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:

$$2X(s) + 3Ag_2O(s) = X_2O_3(s) + 6Ag(s) \qquad (5.2)$$

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:

$$X(s)|X^{3+}(aq)||Zn^{2+}(aq)|Zn(s) \qquad (5.3)$$

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:

$$2X(s) + 3Zn^{2+}(aq) = 2X^{3+}(aq) + 3Zn(s) \qquad (5.4)$$

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 mol dm^{-3}. Select from the key the value that is closest to your answer.

KEY for Q5.8

A	5.34×10^{-13} mol dm^{-3}	E	8.54×10^{-13} mol dm^{-3}
B	6.00×10^{-13} mol dm^{-3}	F	1.12×10^{-12} mol dm^{-3}
C	6.43×10^{-13} mol dm^{-3}	G	1.20×10^{-12} mol dm^{-3}
D	6.75×10^{-13} mol dm^{-3}	H	1.69×10^{-12} 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:

$$Ag^+(aq) + e = Ag(s) \qquad (5.5)$$

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