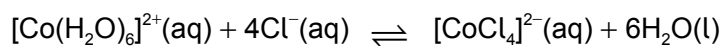


SECTION 1 – CORE CHEMICAL EQUILIBRIUM

Dynamic equilibrium, equilibrium position, $K/K_c/K_p$, reversible reactions, Le Chatelier, equilibrium calculations, reaction quotient / Gibbs–equilibrium links, and solubility–equilibrium questions. Context pages are included where a continuation page would otherwise be incomplete.

- (b) An equilibrium is established when hydrated cobalt ions are mixed with concentrated hydrochloric acid.



Pink

Blue

- (i) Predict the effect on the value of K and the equilibrium position when solid sodium chloride, $\text{NaCl}(\text{s})$, is added to the mixture at constant temperature.

[1]

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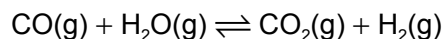
- (ii) Heating an equilibrium mixture that is initially pink changes the colour to purplish-blue. Deduce, giving a reason, whether the formation of $[\text{CoCl}_4]^{2-}(\text{aq})$ is an exothermic or endothermic process.

[1]

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3. An equilibrium is established between gaseous carbon monoxide and steam.



Under certain conditions of temperature and pressure, 2.7 mol of CO(g) and 2.9 mol of H₂O(g) were placed in a 1 dm³ container and allowed to reach equilibrium.

- (a) State the equilibrium constant expression, K , for this equilibrium. [1]

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- (b) At equilibrium, there was 1.5 mol of CO₂(g) present. Calculate the amount, in mol, of the other gases and hence find the value of the equilibrium constant, K . [2]

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(iv) $[\text{Fe}^{2+}]$ is $2.20 \times 10^{-7} \text{ mol dm}^{-3}$ in a 1.00 mol dm^{-3} solution of the complex ion.

Determine the value of the equilibrium constant, K , for the formation of $[\text{Fe}(\text{CN})_6]^{4-}$ from its constituent ions.

[3]

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(iii) Determine the enthalpy change for the reaction between carbon monoxide and chlorine from bond enthalpies. Use section 12 of the data booklet.

[3]

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- (v) Calculate the standard entropy change, $\Delta S^\ominus$, of the reaction between carbon monoxide and chlorine to form phosgene. Use section 13 of the data booklet and the following data:

Standard entropy $S^\ominus$, of chlorine = $223 \text{ J mol}^{-1} \text{ K}^{-1}$

Standard entropy $S^\ominus$, of phosgene = $284 \text{ J mol}^{-1} \text{ K}^{-1}$

[1]

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- (vi) Deduce whether the reaction would go to completion or reach equilibrium at 298 K. Use sections 1 and 2 of the data booklet along with your answers to (a)(iii) and (a)(v).

If you did not get an answer to (a)(iii) and/or (a)(v) use the following values, though these are not the correct answers: (a)(iii) = -120 kJ mol^{-1} ,
(a)(v) = $-150 \text{ J mol}^{-1} \text{ K}^{-1}$.

[3]

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