# PRACTICE TEST 2– Redox AS913913, 3 credits

### Time allowed: 1 hour

### Resources: Resource sheet with SRP values and colour/appearance

QUESTION 1: Electrolysis of aqueous CuCl 2

Stephena sets up an electrolysis cell using copper chloride solution and carbon electrodes. She notices that bubbles of a colourless gas are produced at one electrode and a red-brown coating forms on the other electrode.

* Use the following E° values as well as your sheet: (H2O/H2) 0.00 V (H2O/O2) +1.23 V
* Draw a picture showing how aqueous copper chloride could be electrolysed with carbon electrodes.
* Decide what species gets oxidised and what species gets reduced and justify this decision with oxidation numbers or electron transfer
* Write balanced equations (half and full) for the reaction
* Calculate an E°cell and explain its significance
* Write what would be observed at each electrode and link to the species involved

QUESTION 2: Electrochemical cell comparison

Stephena now sets up an electrochemical cell as follows: in one half cell is a solution of copper ions and a copper electrode and in the other is a solution of gold ions and a gold electrode.

* Draw a cell diagram of the galvanic cell (optional)
* Decide what species gets oxidised and what species gets reduced and justify this decision with oxidation numbers or electron transfer
* Write balanced equations (half and full) for the reaction
* Calculate an E°cell and explain its significance
* Write what would be observed in each half cell and link to the species involved

Finally: COMPARE and CONTRAST the two cells in terms of their spontaneity and energy changes.

### Name: ANSWERS Electrolysis of aqueous CuCl2 etc

# Electrolytic cell

From the observations: H2O is being oxidised to O2 and Cu2+ is being reduced to Cu

E°cell = Ered – E ox, = 0.34 – 1.23 = -0.89 V

Cu2+ + 2e → Cu (x2) 2 H2O→ O2 + 4 H+ + 4e 2 Cu2+ + 2H2O → 2Cu + O2 + 4H+

Cu2+ is being reduced as the ON of Cu is 2+ in Cu2+ and this decreases to 0 in Cu. A decrease in ON is reduction. OR Cu2+ gains 2e to get reduced to Cu and gain in electrons is reduction

H2O is being oxidised as the ON of O is -2 in H2O and this increases to 0 in O2, An increase in ON is oxidation. OR 2H2O lose 4 electrons to get oxidised to O2 and a loss of e is oxidation.

Observations: The cathode (where reduction occurs) would gain in mass as solid red Cu deposits on the electrode. Cu2+ ions are blue in solution so the blue colour lightens as they are reduced. H2O is also a colourless liquid so no observations as H2O is oxidised. However, bubbles of colourless gas (O2) would be observed at the anode as oxidation occurs there.

Because the E°cell is negative, the reaction as calculated is non-spontaneous. Therefore electrical energy must be supplied by a power source in order to force the non-spontaneous reaction to occur.

# Galvanic cell

Assume Cu reduction and Au oxidation

E°cell = Ered – E ox, = 0.34 – 1.5= -1.16 V so reaction occurs in the OPPOSITE direction

Au3+ + 3e → Au (x2) Cu→ Cu2+ + 2e (x3) 3Cu + 2Au3+→ 3Cu2+ + 2Au

Au3+ is being reduced as the ON of Au is 3+ in Au3+ and this decreases to 0 in Au. A decrease in ON is reduction. OR Au3+ gains 3e to get reduced to Au and gain in electrons is reduction

Cu is being oxidised as the ON of Cu is 0 in Cu and this increases to +2 in Cu2+, An increase in ON is oxidation. OR Cu loses 2 electrons to get oxidised to Cu2+ and a loss of e is oxidation.

Observations: The cathode (where reduction occurs – the gold half cell) would gain in mass as solid yellow Au deposits on the electrode. Au3+ ions are colourless in solution so there is no observation as they are reduced. The anode (where oxidation occurs – the copper half cell) would lose mass as solid brown Cu is reduced to Cu2+ ions. Cu2+ ions are blue in solution so the blue solution darkens as they are formed in reduction.

Because the E°cell is positive, the reaction as calculated is spontaneous. Therefore chemical potential energy is converted into electrical energy.

Comparisons:

1. Electrochemical cell is spontaneous (positive Ecell) and in contrast electrolytic is non-spontaneous (negative Ecell)
2. Electrochemical cell is converts chemical potential energy to electrical energy whereas electrolytic uses electrical energy to force a chemical reaction to take place
3. In the electrolytic cell copper is reduced whereas in the galvanic cell copper is oxidised

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|  | A | M | E |
| Identifies oxidation and reduction reaction in both cells with reasons (either transfer of electrons or change in oxidation number) | identification with either electron transfer or ON | number of electrons or ∆ON | linked to either species or atom in species |
| Reference requirement of energy for electrolytic cell and reduction potentials for electrochemical cell | electrolytic requires V, electrochemical produces V | spontaneous or not with minor error  | spontaneous or not with no errors |
| Balanced half equations for both cells |  | ½ | full |
| Relates observations to species |  | ¾ | all |
| Reduction potentials calculated |  |  | with unit (V) |
| Compare and contrast the oxidation–reduction processes occurring in electrolytic and electrochemical cells, including elaborating on the spontaneity of the reactions. Include fully balanced equations and correct calculations |  |  |  |