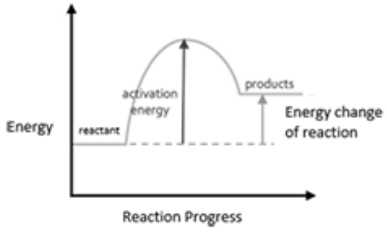
Mark scheme

Question			Answer/Indicative content	Marks	Guidance
1	a	i	Products are lower (in energy) than reactants / **ORA** ✓	1 (AO 2.1)	**ALLOW** the energy/enthalpy change is negative **ALLOW** the energy (level) decreases (as the reaction progresses) **IGNORE** idea that energy is lost in the reaction **IGNORE** ideas linked to bond breaking / making **Examiner's Comments** Many high quality responses to this question were seen with candidates recognising that they needed to refer to the reaction profile diagram. However, there were many references to bond breaking/making or energy being lost, which examiners ignored.
		ii	**Difference** Idea of (energy of) reactants will be lower than (energy of) products / **ORA** ✓ **Similarity** There will still be an activation energy / idea that energy will increase then decrease between reactants and products ✓	2 (2 x AO 1.1)	**ALLOW** idea that the energy/enthalpy change will be positive **ALLOW** the energy (level) increases (as the reaction progresses) **IGNORE** idea that energy is gained in the reaction **IGNORE** references to temperature changes **ALLOW** idea that both will show an upwards curve **ALLOW** idea of same/similar shape or curve **Examiner's Comments** This question differentiated between candidates well. When marks were not gained it tended to be because responses were not detailed enough or because candidates wrote about energy being absorbed or released without reference to how they knew that from the energy profile. Most candidates referred to seeing activation energy on the diagrams as a similarity. Some wrote about both

					diagrams having a curve but did not refer to it being the same shape. Other common responses, which lacked sufficient detail to gain marks, were statements that both diagrams show reactants and products or an energy change (without stating that the energy will increase then decrease between the reactants and the products).
	b	i	**First check the answer on the answer line** **If answer = 8514 (kJ/mol) award 3 marks** 6 × 799 = 4794 ✓ 8 × 465 = 3720 ✓ 4794 + 3720 = 8514 ✓	3 (3 x AO 2.2)	**ALLOW ECF** from bonds formed **IGNORE** + or - sign **Examiner's Comments** This question was well answered in many cases, with candidates setting out their working clearly. However, candidates do need to ensure they read the question carefully as many included calculations involving the reactants as well. Occasionally candidates calculated the overall energy change for the reaction which resulting in them only gaining 2 of the 3 marks available.
		ii	**First check the answer on the answer line** **If answer = -2034 (kJ / mol) award 2 marks** Energy change = Bonds broken - Bonds made / = 6480 - 8514 ✓ = -2034 ✓	2 (2 x AO 2.2)	**ALLOW ECF** from **(b)(i)** **ALLOW** 8514 − 6480 = (+)2034 (kJ / mol) for 1 mark **AND ALLOW ECF** from **(b)(i)** **Examiner's Comments** Candidates who had correctly answered Question 18 (b) (i) tended to gain 2 marks for this question as well. The most common incorrect answer was +2034 kJ/mol due to subtracting the energy transferred when all the bonds break in the reactants from their answer to part (b) (i).
	c	i	D F A B G Step 1 Step 2 Step 3 Step 4 Step 5 D is step 1 ✓	3 (3 x AO 3.3a)	**ALLOW** C in place of B

			F, A and B are chosen in the correct order ✓ G is step 5 ✓		**Examiner's Comments** Many candidates were able to select the correct steps and place them in order. However, where a mark was dropped it tended to be when candidates selected the use of a beaker (E) rather than a polystyrene cup (F) for step 2. This implies that many candidates lack the knowledge of the benefits of polystyrene as an insulator compared to glass and its use to study exothermic reactions.
		ii	The temperature (of the reaction / surroundings) increases ✓ Exothermic reactions give out or release heat / energy ✓	2 (2 x AO 3.1b)	**ALLOW** a correct quoted temperature increase **IGNORE** idea that energy was lost from the reactants / energy is lost to the surroundings **IGNORE** idea that the solution has taken in energy **IGNORE** ideas linked to bond breaking / making **Examiner's Comments** Good responses to this question stated that the temperature increased in the student's experiment, explaining that this was due to energy being released to the surroundings. However, there were many candidates who wrote about energy being lost.
			Total	**13**	
2			C ✓	1 (AO 1.1)	
			Total	**1**	
3			 Products line labelled above reactant line ✓	4 (4 × AO 1.1)	**ALLOW** 1 mark MAX for correctly labelled activation energy on an exothermic reaction profile

			Curve up, then down from reactant to products (on endothermic reaction profile) ✓ Activation energy labelled ✓ Energy change labelled ✓		**DO NOT ALLOW** double headed arrow or line without arrow **DO NOT ALLOW** double headed arrow or line without arrow **Examiner's Comments** Most candidates drew the correct profile for an endothermic reaction. However, double headed arrows were commonly seen which indicates a lack of understanding of what the diagram shows. The GCSE Science Exam Hints for students highlighted that energy profile diagram arrows are single headed, show direction of energy change and extend to the limits of the change.
			Total	**4**	
4			D ✓	1(AO1.1)	
			Total	**1**	