Q6.41 Suppose now that the cell represented by cell diagram 6.15 is set up such that the concentration of $Ni^{2+}(aq)$ ions is 1.0 mol dm^{-3}, and the concentration of $X^{+}(aq)$ ions is 0.1 mol dm^{-3}. What assumptions or approximations would you have to make in order to calculate the cell emf at 298.15 K under these conditions? Select *two* items from the key.

KEY for Q6.41

A For an element in its reference state, $\Delta G_f^{\ominus} = 0$.

B $\Delta H_m^{\ominus}$ for the overall cell reaction does not vary with temperature.

C A solution in which the concentration of $Ni^{2+}(aq)$ ions is 1.0 mol dm^{-3} behaves ideally.

D $\Delta S_m^{\ominus}$ for the overall cell reaction does not vary with temperature.

E In the half-cell on the left-hand side of cell diagram 6.15, the activity of $X^{+}(aq)$ is unity.

F In the half-cell on the left-hand side of cell diagram 6.15, the mean ionic activity coefficient, $\gamma_{\pm}$, of the electrolyte is unity.

Q6.42 Given the necessary assumptions and approximations, what is your estimate of the emf at 298.15 K of the cell represented by cell diagram 6.15 under the conditions specified in question Q6.41? Select from the key the value that is closest to your answer.

KEY for Q6.42

A +0.50 V
B +0.38 V
C +0.16 V
D +0.04 V
E –0.04 V
F –0.16 V
G –0.86 V
H –0.98 V

Q6.43 This question is concerned with Figure 6.6 (*overleaf*), which shows plots of overall cell potential versus current density at 298.15 K for a set of hypothetical self-driving cells, labelled 1 to 4. All four cells have the following characteristics: emf, $E = 2.5$ V; electrodes, each of area $A = 40\ cm^2$; $\alpha_{ox,an} = \alpha_{red,ca} = 0.5$; $i_{e,ca} = i_{e,an}$; $i_{L,ca} = i_{L,an}$. Examine the statements in the key and select *two* that are **correct**.

KEY for Q6.43

A The exchange current densities of the electrode reactions ($i_{e,ca} = i_{e,an}$) are larger in cell 3 than in cell 1.

B The limiting current densities of the electrode reactions ($i_{L,ca} = i_{L,an}$) are higher in cell 4 than in cell 1.

C The internal resistance, R_{cell}, of cell 1 is greater than that of cell 2.

D Under particular conditions, the power output of cell 2 can exceed the power output of cell 3.

E In cell 1, if the overpotential at the cathode, η_{ca}, is due *solely* to the kinetics of the electrode reaction, and $i_{e,ca} = i_{e,an} = 10\ A\ m^{-2}$, then the value of η_{ca} is approximately 283 mV when a current of 10 A is drawn from the cell.

F If the internal resistance, R_{cell}, of cell 2 is due *solely* to the electrical resistance of the electrolyte between the electrodes, then it should be possible to reduce the value of R_{cell} by operating the cell at a higher temperature.