation mark Give credit for the correct structure in the equation e.g. $\text{C}_4\text{H}_9\text{OH} + 2[\text{O}] \rightarrow \text{CH}_3\text{CH}_2\text{CH}_2\text{COOH} + \text{H}_2\text{O}$ scores two marks but $\text{C}_4\text{H}_9\text{OH} + [\text{O}] \rightarrow \text{CH}_3\text{CH}_2\text{CH}_2\text{COOH} + \text{H}_2$ scores one mark $\text{C}_4\text{H}_{10}\text{O} + 2[\text{O}] \rightarrow \text{C}_4\text{H}_8\text{O}_2 + \text{H}_2\text{O}$ scores one mark ALLOW one mark for: $\text{C}_4\text{H}_9\text{OH} + [\text{O}] \rightarrow \text{CH}_3\text{CH}_2\text{CH}_2\text{CHO} + \text{H}_2\text{O}$

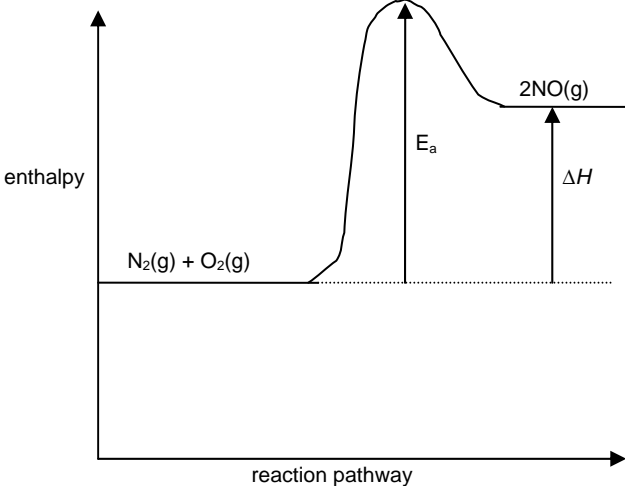
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2	(f)	(i)	methylpropan-2-ol OR 2-methylpropan-2-ol ✓ 	2	DO NOT ALLOW methylprop-2-ol ALLOW (CH ₃) ₃ COH ALLOW vertical 'bond' to any part of the OH group DO NOT ALLOW horizontal –HO in the formula ALLOW 
		(ii)		1	ALLOW CH ₃ CHOHCH ₂ CH ₃ ALLOW  ALLOW vertical 'bond' to any part of the OH group DO NOT ALLOW horizontal –HO in the formula IGNORE an incorrect name
Total				18	

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3	(a)	(i)	Reaction in which energy enters the system (from the surroundings) ✓	1	ALLOW reaction that absorbs energy ALLOW takes energy in (from the surroundings) ALLOW enthalpy of products have higher enthalpy than enthalpy of reactants ALLOW heat instead of energy ALLOW correct reference in terms of bond breaking and bond making IGNORE incorrect reference to bond breaking or bond making
		(ii)	+33 ✓	1	+ sign is not required DO NOT ALLOW –33

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3 (b) (i)	<p>2NO added for product ✓</p> <p>ΔH labelled with product above reactant AND arrow upwards ✓</p> <p>E_a labelled correctly AND above products ✓</p> 	3	<p>ANNOTATE ANSWER WITH TICKS AND CROSSES</p> <p>IGNORE State symbol ALLOW product line above or below reactants line</p> <p>ALLOW (+)66 ALLOW line that has a small gap at the top and bottom</p> <p>IGNORE arrows at both ends of activation energy line The E_a line must go to maximum (or near to the maximum) on the curve ALLOW if the line clearly shows an activation energy and is not an enthalpy change ALLOW line that has a small gap at the top and bottom</p>
	(ii) Activation energy is the minimum amount of energy needed for the reactants to react ✓	1	<p>ALLOW compounds OR elements OR molecules OR chemicals instead of reactants</p> <p>ALLOW minimum energy needed to start a reaction</p>

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3	(c)	(i)	Rate of forward reaction slows down and rate of backward reaction speeds up ✓ (Until) rate of forward reaction is the same as the rate of the backward reaction ✓	2	ALLOW at start rate of forward reaction is fast but rate of backward reaction is slow DO NOT ALLOW forward reaction is the same as backward reaction
		(ii)	Reaction is faster ✓ Increasing pressure mean more particles per unit volume OR increasing pressure gives more crowded particles OR increasing pressure gives more concentrated (particles) ✓ So more collisions per second OR higher collision frequency OR collisions more often ✓ (Changes of pressure) do not change the (position of) equilibrium ✓ Both sides of equation have same number of moles (of gas) ✓	5	ANNOTATE ANSWER WITH TICKS AND CROSSES ALLOW particles are closer together DO NOT ALLOW 'area' instead of 'volume' ALLOW increased rate of collision OR collisions are more likely OR there is a greater chance of collisions 'More collisions' or 'more successful collision' are not sufficient DO NOT ALLOW composition of equilibrium is the same (in question) ALLOW both sides of equation have same number of molecules (of gas)
		(iii)	Not a closed system ✓	1	ALLOW gases can escape OR gases are continuously entering OR it is an open system
	(d)		has an unpaired electron ✓	1	ALLOW plural: unpaired electrons has a lone electron is not sufficient
	(e)	(i)	$2\text{NO} + \text{O}_2 \rightarrow 2\text{NO}_2$ ✓	1	ALLOW any correct multiple including fractions IGNORE state symbols

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3	(e)	(ii)	<p>NO is not consumed OR overall reaction is $\text{O}_3 + \text{O} \rightarrow 2\text{O}_2$ ✓</p> <p>$\text{NO} + \text{O}_3 \rightarrow \text{NO}_2 + \text{O}_2$ ✓</p> <p>$\text{NO}_2 + \text{O} \rightarrow \text{NO} + \text{O}_2$ ✓</p>	3	<p>ANNOTATE ANSWER WITH TICKS AND CROSSES</p> <p>ALLOW $2\text{O}_3 \rightarrow 3\text{O}_2$ OR It is a chain reaction OR NO is reformed OR mechanism of ozone depletion is changed OR NO made can react with more ozone</p> <p>IGNORE dots</p> <p>ALLOW $\text{NO}_2 + \text{O}_3 \rightarrow \text{NO} + 2\text{O}_2$</p>
		(iii)	<p>ANY TWO FROM:</p> <p>To identify the functional groups (in pollutants) OR to identify the bonds (in pollutants) ✓</p> <p>Match spectrum to known pollutants OR each pollutant will have a different spectrum ✓</p> <p>Idea that you can measure the concentration or abundance of pollutant ✓</p>	2	<p>ALLOW a named bond IGNORE any specific wavenumber or range of wavenumbers</p> <p>ALLOW match spectrum to database or datasheet</p>
			Total	21	

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4	(a)		$\text{Atom economy} = \frac{\text{sum of (all) } M_r \text{ of desired product(s)}}{\text{sum of (all) } M_r \text{ of (all) products}}$ <p style="text-align: right;">✓</p>	1	<p>ALLOW</p> $\text{Atom economy} = \frac{\text{sum of (all) } M_r \text{ of desired product(s)}}{\text{sum of (all) } M_r \text{ of (all) reactants}}$ <p>ALLOW for the numerator: 'sum of' to be crossed out and replaced by 'molecular mass of the desired product(s)'</p> <p>ALLOW for the denominator: 'sum of molecular masses of all products'</p>
	(b)	(i)	Process 5 ✓	1	ALLOW $\text{C}_8\text{H}_{18} \rightarrow \text{C}_2\text{H}_4 + \text{C}_6\text{H}_{14}$
		(ii)	Process 1 ✓	1	ALLOW $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3 \rightarrow (\text{CH}_3)_2\text{CHCH}_2\text{CH}_2\text{CH}(\text{CH}_3)_2$
		(iii)	Process 2 ✓ water is a waste product ✓	2	<p>ALLOW $\text{CH}_3\text{CH}_2\text{OH} + \text{CH}_3\text{COOH} \rightarrow \text{CH}_3\text{COOCH}_2\text{CH}_3 + \text{H}_2\text{O}$</p> <p>ALLOW it is a condensation reaction</p> <p>ALLOW water is a by-product / water is a non-desirable product</p> <p>ALLOW process 2 has an 83% atom economy</p> <p>IGNORE it forms more than one product / it forms a waste product</p>
	(c)	(i)	Less waste products OR better sustainability OR get 100% atom economy ✓ (Stops) greenhouse gas emitted OR (stops) gas that (may) cause global warming ✓	2	<p>ALLOW no waste products / there is no longer a waste product</p> <p>ALLOW increase atom economy</p>

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4	(c)	(ii)	<p>High percentage yield with a simple reason e.g. because the aim is to manufacture ethanol; to reduce waste; increases sustainability ✓</p> <p>BUT High percentage yield because there is very efficient conversion from reactant to product OR to reduce the waste of starting materials ✓✓</p> <p>OR High atom economy with a simple reason e.g. because it is cheaper or makes less harmful products; to reduces waste; increases sustainability ✓</p> <p>BUT High atom economy to reduce the amount of waste products OR less by products OR more desired product ✓✓</p>	2	<p>No marks for just percentage yield or for atom economy. Marks are for the quality of the explanation</p> <p>Marks are awarded as follows</p> <p>One mark – a simple reason that is not fully correct whether a choice has been made or not</p> <p>Two marks – a choice must be made and the reason must be correct</p>
			Total	9	

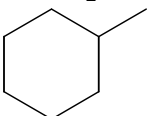
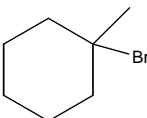
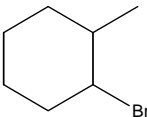
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5	(a)		Compound of hydrogen and carbon only ✓	1	ALLOW contains hydrogen and carbon only DO NOT ALLOW 'it contains hydrogen and carbon' DO NOT ALLOW a mixture of hydrogen and carbon only
	(b)		F ✓	1	ALLOW cyclobutane
	(c)		C ₅ H ₁₀ O ✓	1	ALLOW any order IGNORE structural or displayed formula
	(d)		D and E OR F and G ✓	1	ALLOW pentanal and pentan(-3-)one ALLOW cyclobutane and but(-2-)ene Award mark if both pairs are given
	(e)	(i)	Tetrahedral ✓ Four (single) bonds (around carbon atom) OR four (single) bond pairs (around carbon atom) OR (carbon) bonded to four groups ✓	2	IGNORE incorrect bond angle If shape is not given, explanation mark can be credited If shape is incorrect, explanation mark cannot be credited
		(ii)	Trigonal planar ✓	1	ALLOW planar triangle IGNORE if incorrect bond angle is stated
	(f)	(i)	G ✓	1	ALLOW but-2-ene
		(ii)	Non rotating (carbon–carbon) double bond ✓ Each carbon atom of the double bond attached to (two) different groups/atoms ✓	2	

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5 (g)	<p>Equation</p> <p>$\text{C}_3\text{H}_7\text{X} + \text{KOH} \rightarrow \text{C}_3\text{H}_7\text{OH} + \text{KX}$ OR $\text{C}_3\text{H}_7\text{X} + \text{OH}^- \rightarrow \text{C}_3\text{H}_7\text{OH} + \text{X}^-$ ✓</p> <p>Structure of product</p> <p>$\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$ ✓</p> <p>Reaction mechanism</p> <p>QWC - nucleophilic substitution ✓</p> <p>dipole shown on C–Hal bond, $\text{C}^{\delta+}$ and $\text{Hal}^{\delta-}$ ✓</p> <p>curly arrow from HO^- to carbon atom of C–Hal bond ✓</p> <p>curly arrow from C–Hal bond to the halogen atom ✓</p>	10	<p>ANNOTATE ANSWER WITH TICKS AND CROSSES</p> <p>X = Br or Cl</p> <p>ALLOW molecular, structural, displayed or skeletal formula in equation</p> <p>ALLOW $\text{C}_3\text{H}_7\text{X} + \text{H}_2\text{O} \rightarrow \text{C}_3\text{H}_7\text{OH} + \text{HX}$</p> <p>ALLOW equation from the mechanism</p> <p>IGNORE incorrect equations</p> <p>ALLOW structural, displayed or skeletal formula of product if seen ONCE in equation, mechanism or drawn out</p> <p>If two mechanism shown award marks from the mechanism that gives the higher mark</p> <div style="text-align: center;"> <p>The curly arrow must start from the oxygen lone pair or the negative charge on the oxygen of HO^- ion</p> <p>No need to show lone pair on the oxygen atom</p> </div>

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5	(g)		<p>Type of bond fission</p> <p>QWC - heterolytic ✓</p> <p>Reasons for the difference in rate of hydrolysis</p> <p>1-bromopropane reacts faster (than 1-chloropropane) OR B reacts faster (than C) OR C–Br reacts faster ✓</p> <p>Because the C–Br bond is weaker OR C–Br has a lower bond enthalpy OR C–Br bond is longer ✓</p> <p>C–Br is more easy to break ✓</p>		<p>ALLOW S_N1 mechanism</p> <p>dipole shown on C–Hal bond, C^{δ+} and Hal^{δ-} ✓</p> <p>curly arrow from C–Hal bond to the halogen atom ✓</p> <p>curly arrow from OH⁻ to correct carbocation ✓</p> <p>IGNORE bromine reacts faster than chlorine ALLOW ora</p> <p>ALLOW less energy to break C–Br ALLOW ora ALLOW ora</p>
	(h)		<p>With H₂</p>  ✓ <p>With HBr</p>  ✓  ✓	3	<p>ALLOW methylcyclohexane</p> <p>ALLOW 1-bromo-1-methylcyclohexane</p> <p>ALLOW 1-bromo-2-methylcyclohexane ALLOW 2-bromo-1-methylcyclohexane</p>
			Total	23	

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6	(a)	(i)	But-1-ene ✓ $\begin{array}{c} \text{H} \quad \text{C}_2\text{H}_5 \\ \quad \\ \text{C} = \text{C} \\ \quad \\ \text{H} \quad \text{H} \end{array}$ ✓	2	ALLOW displayed formula ALLOW C ₂ H ₅ CH=CH ₂
		(ii)	Poly(ethenol) has (many) O–H group(s) ✓ Poly(ethenol) forms hydrogen bonds with water ✓	2	ALLOW poly(ethenol) has hydroxyl group OR hydroxy group OR is an alcohol DO NOT ALLOW hydroxide DO NOT ALLOW 'it forms hydrogen bonds'
	(b)		CO is a poisonous gas ✓ HC/ is acidic/forms acid rain OR corrosive OR HC/ will react with metalwork OR HC/ will react with marble/limestone buildings ✓ ANY TWO METHODS FROM: Method 1 Remove HC/ by reacting with a base OR remove HC/ by use of a gas scrubber ✓ Method 2 Develop ways of ensuring all CO is oxidised to CO ₂ OR ensure complete combustion to avoid making CO ✓ Method 3 Remove CO ₂ by CCS ✓ Method 4 (Use methods to remove the need for incineration such as) separation AND recycling of the plastics/polymers ✓ Method 5 (Use methods to remove the need for incineration such as) developing biodegradable/compostable plastics/polymers ✓	4	ANNOTATE ANSWER WITH TICKS AND CROSSES ALLOW CO reduces amount of oxygen transported in blood Forming carboxyhaemoglobin/binds with haemoglobin is not sufficient IGNORE HC/ is toxic IGNORE references to ozone layer and greenhouse effect Methods 1 to 3 must be linked to a gas IGNORE reference to catalytic converter ALLOW specific examples of CCS e.g. CO ₂ stored as a metal carbonate / CO ₂ stored deep under sea / CO ₂ stored in rock ALLOW (Use methods to remove the need for incineration such as) use of plastics/polymers as a feedstock for making other chemicals

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6	(c)		<p>ANY TWO FROM:</p> <p>Idea that all countries contribute towards pollution ✓</p> <p>Idea that atmospheric pollution (from incineration travels) across borders</p> <p>OR waste plastics travel across borders / waste plastics travel across the sea ✓</p> <p>Cooperation means that scientists can share ideas</p> <p>OR scientists can warn governments of risk</p> <p>OR world-wide legislation can be introduced</p> <p>OR allows monitoring of pollution in different countries</p> <p>OR richer countries can help poorer countries introduce pollution controls ✓</p> <p>One country cannot control pollution unless all countries do ✓</p>	2	<p>ALLOW some countries produce more pollution than others.</p> <p>ALLOW reference to protocols</p>
			Total	10	

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7	<p>ANY SEVEN FROM:</p> <p>Compound X QWC: X contains C=O because of absorption at 1720 cm^{-1} AND contains O–H because of (broad) absorption between 2500 to 3300 cm^{-1} ✓</p> <p>So X is a carboxylic acid ✓</p> <p>Molar ratio (C:H:O) of X is 4.05 : 8.1 : 2.7 OR $\frac{48.65}{12.0} : \frac{8.11}{1.0} : \frac{43.24}{16.0}$ ✓ (Empirical formula) is $\text{C}_3\text{H}_6\text{O}_2$ ✓</p> <p>M_r is 74.0 so X is $\text{C}_3\text{H}_6\text{O}_2$ ✓</p>	7	<p>ANNOTATE ANSWER WITH TICKS AND CROSSES</p> <p>PLEASE ENSURE YOU LOOK AT THE DATA AND SPECTRA ON PAGE 20 IN CASE THEY INCLUDE COMMENTS THAT ARE WORTHY OF CREDIT. MARK THIS PAGE WITH AN OMISSION MARK, ^ , IF BLANK</p> <p>QWC: mark is integrated into the chemistry marks. These marks need to link evidence with an explanation</p> <p>ALLOW X contains C=O and O–H because of absorptions at 1720 cm^{-1} and 2500 to 3300 cm^{-1}</p> <p>ALLOW X contains carboxylic acid/COOH because of absorption at 1720 cm^{-1} and (broad) absorption between 2500 to 3300 cm^{-1} ✓✓</p> <p>ALLOW alternative approach to molecular formula</p> <p>M_r is 74.0 ✓ $74 \times \frac{48.65}{100} : 74 \times \frac{8.11}{100} : 74 \times \frac{43.24}{100} = 36 : 6 : 32$ ✓ $\text{C}_3\text{H}_6\text{O}_2$ ✓</p> <p>This mark is for some evidence of using M_r to deduce the molecular or structural formula ALLOW M_r is 74.0 so X is $\text{CH}_3\text{CH}_2\text{COOH}$ ✓ DO NOT ALLOW ECF from the empirical formula with the wrong molar ratio</p>

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7	<p>Compound Y</p> <p>QWC Y contains O–H because of absorption between 3100 and 3500 cm^{-1} ✓</p> <p>QWC Mass spec of Y has molecular ion, $m/z = 46$ so M_r is 46 ✓</p> <p>Correct identification of one fragment from a m/z value e.g. $m/z = 31$ is CH_2OH^+; $m/z = 29$ is C_2H_5^+; $m/z = 15$ is CH_3^+ ✓</p>		<p>ANNOTATE ANSWER WITH TICKS AND CROSSES</p> <p>ALLOW Y is an alcohol (or phenol) because of absorption between 3200 and 3550 cm^{-1}</p> <p>ALLOW Y contains C–O, C–H and O–H bonds because of absorptions at approximately 1030, 2950 and 3350 cm^{-1}</p> <p>ALLOW $m/z = 46$ so M_r is 46</p> <p>OR mass spectrum has a peak at 46 which is the M_r</p> <p>OR M_r is 46 because of m/z peak shown on the actual spectra</p> <p>$M_r = 46$ on its own is not sufficient</p> <p>$m/z = 46$ on its own is not sufficient</p> <p>ALLOW $m/z = 31$ shows CH_2OH (fragment);</p> <p>$m/z = 29$ shows C_2H_5 (fragment);</p> <p>$m/z = 15$ is CH_3 (fragment)</p>
	<p>Identification of compounds</p> <p>So X must be $\text{CH}_3\text{CH}_2\text{COOH}$ OR propanoic acid ✓</p> <p>So Y is ethanol OR $\text{C}_2\text{H}_5\text{OH}$ OR $\text{CH}_3\text{CH}_2\text{OH}$ ✓</p> <p>Z is $\text{CH}_3\text{CH}_2\text{COOC}_2\text{H}_5$ OR ethyl propanoate ✓</p>	3	<p>Note: an incorrect name CONS a correct structure</p> <p>ALLOW skeletal OR displayed formula throughout</p> <p>DO NOT ALLOW propanoic acid with wrong structure or incorrect molecular formula</p> <p>DO NOT ALLOW ethanol with wrong structure or incorrect molecular formula</p> <p>DO NOT ALLOW ethyl propanoate with wrong structure or incorrect molecular formula</p> <p>ALLOW ECF for identification of Z from incorrect X and Y.</p> <p>DO NOT ALLOW this ECF if name and structures of X or Y do not match</p>
	Total	10	