

**Q5.3 and Q5.4** These questions are concerned with a hypothetical battery system for which the overall cell reaction can be written as follows:



Assume that the half-reaction at each electrode involves the transfer of six electrons.

**Q5.3** What is the standard emf of the cell at 298.15 K? Select from the key the value that is closest to your answer.

KEY for Q5.3

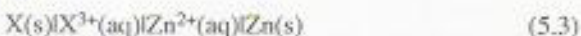
- |          |          |
|----------|----------|
| A 2.34 V | E 1.13 V |
| B 2.15 V | F 0.98 V |
| C 1.67 V | G 0.79 V |
| D 1.47 V | H 0.30 V |

**Q5.4** Select from the key the **correct** statement about the temperature-dependence of the cell emf.

KEY for Q5.4

- A The standard emf will increase with increasing temperature.  
 B The standard emf will decrease with increasing temperature.  
 C There is insufficient information to decide.

**Q5.5 to Q5.7** These questions are concerned with the electrochemical cell represented by the following cell diagram:



Only those species shown in the cell diagram take part in the cell reaction. Assume that steps have been taken to eliminate any liquid junction potentials.

**Q5.5** What is the standard emf at 298.15 K of the cell represented by cell diagram 5.3? Select from the key the value that is closest to your answer.

KEY for Q5.5

- |           |           |
|-----------|-----------|
| A -3.38 V | E +0.21 V |
| B -1.31 V | F +1.18 V |
| C -1.18 V | G +1.31 V |
| D -0.21 V | H +3.38 V |

**Q5.6** Suppose now that solid sodium hydroxide is gradually dissolved in the half-cell containing  $X^{3+}(aq)$ , leading to formation of a precipitate of  $X(OH)_3$ . The process is continued until the pH of the solution steadies at a value of 10.0. Assuming that the other species in the cell remain in their standard states, what is the emf at 298.15 K of the cell represented by cell diagram 5.3 under these conditions? Select from the key the value that is closest to your answer.

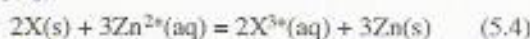
KEY for Q5.6

- |           |           |
|-----------|-----------|
| A -1.92 V | E -0.25 V |
| B -1.77 V | F +0.25 V |
| C -1.01 V | G +0.40 V |
| D -0.40 V | H +1.77 V |

**Q5.7** The key lists statements about the cell represented by cell diagram 5.3. Select from the key **two** statements that are **correct**.

KEY for Q5.7

A For cell diagram 5.3, the implied cell reaction is as follows:



- B When the cell operates under standard conditions at 298.15 K, the spontaneous cell reaction is given by equation 5.4.  
 C When the cell is operating spontaneously under standard conditions at 298.15 K, the zinc electrode will be the positive electrode.  
 D When the cell operates under the conditions specified in question Q5.6, and is represented by the cell diagram 5.3, electrons will flow spontaneously from the left-hand electrode to the right-hand electrode in the external circuit.  
 E When the cell operates under the conditions specified in question Q5.6, the metal X electrode will be the cathode.

## PART B

The question in Part B tests Objectives 4, 6, 7, 8 and 9 of Block 7.

**Q5.8** Zinc sulphide,  $ZnS$ , is a sparingly soluble salt with  $K_{sp}^\ominus = 2.85 \times 10^{-25}$  at 298.15 K. Use the Debye-Hückel limiting law (equation 63 in Section 4.7.3 of Block 7) to estimate the solubility of  $ZnS$  at 298.15 K in a solution of  $Na_2SO_4$  of concentration  $0.01 \text{ mol dm}^{-3}$ . Select from the key the value that is closest to your answer.

KEY for Q5.8

- |  |  |
|--|--|
| A $5.34 \times 10^{-13} \text{ mol dm}^{-3}$ | E $8.54 \times 10^{-13} \text{ mol dm}^{-3}$ |
| B $6.00 \times 10^{-13} \text{ mol dm}^{-3}$ | F $1.12 \times 10^{-12} \text{ mol dm}^{-3}$ |
| C $6.43 \times 10^{-13} \text{ mol dm}^{-3}$ | G $1.20 \times 10^{-12} \text{ mol dm}^{-3}$ |
| D $6.75 \times 10^{-13} \text{ mol dm}^{-3}$ | H $1.69 \times 10^{-12} \text{ mol dm}^{-3}$ |

## PART C

The questions in Part C test Objectives 1, 2, 7, 8, 9, 10, 11 and 12 of Block 8.

**Q5.9** Consider one half of an electrochemical cell consisting of a silver rod dipping into a solution of silver(I) ions, set up under standard conditions at 298.15 K. The appropriate half-cell reaction is given by equation 5.5:



Select from the key **two correct** statements.