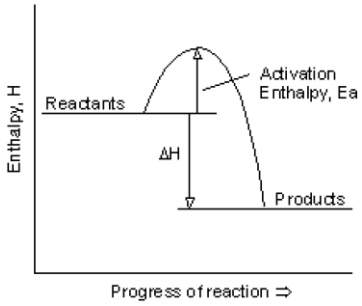
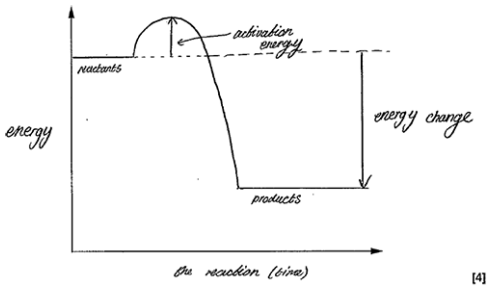
Mark scheme – Energetics (H)

Question			Answer/Indicative content	Marks	Guidance
1	a	i	Bond breaking is endothermic / takes in energy ✓ Bond making is exothermic / gives out energy ✓ More energy is given out (during bond making) than is taken in (during bond breaking) ✓	3 (AO2 × 1.1) (AO2.1)	**DO NOT ALLOW** ideas about more bonds **IGNORE** idea that more energy is **used** during bond making than is taken in during bond breaking **IGNORE** idea that it takes more energy to make bonds than to break bonds
		ii	C–H: 4 × 413 = 1652 **AND** O=O: 2 × 498 = 996 Total energy = 1652 + 996 = 2648 (kJ / mol) ✓	1 (AO1.2)	
		iii	C=O: 2 × 805 = 1610 **AND** O–H: 4 × 464 = 1856 Total energy = 1610 + 1856 = 3466 (kJ / mol) ✓	1 (AO1.2)	
		iv	Energy change = 2648 – 3466 = –818 (kJ / mol) ✓	1 (AO1.2)	Answer MUST show – sign for mark **ALLOW** ECF from parts (ii) & (iii)
	b	i	$Zn + 2HCl \rightarrow ZnCl_2 + H_2$ Reactants ✓ Balancing ✓	2 (AO2.2)	**ALLOW** any correct multiple, including fractions **ALLOW** = **OR** ⇌ instead of → **DO NOT ALLOW** and / & instead of '+' balancing mark is dependent on the correct formulae but **ALLOW** 1 mark for a balanced equation with a minor error in subscripts / formulae eg $Zn + 2HCL \rightarrow ZNCl_2 + H_2$
		ii	Exothermic ✓	1 (AO1.1)	
	c		Energy required to start the reaction / energy required for a successful collision to occur / AW ✓	1 (AO1.1)	**IGNORE** energy needed to activate the reaction / amount of energy for the reaction to take place
			Total	**10**	

2		i	 Correctly labelled axes ✓ Products shown below reactants ✓ Activation energy correctly labelled ✓ Energy change or ΔH correctly labelled ✓	4 (AO1.2) (AO2.2) (AO2.2) (AO2.2)	**ALLOW** 'energy' for 'enthalpy' and 'time' for 'progress of reaction' Reactants and products **must** be labelled (**ALLOW** formulae or names) **DO NOT ALLOW** double headed arrow **DO NOT ALLOW** double headed arrow **Examiner's Comments** Many candidates correctly labelled the reactants and products, with the products shown below the reactants. They also drew the correctly shaped curve. Candidates who did not gain full marks usually omitted the labels on the axes. Fewer candidates than on a similar question 2018 lost marks by indicating the energy change and the activation energy with either a double headed arrow or a line without any arrow. **Exemplar 4**  [4] This response illustrates a correctly drawn and labelled reaction profile. The candidate's response illustrates the comment that examiners only gave credit for correctly drawn single headed arrows, as is the correct convention for reaction profile diagrams.
		ii	Carbon donates or gives or loses electrons (to the lead ions) / electrons are transferred from carbon (to lead ions) ✓	1(AO1.1)	**IGNORE** carbon is oxidised **IGNORE** reference to lead oxide **DO NOT ALLOW** idea of transfer of electrons to oxygen / oxide ion **Examiner's Comments**

					Good responses to this question described that carbon donates / gives / loses electrons. Lower ability candidates gave a response in terms of carbon removing oxygen, which did not address the question.
			Total	**5**	
3	a		More energy is given out during bond making than is taking in during bond breaking / AW ✓	1(AO1.1)	**DO NOT ALLOW** ideas about more bonds **IGNORE** idea that more energy is **used** during bond making than is taken in during bond breaking **IGNORE** idea that it takes more energy to make bonds than to break bonds **Examiner's Comments** Good responses to this question described that more energy is given out during bond making than is taken in during bond breaking. When candidates did not gain the mark, it was usually because they gave an answer in terms of the number of bonds broken or made. Many candidates still refer to bond breaking as exothermic and bond making as endothermic. A significant proportion of candidates contradicted themselves within their answers and therefore did not gain credit.
	b	i	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = (+)3057 (kJ / mol) award 2 marks** (413 × 3) + (358) + (464) + (2 × 498) ✓ = 3057 (kJ / mol) ✓	2(AO2.2)	**IGNORE** + or - sign **Examiner's Comments** If candidates did not obtain the correct answers to parts (i) and / or (ii), examiners looked to award 'error carried forward' in part (iii). A common error was for candidates to subtract the smaller of their answers in parts (i) and (ii) from the larger, rather than appreciating that the energy change is calculated by 'energy transferred breaking bonds - energy transferred making bonds'. In part (i) the most common error was to omit the C-O bond energy from the calculation. In part (ii) the most common error was to use

					2 × 358 (i.e. twice the C-O bond energy) rather than 2 × 805 (i.e. twice the C=O bond energy).
		ii	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = (-)3466 (kJ / mol) award 2 marks** (805 × 2) + (464 × 4) ✓ = 3466 (kJ / mol) ✓	2(AO2.2)	**IGNORE** + or - sign
		iii	3057 – 3466 = -409 (kJ / mol) ✓	1(AO2.2)	**ALLOW** ecf from parts (i) and (ii) **DO NOT ALLOW** +409
			Total	**6**	
4	a		**any four from:** reaction is exothermic (1) as reactants have more energy than products (1) **A** is the activation energy (1) activation energy is the amount of energy supplied to get the reaction started (1) **B** is the energy change for the reaction (1) the value of **B** is negative (1)	4	
	b	i	bonds broken – endothermic (1) bonds made – exothermic (1)	2	both required
		ii	energy needed to break bonds = 2736 (kJ) (1) energy released when new bonds form = 3466 (kJ) (1) energy change for a reaction = 730 (kJ) given out / − 730 (kJ) (1)	3	Correct answer scores 3 if no working is shown
	c		energy transferred = 4.2 × 200 × (100 – 15) (1) = 71400 J (1) Mass of fuel needed to boil water (g) = energy needed to boil water (J) / energy per gram 50 kJ = 50000 J (1) = 71400 / 50000 (1) = 1.43 g (1)	5	**ALLOW** 1.428 g instead of 1.43 (1)
			Total	**14**	