REDOX AHL (HL only)

Please ensure that you have also completed the Core (SL & HL) questions

1. A voltaic cell is set up, cell notation below.

$$Zn(s) \mid Zn^{2+}(aq) \parallel Cl^{-}(aq) \mid Cl_2(g) \mid Pt(s)$$

(a) Draw a diagram of the voltaic cell. Label the components including the salt bridge.

[3]

(b) If current can flow, mark arrows on the wires in the diagram above to show the direction of electron flow.

[1]

(c) Write an equation for the overall cell reaction.

[1]

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(d) Calculate the standard cell potential, in V, at 298K, using **section 24** of the data booklet.

[1]

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(e) State the standard conditions under which the cell potential is measured.

[1]

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(f) Calculate the standard free energy change, $\Delta G^{\ominus}$, for the cell using **sections 1 and 2** of the data booklet. Include units in your answer.

[3]

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(g) If the salt bridge is made of filter paper soaked in saturated potassium nitrate, $KNO_3(aq)$, describe the movement of the ions in the salt bridge when current is flowing.

[1]

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2. The standard electrode potentials for three half-equations are given below:

$$Cf^{2+}(aq) + 2e^- \rightleftharpoons Cf(s) \quad E^{\ominus} = -2.12 \text{ V}$$

$$Sn^{4+}(aq) + 2e^- \rightleftharpoons Sn^{2+}(aq) \quad E^{\ominus} = +0.15 \text{ V}$$

$$Co^{3+}(aq) + e^- \rightleftharpoons Co^{2+}(aq) \quad E^{\ominus} = +1.82 \text{ V}$$

(a) Deduce which species from the half-equations above is the best reducing agent and explain why in terms of electrons.

[2]

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(b) Using the half-equations above, write an equation for the spontaneous cell reaction with the highest cell potential.

[2]

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(c) Calculate the cell potential for the reaction in (b).

[1]

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(d) Using **section 24** of the data booklet, identify a chemical species that could be used to oxidise $Co^{2+}(aq)$ ions. Explain your reasoning.

[2]

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2. A blue aqueous solution of copper sulfate, $CuSO_4(aq)$, can be electrolysed.

(a) Carbon electrodes are used in the electrolysis. Write half-equations for the reactions that would take place at the electrodes:

(i) Anode (positive electrode):

[1]

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(ii) Cathode (negative electrode):

[1]

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(iii) State and explain whether or not the intensity of the colour of the solution will change as the electrolysis in (a) proceeds.

[1]

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(b) The experiment is repeated using **copper** electrodes, instead of carbon.

(i) Write a half-equation for the reaction that would now take place at the anode.

[1]

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(ii) State and explain whether or not the intensity of the colour of the solution will change as the electrolysis proceeds in experiment (b).

[1]

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(c) Calculate the mass of copper produced when a current of 2.0 A is passed through a concentrated solution of copper sulphate for 16 minutes and 20 seconds.

[4]

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Total Marks 27 (41 minutes)