**Electrolysis Question**

Copper metal and chlorine gas can be extracted from a solution of copper chloride, CuCl2.

(a) Explain what is meant by the term “electrolysis”.

**Electrolysis is where energy is required to make a non-spontaneous reaction occur**

(b) For both the anode and the cathode of the electrolytic cell:

**Anode: oxidation, Cl- to Cl2**

**Cathode: reduction, Cu2+ to Cu**

* describe what will be observed

**At anode: bubbles of chlorine gas, at cathode production of pink/brown copper metal**

* write half equations for the reaction at each electrode

**At anode: 2 Cl- 🡪 Cl2 + 2 e, at cathode: Cu2+ + 2 e 🡪 Cu**

* describe the reaction as oxidation or reduction and link your answer to changes in oxidation number.

**At anode: oxidation (loss of e), at cathode: reduction (gain of e)**

(c) Link the oxidation-reduction reactions occurring at each electrode to the movement of electrons within the cell. Justify your answer by considering the spontaneity of the reaction and the calculated electrode potential for the cell reaction.

|  |  |
| --- | --- |
| **Standard Reduction Potentials *E° /V*** | |
| Cl2/Cl– | +1.36 |
| Cu2+/Cu | +0.34 |

**Overall reaction is 2 Cl- + Cu2+ 🡪 Cl2 + Cu**

**E0 = Ered - Eox = 0.34 – 1.36 = -1.02 V**

**This reaction is not spontaneous (*E*°< 0) so, in order for the unfavourable reaction to proceed, energy must be supplied (voltage supplied) to the reaction. The application of electrical energy allows the electrons released at the anode by the oxidation of the Cl- ions to be supplied to the Cu2+ ions and reduce them to Cu atoms.**

**Electrochemistry Question**

The following electrochemical cell was set up.



Electrode B

Solution B

Electrode A

Solution A

Electrode A: Pb Electrode B: Pt

Solution A: Pb2+ Solution B: MnO4-, Mn2+

Use the standard reduction potentials to answer the following questions.

|  |  |
| --- | --- |
| **Standard Reduction Potentials *E° /V*** | |
| MnO4-/Mn2+ | +1.49 |
| Pb2+/Pb | -0.13 |
| Fe2+/Fe | -0.44 |

* Write half equations for each half cell

**Pb 🡪 Pb2+ + 2 e**

**MnO4- + 8 H+ + 5 e 🡪 Mn2+ + 4 H2O**

* Write a balanced equation for the overall cell reaction

**5 Pb + 2 MnO4- + 16 H+ 🡪 5 Pb2+ + 2 Mn2+ + 8 H2O**

* Identify and explain which half cell is undergoing oxidation and which half cell is undergoing reduction using loss or gain or electrons or change in oxidation number

**Half cell A is undergoing oxidation as it loses electrons**

**Half cell B is undergong reduction as it gains electrons**

* Write the cell diagram notation

**Pb l Pb2+ ll MnO4-, Mn2+ l Pt**

* Calculate the E0cell

**E0 = Ered – Eox­ = 1.49 – (-0.13) = 1.62 V**

* Determine the direction of the electron flow (from A to B or from B to A)

**From A to B – electrons leave the anode (oxidation, A) to go to the cathode (reduction, B)**

* Describe any observations that will occur in the cell when the voltmeter is replaced by a wire

**The lead electrode will decrease in size, the purple MnO4- solution will get lighter in colour when colourless Mn2+ is formed.**

Determine whether a reaction will be observed when a piece of lead (Pb) is placed into a solution of FeCl2. Give a reason for your answer.

**The reaction that would have to occur is Pb + Fe2+ 🡪 Pb2+ + Fe**

**Pb is oxidised and Fe2+ is reduced**

**The E0 = Ered - Eox = -0.44 – (-0.13) = -0.57 V**

**This reaction as a negative cell potential so it will be non-spontaneous and the reaction will not occur.**