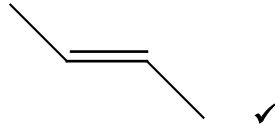


Question		Expected Answers	Marks	Additional Guidance
1	(a)	Respiration ✓	1	<b>IGNORE</b> anaerobic
	(b) (i)	100 × 4.18 × 17.3 ✓ 7.23 (kJ) ✓	2	<b>ALLOW</b> 7231 J ✓ <b>ALLOW</b> 7.23 with no working out <b>ALLOW</b> from 7.2 up to calculator value of 7.2314 <b>ALLOW</b> from 0.060 up to calculator value for 1 mark (i.e. ECF from use of $m = 0.831$ in first stage) <b>IGNORE</b> sign
	(ii)	$M_r = 180$ ✓ amount = $4.62 \times 10^{-3}$ (mol) ✓	2	<b>ALLOW</b> $4.6 \times 10^{-3}$ <b>OR</b> $4.62 \times 10^{-3}$ <b>OR</b> $4.617 \times 10^{-3}$ up to calculator value <b>DO NOT ALLOW</b> 0.005 <b>ALLOW</b> ECF from wrong $M_r$
	(iii)	$\Delta H_c = 1560$ (kJ) <b>OR</b> 1570 (kJ) but answer must be to 3 sig fig ✓ minus sign ✓	2	<b>ALLOW</b> ECF from 'answer to (i) ÷ answer to (ii)' but answer must be to 3 sig fig minus mark is an independent mark

Question		Expected Answers	Marks	Additional Guidance
	(c)	+1250 ✓ +(-394 × 6) + (-286 × 6) <b>OR</b> -4080 ✓ -2830 ✓	3	<b>ALLOW</b> full marks for -2830 with no working out ✓✓✓ <b>ALLOW for 2 marks:</b> +2830 cycle wrong way around <b>OR</b> 1400 <b>OR</b> 860 one value not × 6 <b>OR</b> -5330 <b>OR</b> +5330 wrong sign for 1250 or 4080 <b>OR</b> +570 ✓✓ correct cycle but not × 6 <b>ALLOW for 1 mark:</b> -1400 <b>OR</b> -860 cycle wrong way around and one value not × 6 <b>OR</b> -570 cycle wrong way around and not × 6 <b>OR</b> -1930 <b>OR</b> +1930 ✓ wrong sign and not × 6 <b>Note:</b> There may be other possibilities.
	(d)	<b>Any two from the following:</b> Heat released to the surroundings ✓ Incomplete combustion <b>OR</b> incomplete reaction <b>OR</b> not everything burns ✓ Non-standard conditions ✓	2	<b>ALLOW</b> heat loss <b>IGNORE</b> reference to evaporation
<b>Total</b>			<b>12</b>	

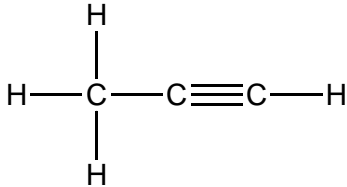
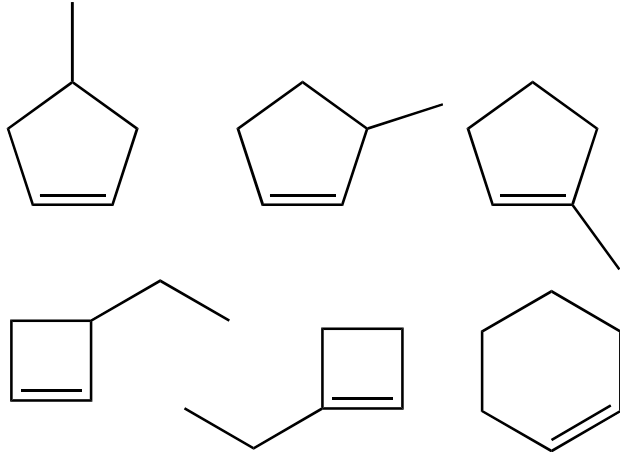
Question		Answer	Marks	Guidance
2	(a)	alkene ✓  ester ✓	2	<b>ALLOW</b> carbon-carbon double bond <b>OR</b> a C-C <u>double</u> bond  A double bonded carbon is <b>not</b> sufficient C=C is <b>not</b> sufficient Carbon-carbon multiple bond is <b>not</b> sufficient  Ketone / carbonyl / aldehyde / carboxylic acid contradicts the ester mark
	(b)	contains a C=C bond ✓	1	Contains a double bond is <b>not</b> sufficient Carbon-carbon multiple bond is <b>not</b> sufficient <b>DO NOT ALLOW</b> contains a C=O bond
	(c)	(from) orange (to) colourless ✓	1	<b>ALLOW</b> shades of orange <b>OR</b> yellow <b>OR</b> brown <b>ALLOW</b> orange to decolourised  <b>DO NOT ALLOW</b> red alone <b>DO NOT ALLOW</b> any response that includes precipitate <b>OR</b> solid, irrespective of colour <b>DO NOT ALLOW</b> clear for colourless
	(d)	(i)		Same structural formula <b>AND</b> different arrangement (of atoms) <b>in space</b> <b>OR</b> different <b>spatial</b> arrangement ✓
			1	<b>ALLOW</b> have the same structure/displayed formula/skeletal formula  <b>DO NOT ALLOW</b> same empirical formula <b>OR</b> same general formula  Stereoisomers have the same formula or molecular formula is <b>not</b> sufficient Different three dimensional arrangement is <b>not</b> sufficient Reference to <i>E/Z</i> isomerism or optical isomerism is <b>not</b> sufficient

Question		Answer	Marks	Guidance
(d)	(ii)		1	<p><b>Any writing must not contradict the diagram</b></p> <p><b>IGNORE</b> any other feature of the structure drawn</p> <p><b>ALLOW</b> the <b>J</b> will be the <i>E</i> isomer and <b>I</b> is the <i>Z</i> isomer</p> <p><b>ALLOW</b> the <b>J</b> will be the <i>trans</i> isomer and <b>I</b> is the <i>cis</i> isomer</p> <p><b>ALLOW</b> a description, eg the other isomer will have (carbon) chains diagonally arranged across the C=C or the other isomer will have hydrogen atoms diagonally arranged across the C=C bond</p> <p><b>DO NOT ALLOW</b> draw <i>trans</i> but label as <i>cis</i></p>
(e)	(i)	<p>(Enthalpy change that occurs) when one mole of a substance ✓</p> <p>completely combusts <b>OR</b> reacts fully with oxygen ✓</p>	2	<p><b>ALLOW</b> energy required <b>OR</b> energy released</p> <p><b>ALLOW</b> (energy change) when one mole of an element / compound / molecule / reactant</p> <p><b>DO NOT ALLOW</b> one mole of reactants / product / substances / fuel / atoms</p> <p><b>ALLOW</b> combusts in excess oxygen</p> <p><b>ALLOW</b> burns in excess oxygen</p> <p><b>DO NOT ALLOW</b> combust in excess air</p> <p><b>IGNORE</b> fully oxidised</p> <p><b>IGNORE</b> any conditions stated</p>

Question		Answer	Marks	Guidance
(e)	(ii)	<p><b>FIRST, CHECK THE ANSWER ON ANSWER LINE</b>  <b>IF</b> answer = 7.06(42), award <b>2 marks</b>.  <b>IF</b> answer = 7.1, award <b>1 mark</b>.</p> <p><math>q = 50.0 \times 4.18 \times 33.8</math> <b>OR</b> 7064.2 (J) ✓  = 7.06(42) (kJ) ✓</p>	2	<p><b>ALLOW</b> 7.06 up to calculator value of 7.0642 correctly rounded</p> <p><b>DO NOT ALLOW ECF</b> from marking point 1  <b>IGNORE</b> negative sign in answer</p>
	(iii)	<p><b>FIRST, CHECK THE ANSWER ON ANSWER LINE</b>  <b>IF</b> answer = 0.005(00), award <b>2 marks</b>.</p> <p><math>M_r = 268.0</math> ✓</p> <p>amount used = 0.005(00) (mol) ✓</p>	2	<p><b>IF</b> there is an alternative answer, check to see if there is any <b>ECF</b> credit possible using working below</p> <p><b>ALLOW</b> 268</p> <p><b>ALLOW</b> <math>5 \times 10^{-3}</math>  <b>ALLOW</b> ECF from incorrect <math>M_r</math>  <b>IGNORE</b> trailing zeros</p>
	(iv)	<p><b>FIRST, CHECK THE ANSWER ON ANSWER LINE</b>  <b>IF</b> answer = -1413, award <b>3 marks</b>.  <b>IF</b> answer = 1413, award <b>2 marks</b>.</p> <p><math>\Delta H = \frac{\text{answer to (ii)}}{\text{answer to (iii)}} \text{ OR } \frac{7.0642}{0.005}</math> ✓</p> <p>1413 ✓</p> <p>minus sign (this is an independent mark) ✓</p>	3	<p><b>IF</b> there is an alternative answer, check to see if there is any <b>ECF</b> credit possible using working below</p> <p><b>ALLOW</b> ECF from (ii) and (iii)</p> <p><b>ALLOW</b> 1410 up to calculator value of 1412.84 correctly rounded  <b>ALLOW</b> answers in standard form <math>1.41 \times 10^3</math> up to calculator value of <math>1.41284 \times 10^3</math> correctly rounded</p> <p>Answer must be at least <b>three</b> significant figures</p> <p><b>ALLOW</b> 1412 if answer to (ii) is 7.06  <b>ALLOW</b> 1420 if answer to (ii) is 7.1</p>

Question		Answer	Marks	Guidance
(e)	(v)	incomplete combustion <b>OR</b> not sufficient oxygen available <b>AND</b> carbon is formed ✓	1	<b>IGNORE</b> soot is formed, carbon monoxide is formed or carbon dioxide is formed
(f)		$\text{C}_6\text{H}_{12}\text{O}_6 \rightarrow 2\text{CO}_2 + 2\text{C}_2\text{H}_5\text{OH} \checkmark$  use of yeast <b>OR</b> zymase ✓  anaerobic <b>OR</b> absence of oxygen <b>OR</b> any temperature between 20 and 45 °C <b>OR</b> water <b>OR</b> aqueous ✓	3	<b>ALLOW</b> correct molecular <b>OR</b> structural <b>OR</b> displayed <b>OR</b> skeletal formula <b>OR</b> mixture of the above (as long as unambiguous) <b>IGNORE</b> state symbols  Enzyme is <b>not</b> sufficient <b>DO NOT ALLOW</b> acid catalyst  <b>If there is a contradiction or an incorrect answer in any condition given then do not award this mark.</b>  <b>ALLOW</b> room temperature Temperature quoted <b>must</b> include unit  <b>ALLOW</b> conditions shown in the equation  <b>IGNORE</b> warm temperature <b>IGNORE</b> heat / warm  Body temperature is <b>not</b> sufficient A limited supply of oxygen is <b>not</b> sufficient  <b>IGNORE</b> low pressure <b>OR</b> atmospheric pressure <b>DO NOT ALLOW</b> high pressure <b>OR</b> a pressure above 2 atmospheres
<b>Total</b>			<b>19</b>	

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

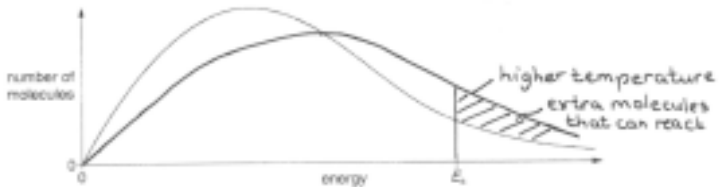
Question		Expected Answers	Marks	Additional Guidance
<b>b</b>	<b>iii</b>	Correct displayed formula ✓	1	
	<b>iv</b>	Correct skeletal formula of cyclic hydrocarbon with formula $C_6H_{10}$ ✓	1	<p>Examples of correct skeletal formulae include</p> 
<b>c</b>		<p>Energy required to break bonds = (+) 2912 ✓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



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

Question		Expected Answers	Marks	Additional Guidance
e	ii	$1.56 \times 10^4$ OR 15600 OR 15601 ✓	1	<b>ALLOW</b> calculator value of 15600.62402 and any rounded value to a minimum of three significant figures
	iii	$1.5 \times 10^4$ OR 15000 ✓	1	<b>ALLOW</b> $1.50 \times 10^4$ etc.
	iv	96.2 ✓	1	<b>ALLOW</b> ECF from (iii) ÷ (ii) <b>ALLOW</b> calculator value 96.1538461 and any rounded value to a minimum of two significant figures <b>ALLOW</b> 96.14768284 if 15601 is used  <b>ALLOW</b> any value between 88 to 89 if answer to (iii) was calculated by dividing by 26
	v	<b>Any two from:</b> 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	<b>ANNOTATE WITH TICKS AND CROSSES</b> <b>IGNORE</b> comments about percentage yield  <b>ALLOW</b> ECF from (i) e.g. high atom economy will have good sustainability  <b>ALLOW</b> find a use for the waste to increase atom economy
<b>Total</b>			<b>23</b>	

Question			Expected Answers	Marks	Additional Guidance
4	(a)	(i)	$2\text{H}_2\text{O}_2 \longrightarrow 2\text{H}_2\text{O} + \text{O}_2$ ✓	1	<b>ALLOW</b> any correct multiple including fractions <b>IGNORE</b> state symbols
		(ii)	More crowded particles <b>OR</b> more particles per (unit) volume ✓  more collisions per second <b>OR</b> more frequent collisions ✓	2	<b>ALLOW</b> particles are closer together <b>DO NOT ALLOW</b> 'area' instead of 'volume' <b>IGNORE</b> 'more concentrated particles'  <b>ALLOW</b> collisions more often <b>OR</b> increased rate of collision <b>OR</b> collisions are more likely <b>OR</b> there is a greater chance of collisions  'More collisions' is <b>not</b> sufficient
		(iii)	<b>Any two from the following:</b>  Reaction takes alternative route ✓  Activation energy is lowered ✓  More molecules have energy above activation energy <b>OR</b> more molecules have enough energy to react ✓	2	<b>ALLOW</b> catalyst changes reaction mechanism  <b>ALLOW</b> an alternative approach using adsorption particles <b>adsorbed</b> onto surface ✓  so bonds weakened as a result of the adsorption ✓

Question		Expected Answers	Marks	Additional Guidance
	(iv)	<p>Correct curve for higher temperature ✓</p> <p>Activation energy does not change  <b>OR</b> clearly labelled on diagram, e.g. <math>E_a</math> <b>OR</b> <math>E</math> ✓</p> <p>More molecules have energy above activation energy  <b>OR</b> more molecules have enough energy to react ✓</p>	3	<p>maximum of curve to right  <b>AND</b> lower than maximum of original curve  <b>AND</b> above dotted line at higher energy as shown in diagram below</p> <p><b>IGNORE</b> minor point of inflexion of curve</p>  <p>Note that the diagram above would score all 3 marks</p> <p>More successful collisions is <b>not</b> sufficient</p>
(b)	(i)	<p><math>\frac{34.0}{267.4} \times 100</math>  <b>267.4</b> ✓</p> <p>12.7% ✓</p>	2	<p>First mark for 267.4 <b>OR</b> (34.0 + 233.4) <b>OR</b> (169.3 + 98.1) at <b>bottom</b> of fraction with or without <math>\times 100</math></p> <p><b>ALLOW</b> from 2 sig figs up to calculator value  <b>ALLOW</b> full marks for 13 <b>OR</b> 12.7 <b>OR</b> 12.72 <b>OR</b> 12.715 up to calculator value with no working out  12.71 scores one mark only  <b>NO ECF</b> for this part from incorrect numbers in first expression</p>

Question		Expected Answers	Marks	Additional Guidance
	(ii)	<p><b>Any three from the following:</b></p> <p>Oxygen comes from air ✓</p> <p>No poisonous materials formed <b>OR</b> no poisonous materials involved ✓</p> <p>No waste products formed <b>OR</b> atom economy is 100% ✓</p> <p>Anthraquinone is regenerated <b>OR</b> recycled <b>OR</b> used again <b>OR</b> Anthraquinone acts as a catalyst ✓</p>	3	<p><b>IGNORE</b> hydrogen comes from the air</p> <p><b>IGNORE</b> harmful</p> <p><b>ALLOW</b> higher atom economy</p>
	(c)	<p>Bond breaking absorbs energy <b>AND</b> bond making releases energy ✓</p> <p>More energy released than absorbed ✓</p>	2	<p><b>ALLOW</b> bond breaking is endothermic <b>AND</b> bond making is exothermic</p> <p><b>ALLOW</b> exothermic change transfers more energy than endothermic change <b>OR</b> bond making transfers more energy than bond breaking <b>OR</b> '(the sum of the) bond enthalpies in the products is greater than the (sum of the) bond enthalpies in the reactants' <b>OR</b> '(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><b>IGNORE</b> reference to strong and weak bonds</p> <p><b>IGNORE</b> enthalpy of products is less than enthalpy of reactants</p>
		<b>Total</b>	<b>15</b>	