

2 (a) The Group 2 sulfates and the Group 2 chromates show similar trends in solubility.

Suggest the trend in the solubility of the Group 2 chromates down the group.

Explain your answer.

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 [4]

(b) Silver(I) chromate, Ag_2CrO_4 , is sparingly soluble in water.

(i) Write an ionic equation to show the equilibrium between solid Ag_2CrO_4 and its aqueous solution.

Include state symbols.

..... [1]

(ii) The value of the solubility product, K_{sp} , of Ag_2CrO_4 is 1.12×10^{-12} at 298 K.

Calculate the equilibrium concentration of Ag^+ , in mol dm^{-3} , in a saturated solution of Ag_2CrO_4 at 298 K.

equilibrium concentration of Ag^+ = mol dm^{-3} [3]

(c) The hydrogenchromate ion, HCrO_4^- , is a weak acid. The $\text{p}K_{\text{a}}$ of HCrO_4^- is 6.49.

(i) Calculate the pH of a $0.0250 \text{ mol dm}^{-3}$ HCrO_4^- solution.

pH = [2]

(ii) HCrO_4^- can show amphoteric behaviour.

State the formula of:

- the conjugate acid of HCrO_4^-
- the conjugate base of HCrO_4^-

[1]

(d) Table 2.1 shows some energy changes.

Table 2.1

energy change	value / kJ mol^{-1}
first ionisation energy of silver	+731
second ionisation energy of silver	+2074
first ionisation energy of sulfur	+1000
second ionisation energy of sulfur	+2251
first electron affinity of sulfur	-200
second electron affinity of sulfur	+532
enthalpy change of atomisation of sulfur	+279
enthalpy change of formation of silver(I) sulfide, $\text{Ag}_2\text{S}(\text{s})$	-33
lattice energy of silver(I) sulfide, $\text{Ag}_2\text{S}(\text{s})$	-2677

(i) Define the term first electron affinity.

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 [1]

(ii) Explain why the value for the second electron affinity of sulfur is positive.

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 [1]

(iii) Construct an equation for the lattice energy of Ag_2S .

Include state symbols.

..... [1]

(iv) Calculate the enthalpy change of atomisation, ΔH_{at} , in kJ mol^{-1} , of silver using relevant data from Table 2.1.

It may be helpful to draw a labelled Born–Haber cycle.

Show your working.

ΔH_{at} of silver = kJ mol^{-1} [3]

(e) Suggest how the magnitude for the lattice energy of $\text{Ag}_2\text{S}(\text{s})$ differs from the lattice energy of $\text{Cu}_2\text{S}(\text{s})$.

Explain your answer.

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 [1]