KEY for Q5.9

A When the overpotential is zero, the potential difference ($\Delta\phi$) across the metal–solution interface must be 0.80 V.

B When the overpotential is zero, the value of α_{ox} must equal the value of α_{red}.

C When the overpotential is zero, the rate of the oxidation reaction is zero.

D When the overpotential is negative, the sign of the Tafel slope is negative.

E When the overpotential is negative, the only reaction occurring at the electrode is the reduction of silver ions to silver metal.

F When the overpotential is positive, net oxidation occurs at the electrode.

Q5.10 to Q5.14 In these questions, you are asked to consider Figure 5.1, which shows competing Tafel plots for the electrolysis of an aqueous solution of a salt of metal M, using electrodes composed of M under a particular set of experimental conditions at 300 K. Use the figure to answer questions Q5.10 to Q5.14.

Q5.10 What is the value of the exchange current density for hydrogen liberation, $i_e(H)$, under the experimental conditions in Figure 5.1? Select from the key for Q5.10 and Q5.11 the value that is closest to your answer.

KEY for Q5.10 and Q5.11

A 10^{-5} A m^{-2}

B 10^{-6} A m^{-2}

C 10^{-7} A m^{-2}

D 10^{-8} A m^{-2}

E 10^{-9} A m^{-2}

F There is insufficient information to decide.

Q5.11 What is the value of the exchange current density for metal M deposition, $i_e(M)$, under conditions suitable for inclusion in Table 1 in Block 8? Select from the key for Q5.10 and Q5.11 the value that is closest to your answer.

Q5.12 What is the value of $\alpha_{red}(M)$ under the experimental conditions in Figure 5.1? Select from the key the value that is closest to your answer.

KEY for Q5.12

A 0

B 0.5

C 1.0

D 1.5

E 2.0

F 2.5

Q5.13 If the mechanism for production of metal M is as follows:

$$M^{2+} + H_2O \longrightarrow MOH^+ + H^+ \qquad \text{(i)}$$

$$MOH^+ + e \longrightarrow MOH \qquad \text{(ii)}$$

$$MOH + H^+ + e \longrightarrow M + H_2O \qquad \text{(iii)}$$

which step in the mechanism must be rate limiting? Select *one* answer from the key.

KEY for Q5.13

A Step (i)

B Step (ii)

C Step (iii)

Q5.14 With reference to Figure 5.1, select from the key *two* **correct** statements. (Where necessary, you should assume that the mechanism of hydrogen evolution and the rate of metal deposition are independent of the pH of the solution.)

KEY for Q5.14

A Under the experimental conditions in Figure 5.1, neither hydrogen gas nor metal M is produced at an applied potential difference of −0.40 V (relative to the S.H.E.).

B Under the experimental conditions in Figure 5.1, the solution has a pH of 4.0.

C Under the experimental conditions in Figure 5.1, the efficiency of production of metal M will be increased by changing the applied potential difference from −0.80 V to −0.90 V (relative to the S.H.E.).

D If the electrode has a surface area of 10^{-3} m^2, the observed current at an applied potential difference of −0.90 V (relative to the S.H.E.) will be 1.0×10^{-4} A (under the experimental conditions in Figure 5.1).

E At an applied potential difference of −0.87 V (relative to the S.H.E.), the efficiency of production of metal M will not be affected by increasing the pH of the solution.

F At an applied potential difference of −0.80 V (relative to the S.H.E.), the efficiency of production of metal M will be increased by increasing the pH of the solution.

Q5.15 Select from the key *two* **correct** statements about a complete electrochemical cell.

KEY for Q5.15

A At constant temperature, the working potential of a self-driving cell must be greater than the emf of the cell.

B The working potential of a self-driving cell is independent of the current drawn from the cell.

C For a driven cell, the overpotential at the anode, η_{an}, must be positive.

D For a self-driving cell, electrode reactions having low exchange current densities will help to maintain a high working potential.

E The resistance of the electrolyte between the electrodes of a complete cell can be decreased by increasing the gap between the electrodes.

F The resistance of the electrolyte between the electrodes of a complete cell can be decreased by increasing the surface areas of the electrodes.