1(a)(i)	$Sr(HCO_3)_2 \rightarrow SrCO_3 + CO_2 + H_2O$
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 $CaF_2 < SrF_2 < BaF_2$ 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 × (–505) **M2**: correct signs and evaluation ΔH_{sol} of $MgF_2(s) = -1926 + (2 \times -505) - (-2957) = (+)21$ kJ mol^{-1}
1(e)(i)	**M1:** $K_{sp} = [Hg_2^{2+}][F^-]^2$ **M2:** units = mol^3 dm^{-9}
1(e)(ii)	$K_{sp} = 2^2 \times (9.20 \times 10^{-3})^3$ = **3.11 × 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:** ½ (–486 + (2 × 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)	$Ag_2CrO_4(s) \rightleftharpoons 2Ag^+(aq) + CrO_4^{2-}(aq)$
2(b)(ii)	**M1:** $K_{sp} = [Ag^+]^2[CrO_4^{2-}]$ **M2:** $\sqrt[3]{(1.12 \times 10^{-12} \div 4)} = 6.54 \times 10^{-5}$ **M3:** $[Ag^+] = 2 \times 6.54 \times 10^{-5} = 1.31 \times 10^{-4}$ (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)	$2Ag^+(g)$ $S^{2-}(g) \rightarrow Ag_2S(s)$
2(d)(iv)	**M1:** selection of correct six numbers only: –33, 731, 279, –200, 532, –2677 **M2:** use of × 2 as only multiplier with Ag **M3:** correct signs and evaluation of data $-33 = 2\Delta H_{at} + (2 \times 731) + 279 + (-200) + 532 + (-2677)$ $2\Delta H_{at} = 571$ (kJ mol^{-1}) $\Delta H_{at} = +285.5$ (kJ mol^{-1})
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><th>process</th><th>ΔS is negative</th><th>ΔS is positive</th></tr><tr><td>steam condensing into water</td><td>✓</td><td></td></tr><tr><td>solid KC*l* dissolving into water</td><td></td><td>✓</td></tr></table>
3(b)(ii)	**M1:** three numbers and correct multipliers used **M2:** correct signs and evaluation $\Delta S^\ominus = (3 \times 203.0) + (223.1) - (2 \times 281.6) = (+)268.9$ (J K^{-1} mol^{-1})
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 = (–)140 / 900 = (–)0.1556 $\Delta S^\ominus = (-)0.1556 \times 1000$ $= (+)155.6 \pm 5$ (J K^{-1} mol^{-1}) **M3**: $T = 1120 \pm 5$ (K) **M4**: $\Delta H^\ominus = (+)172 \pm 10$ (kJ mol^{-1})