- In the electrolytic production of Al, what mass of Al can be deposited in 2.00 hours by a current of 1.8 A? **2**

Answer:

- What products would you expect at the anode and the cathode on electrolysis of a 1 M aqueous solution of NiI_2? Explain your answers. **2**

Marks 8

- An electrochemical cell is consists of 1.0 L half-cells of Fe/Fe^{2+} and Cd/Cd^{2+} with the following initial concentrations: $[Fe^{2+}] = 0.800$ M, $[Cd^{2+}] = 0.200$ M.

  What is the initial E_{cell} at 25 °C?

	Answer:

What is E_{cell} when $[Cd^{2+}]$ reaches 0.15 M?

	Answer:

What is $[Cd^{2+}]$ when E_{cell} reaches 0.015 V?

	Answer:

What are the equilibrium concentrations of both ions?

$[Cd^{2+}] =$	$[Fe^{2+}] =$

	Marks
• What is the electrochemical potential of the following cell at 25 ^{o}C? $Fe \mid FeSO_4\ (0.010\ M) \parallel (FeSO_4\ (0.100\ M) \mid Fe$	**3**
Answer:	
• Calculate the mass of aluminium which can be produced with the same quantity of electricity that is used to produce 1.00 kg of copper metal.	**2**
Answer:	
• Explain why Na(s) cannot be obtained by the electrolysis of aqueous NaCl solutions.	**2**

Marks 6

- A galvanic cell consists of a Cr^{3+}/Cr half-cell with unknown $[Cr^{3+}]$ and a Ni^{2+}/Ni half-cell with $[Ni^{2+}] = 1.20$ M. The electromotive force of the cell at 25 °C was measured to be 0.55 V. What is the concentration of Cr^{3+} in the Cr^{3+}/Cr half-cell?

Answer:

Calculate the equilibrium constant of the reaction at 25 °C.

Answer:

Calculate the standard Gibbs free energy of the reaction at 25 °C.

Answer:

Express the overall reaction in the shorthand voltaic cell notation.

	Marks
• A strip of copper and a strip of zinc are embedded in a lemon, and are connected by wires to a voltmeter; a voltage is generated and can be read at the voltmeter. What chemical reactions are occurring that lead to the generation of current?	**3**
Assuming there are no losses in the circuit and the conditions are similar to standard, what voltage can be read at the voltmeter?	

	Marks
• A 20.0 mL sample of 0.121 M Fe^{2+} in an acid solution was used to titrate 23.5 mL of a $KMnO_4$ solution of unknown concentration. Write the balanced redox reaction that occurs in solution upon titration, and calculate the molarity of the $KMnO_4$ solution.	**4**
Answer:	

- How many minutes would be required to obtain 10.0 g of liquid mercury by passing a constant current of 0.17 A through a solution containing $Hg_2(NO_3)_2(aq)$?

2

Answer:

Page Total:

Marks
3

- Calculate $\Delta G°$ for the following reaction:

$$3Cu(s) + Cr^{3+}(aq) \rightleftharpoons 3Cu^{+}(aq) + Cr(s)$$

Answer:

Is the reaction spontaneous under standard conditions? Give a reason for your answer.

THE REMAINDER OF THIS PAGE IS FOR ROUGH WORKING ONLY.

Page Total:

Marks

- The standard reduction potential of phosphorous acid to hypophosphorous acid is −0.499 V, with the following half-reaction:

$$H_3PO_3(aq) + 2H^+(aq) + 2e^- \rightarrow H_3PO_2(aq) + H_2O(l)$$

What would the reduction potential be for this half reaction at a temperature of 25 °C in an aqueous solution with pH of 2.3 and concentrations of $[H_3PO_3(aq)] = 0.37$ M and $[H_3PO_2(aq)] = 0.00025$ M?

3

Answer:

- A number of bacteria can reduce the nitrate ion in the presence of sulfur. A simplified unbalanced redox reaction can be written as:

$$S(s) + NO_3^-(aq) \rightarrow SO_2(g) + NO(g)$$

Balance this redox equation for acidic conditions.

2

	Marks
• What is the value of the equilibrium constant for the following reaction at 298 K? $2Fe^{3+}(aq) + 3Sn(s) \rightarrow 2Fe(s) + 3Sn^{2+}(aq)$ Relevant electrode potentials can be found on the data page.	**3**
Answer:	

	Marks
• A galvanic cell is made of a Zn^{2+}/Zn half cell with $[Zn^{2+}] = 2.0$ M and an Ag^{+}/Ag half cell with $[Ag^{+}] = 0.050$ M. Calculate the electromotive force of the cell at 25 °C.	**5**

Answer:

Calculate the equilibrium constant of the reaction at 25 °C.

Answer:

Calculate the standard Gibbs free energy of the reaction at 25 °C.

Answer:

Indicate whether the reaction is spontaneous or not. Give a reason for your answer.

Express the overall reaction in the shorthand voltaic cell notation.

- A melt of NaCl is electrolysed for 35 minutes with a current of 3.50 A. Calculate the mass of sodium and volume of chlorine at 40 °C and 1.00 atm that are formed. **4**

Marks

- A concentration cell containing aqueous solutions of $Cu(NO_3)_2$ and solid copper metal is constructed so that the Cu^{2+} ion concentration in the cathode half-cell is 0.66 M. Calculate the concentration of the Cu^{2+} ion in the anode half-cell if the cell potential for the concentration cell at 25 °C is 0.03 V. **2**

Answer:

- In **acid solution**, dichromate ion oxidises iron(II) to iron(III) as illustrated in the partial equation: **3**

$$Fe^{2+} + Cr_2O_7^{2-} \rightarrow Fe^{3+} + Cr^{3+}$$

Write a balanced equation for this reaction.

What would happen to the cell potential if the concentration of Cr^{3+} were increased?

	Marks
• How many minutes would be required to electroplate 25.0 g of manganese by passing a constant current of 4.8 A through a solution containing MnO_4^-?	**2**
Answer:	

Marks 6

- The solubility product constant of AgCl is $K_{sp} = 1.8 \times 10^{-10}\ M^2$. Using the relevant electrode potentials found on the data page, calculate the reduction potential at 298 K of a half-cell formed by:
  (a) an Ag electrode immersed in a saturated solution of AgCl.

Answer:

(b) an Ag electrode immersed in a 0.5 M solution of KCl containing some AgCl precipitate.

Answer:

Each of these half-cells is connected to a standard Cu^{2+}(1 M)/Cu(s) half-cell. In which half-cell, (a) or (b), will clear evidence of a reaction be seen? Describe the change(s) observed.

3

- The physiological properties of chromium depend on its oxidation state. Consider the half reaction in which Cr(VI) is reduced to Cr(III).

  $CrO_4^{2-}(aq) + 4H_2O(l) + 3e^- \rightarrow Cr(OH)_3(s) + 5OH^-(aq)$ $\quad E^o = -0.13$ V

  Calculate the potential for this half reaction at 25 ^oC, where pH = 7.40 and $[CrO_4^{2-}(aq)] = 1.0 \times 10^{-6}$ M.

Answer:

Marks

- Consider the following reaction at 298 K. **5**

$$Ni^{2+}(aq) + Zn(s) \rightleftharpoons Ni(s) + Zn^{2+}(aq)$$

Calculate ΔG^o for the cell. (Relevant electrode potentials can be found on the data page.)

Answer:

What is the value of the equilibrium constant for the reaction at 298 K?

Answer:

Express the overall reaction in voltaic cell notation.

- Using a current of 2.00 A, how long (in minutes) will it take to plate out all of the silver from 0.250 L of a 1.14×10^{-2} M $Ag^+(aq)$ solution? **2**

2

- Calculate the standard free-energy change for the following reaction at 298 K.

$$2Au(s) + 3Mg^{2+}(1.0\ M) \rightarrow 2Au^{3+}(1.0\ M) + 3Mg(s)$$

Answer:

Marks

- Calculate the standard free-energy change for the following reaction at 298 K. **2**

$$2Au(s) + 3Ca^{2+}(1.0\ M) \rightarrow 2Au^{3+}(1.0\ M) + 3Ca(s)$$

Answer:

Complete and balance the following equation for the reaction between iron(II) ions and permanganate ions in an acidic solution. **2**

$$Fe^{2+} + MnO_4^- \rightarrow Fe^{3+} + Mn^{2+}$$

- What is the value of the equilibrium constant for the following reaction at 298 K? **2**

$$2Fe^{3+}(aq) + Sn(s) \rightleftharpoons Sn^{2+}(aq) + 2Fe^{2+}(aq)$$

Answer:

Marks

- Consider the following balanced redox reaction. **2**

$$2In(s) + 3MnO_2(s) + 12H^+(aq) \rightarrow 2In^{3+}(aq) + 3Mn^{2+}(aq) + 6H_2O$$

If $E^o = 1.568$ V, what would be the measured potential of this cell at 298 K at the following concentrations?

$[H^+(aq)] = 0.25$ M; $[In^{3+}(aq)] = 0.20$ M; $[Mn^{2+}(aq)] = 0.42$ M

Answer:

- What is the value of the equilibrium constant for the following reaction at 298 K? **2**

$$Cu^{2+}(aq) + Zn(s) \rightarrow Zn^{2+}(aq) + Cu(s)$$

Relevant electrode potentials can be found on the data page.

Answer:

3

- Consider the following half-reactions and their standard reduction potentials.

$$2ClO_3^- + 12H^+ + 10e^- \rightarrow Cl_2 + 6H_2O \qquad E° = 1.47\ V$$

$$S_2O_8^{2-} + 2e^- \rightarrow 2SO_4^{2-} \qquad E° = 2.01\ V$$

Give the overall cell reaction.

Calculate $\Delta G°$ and hence the value of K_c for the cell reaction at 298 K.

$\Delta G° =$	$K_c =$