

Past-paper walk-through

Calculating Equilibrium Concentrations ■ 7.7

eXercise

Questions in this set

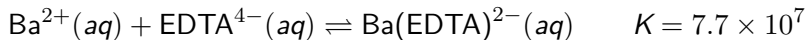
- 2016 Q6

Reading the mark scheme

- **B1** a mark that stands on its own – the point is either made or not.
- **M1** a *method* mark: the right approach, even if the number is wrong.
- **A1** an *answer* mark, and it usually needs its M mark first.
- **C1** a working mark on the way to the answer.
- **//** separates answers the examiner accepts equally.
- **ecf** = error carried forward: a later part is marked on your own earlier answer.
- **owtte** = “or words to that effect” – the wording need not match.

Question 6

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The polyatomic ion $\text{C}_{10}\text{H}_{12}\text{N}_2\text{O}_8^{4-}$ is commonly abbreviated as EDTA^{4-} . The ion can form complexes with metal ions in aqueous solutions. A complex of EDTA^{4-} with Ba^{2+} ion forms according to the equation above. A 50.0 mL volume of a solution that has an $\text{EDTA}^{4-}(\text{aq})$ concentration of 0.30 M is mixed with 50.0 mL of 0.20 M $\text{Ba}(\text{NO}_3)_2$ to produce 100.0 mL of solution.

- (a) Considering the value of K for the reaction, determine the concentration of $\text{Ba}(\text{EDTA})^{2-}(\text{aq})$ in the 100.0 mL of solution. Justify your answer.
- (b) The solution is diluted with distilled water to a total volume of 1.00 L. After equilibrium has been reestablished, is the number of moles of $\text{Ba}^{2+}(\text{aq})$ present in the

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solution greater than, less than, or equal to the number of moles of $\text{Ba}^{2+}(\text{aq})$ present in the original solution before it was diluted? Justify your answer.

Solution 6

(a) Mark scheme

- K is very large (7.7×10^7), so the reaction goes essentially to completion with $\text{Ba}^{2+}(\text{aq})$ as the limiting reactant. The concentration of Ba^{2+} when the two solutions are first mixed, before reaction, is $0.20 \text{ M} / 2 = 0.10 \text{ M}$ (50.0 mL diluted into 100.0 mL total). Since the reaction proceeds essentially to completion, the equilibrium concentration of $\text{Ba}(\text{EDTA})^{2-}(\text{aq})$ in the 100.0 mL of solution is 0.10 M. 1 point for indicating that the equilibrium concentration of $\text{Ba}(\text{EDTA})^{2-}$ equals the original (pre-reaction, post-mixing) concentration of Ba^{2+} , 1 point for the concentration (0.10 M) with appropriate supporting calculation.

Solution 6

(b) Mark scheme

- The number of moles of $\text{Ba}^{2+}(\text{aq})$ will be greater than in the original solution. Justification: diluting from 100.0 mL to 1.00 L reduces the concentrations of all species to one tenth of their original values, so immediately after dilution $Q = (1/10[\text{Ba}(\text{EDTA})^{2-}]) / ((1/10[\text{Ba}^{2+}])(1/10[\text{EDTA}^{4-}])) = 10K$. Because $Q > K$, the reaction shifts toward reactants (more dissociation) to re-establish equilibrium, so the number of moles of $\text{Ba}^{2+}(\text{aq})$ increases relative to before dilution. (Equivalently: the percent dissociation of $\text{Ba}(\text{EDTA})^{2-}$ increases upon dilution.) 1 point for stating that the number of moles of $\text{Ba}^{2+}(\text{aq})$ will increase, 1 point for a valid justification (the $Q > K$ argument, or an equivalent percent-dissociation argument).