

1(a)(i)	$\text{Sr}(\text{HCO}_3)_2 \rightarrow \text{SrCO}_3 + \text{CO}_2 + \text{H}_2\text{O}$
1(a)(ii)	M1: radius of cation / M^{2+} increases OR charge density of cation / M^{2+} decreases M2: less polarisation / less distortion of the anion / carbonate ion
1(b)	M1: least soluble $\text{CaF}_2 < \text{SrF}_2 < \text{BaF}_2$ most soluble M2: ΔH_{latt} and ΔH_{hyd} both become less exothermic / less negative M3: ΔH_{hyd} changes less / becomes less exothermic by a smaller extent OR ΔH_{latt} changes more / becomes less exothermic by a larger extent M4: ΔH_{sol} becomes more exothermic / more negative
1(c)(i)	enthalpy change when one mole of gaseous ions dissolve in water to form a solution
1(c)(ii)	M1: ionic radii AND ionic charge M2: (ionic) radii increase / charge density decreases AND ΔH_{hyd} decreases/less exothermic AND less attraction between water molecules and (gaseous) ions OR as ionic charge increases / charge density increases AND ΔH_{hyd} increases/more exothermic AND more attraction between water molecules and (gaseous) ions
1(d)	M1: use of $-2957 / -1926 / -505$ AND $2 \times (-505)$ M2: correct signs and evaluation ΔH_{sol} of $\text{MgF}_2(\text{s}) = -1926 + (2 \times -505) - (-2957) = (+)21 \text{ kJ mol}^{-1}$
1(e)(i)	M1: $K_{\text{sp}} = [\text{Hg}_2^{2+}] [\text{F}^-]^2$ M2: units = $\text{mol}^3 \text{ dm}^{-9}$
1(e)(ii)	$K_{\text{sp}} = 2^2 \times (9.20 \times 10^{-3})^3 = 3.11 \times 10^{-6}$ min 2sf

4(a)	energy required when one mole of gaseous atoms is formed from the element
4(b)	energy released when one mole of gaseous atoms gains one mole of electrons and becomes one mole of gaseous 1^- ions
4(c)	M1: iodine atom has greater radius M2: less attraction between nucleus and incoming electron in iodine
4(d)	M1: $\frac{1}{2}(-486 + (2 \times 364))$ M2: +121

2(a)	M1: (solubility) decreases down the group M2: ΔH_{latt} and ΔH_{hyd} decrease / become less exothermic / less negative M3: ΔH_{hyd} decreases / changes more / dominant factor / becomes less exothermic by a larger extent OR ΔH_{latt} decreases / changes less / changes slower M4: ΔH_{sol} becomes less exothermic / less negative OR ΔH_{sol} becomes (more) endothermic / (more) positive
2(b)(i)	$\text{Ag}_2\text{CrO}_4(\text{s}) \rightleftharpoons 2\text{Ag}^+(\text{aq}) + \text{CrO}_4^{2-}(\text{aq})$
2(b)(ii)	M1: $K_{\text{sp}} = [\text{Ag}^+]^2 [\text{CrO}_4^{2-}]$ M2: $\sqrt[3]{(1.12 \times 10^{-12} \div 4)} = 6.54 \times 10^{-5}$ M3: $[\text{Ag}^+] = 2 \times 6.54 \times 10^{-5} = 1.31 \times 10^{-4} (\text{mol dm}^{-3})$ min 2sf

2(c)(i)	$K_a = 10^{-6.49} = 3.236 \times 10^{-7}$ $[H^+]^2 = 8.08984 \times 10^{-9}$ M1: $[H^+] = 8.99 \times 10^{-5}$ M2: $pH = -\log(8.99 \times 10^{-5}) = 4.05$ min 2sf
2(c)(ii)	conjugate acid H_2CrO_4 AND conjugate base CrO_4^{2-}
2(d)(i)	(the energy change / released when) one mole of gaseous atoms become 1^- ions / gain one mole of electrons
2(d)(ii)	due to repulsion between negative ion and incoming / gained electron
2(d)(iii)	$2Ag^+(g) \quad S^{2-}(g) \rightarrow Ag_2S(s)$
2(d)(iv)	M1: selection of correct six numbers only: -33, 731, 279, -200, 532, -2677 M2: use of $\times 2$ as only multiplier with Ag M3: correct signs and evaluation of data $-33 = 2\Delta H_{lat} + (2 \times 731) + 279 + (-200) + 532 + (-2677)$ $2\Delta H_{lat} = 571 \text{ (kJ mol}^{-1}\text{)}$ $\Delta H_{lat} = +285.5 \text{ (kJ mol}^{-1}\text{)}$
2(e)	Ag_2S smaller / less negative / less exothermic lattice neergy AND larger ionic radius (of cation)

3(a)	number of possible arrangements of particles and energy in a system									
3(b)(i)	<table><tr><td>process</td><td>ΔS is negative</td><td>ΔS is positive</td></tr><tr><td>steam condensing into water</td><td>✓</td><td></td></tr><tr><td>solid KCl dissolving into water</td><td></td><td>✓</td></tr></table>	process	ΔS is negative	ΔS is positive	steam condensing into water	✓		solid KCl dissolving into water		✓
process	ΔS is negative	ΔS is positive								
steam condensing into water	✓									
solid KCl dissolving into water		✓								
3(b)(ii)	M1: three numbers and correct multipliers used M2: correct signs and evaluation $\Delta S^\circ = (3 \times 203.0) + (223.1) - (2 \times 281.6) = (+)268.9 \text{ (J K}^{-1} \text{ mol}^{-1}\text{)}$									
3(c)(i)	positive AND gas produced / on the right OR less / no gas on left									
3(c)(ii)	M1 and M2: calculation of gradient from the graph for ΔS gradient = $(-)\text{140} / \text{900} = (-)\text{0.1556}$ $\Delta S^\circ = (-)\text{0.1556} \times \text{1000}$ $= (+)\text{155.6} \pm \text{5 (J K}^{-1} \text{ mol}^{-1}\text{)}$ M3: $T = \text{1120} \pm \text{5 (K)}$ M4: $\Delta H^\circ = (+)\text{172} \pm \text{10 (kJ mol}^{-1}\text{)}$									