# Past-paper walk-through

## Magnitude of the Equilibrium Constant ▪ 7.5

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

2016 ▪ Q6

$$Ba^{2+}(aq) + EDTA^{4-}(aq) \rightleftharpoons Ba(EDTA)^{2-}(aq) \qquad K = 7.7 \times 10^{7}$$

The polyatomic ion $C_{10}H_{12}N_2O_8^{4-}$ 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 $EDTA^{4-}(aq)$ concentration of 0.30 *M* is mixed with 50.0 mL of 0.20 *M* $Ba(NO_3)_2$ to produce 100.0 mL of solution.

**(a)** Considering the value of *K* for the reaction, determine the concentration of $Ba(EDTA)^{2-}(aq)$ 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 $Ba^{2+}(aq)$ present in the

# Question 6

solution greater than, less than, or equal to the number of moles of $Ba^{2+}(aq)$ 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 $Ba^{2+}(aq)$ as the limiting reactant. The concentration of $Ba^{2+}$ when the two solutions are first mixed, before reaction, is 0.20 M / 2 = 0.10 M (50.0 mL diluted into 100.0 mL total). Since the reaction proceeds essentially to completion, the equilibrium concentration of $Ba(EDTA)^{2-}(aq)$ in the 100.0 mL of solution is 0.10 M. 1 point for indicating that the equilibrium concentration of $Ba(EDTA)^{2-}$ 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 Ba2+(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[Ba(EDTA)2−]) / ((1/10[Ba2+])(1/10[EDTA4−])) = 10K. Because Q > K, the reaction shifts toward reactants (more dissociation) to re-establish equilibrium, so the number of moles of Ba2+(aq) increases relative to before dilution. (Equivalently: the percent dissociation of Ba(EDTA)2− increases upon dilution.) 1 point for stating that the number of moles of Ba2+(aq) will increase, 1 point for a valid justification (the Q > K argument, or an equivalent percent-dissociation argument).