Question	Answer	Marks	AO Element	Notes	Guidance
1	**M1** right hand energy level lower than left hand side energy level **M2** reactants and product positions identified **M3** energy change shown as approximately vertical line indicating gap between reactants and products with arrow head pointing from reactant to products. Arrow needs to be labelled	3			
2(a)	$ZnSO_4$ written on product line (1) H_2 written on product line (1) states (aq) **AND** (g) (1)	3			
2(b)	(labelled) arrow pointing upwards starting level with reactants and finishing level with top of the hump.	1			
2(c)	exothermic **AND** products are at lower energy (than reactants)	1			
3	lower hump starting from reactants line	1			

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4(a)	(reactants 2 × 3 × 390 (= 2340) + 3 × 240 (= 720) =) 3060	**1**			
4(b)	(products 945 + 6 × 430 (= 2580) =) 3525	**1**			
4(c)	**(a)** – **(b)** (3060 – 3525 = –465)	**1**			
4(d)	**((c)** is exothermic then) exothermic and more energy released than used **OR** **((c)** is endothermic then) endothermic and less energy released than used	**1**			**allow** Δ *H* is negative **allow** Δ *H* is positive
5(a)	2 × ((3 × 410) + 360 + 460) + (3 × 500) 2 × (1230 + 360 + 460) + 1500 2 × 2050 + 1500 4100 + 1500 = 5600	**1**			
5(b)	(2 × (2 × 805)) + (4 × (2 × 460)) 2 × 1610 + 4 × 920 3220 + 3680 = 6900	**1**			

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5(c)	**M1 = (a) – (b)** energy change of reaction = 5600 – 6900 = –1300 **M2 = M1** / 2 **OR** –650	**2**			
6(a)	*exothermic:* horizontal line representing the energy of the products below the energy of the reactants (1) *label of products:* product line labelled with $2CO_2 + 3H_2O$ (1) correct direction of vertical heat of reaction arrow: arrow starts level with reactant energy and finishes level with product energy **AND** has (only) **one** arrow head (1)	**3**			
6(b)	activation energy / E_a	**1**			
7	A - 158 kJ / mol	**1**			
8	B	**1**			
					[Total: 23]