19.1 Electrochemical Cells

Question Paper

Course	DP IB Chemistry
Section	19. Redox Processes (HL only)
Topic	19.1 Electrochemical Cells
Difficulty	Hard

Time allowed: 50

Score: /36

Percentage: /100

Question 1a

a)
Use section 24 of the data booklet to draw the electrochemical cell for the feasible reaction of Ag / Ag^{+} and Al / Al^{3+}. Write the conventional representation, including state symbols, for this cell.

[3]

[3 marks]

Question 1b

b)
Write the conventional representation, including state symbols, for this cell.

[1]

[1 mark]

Question 1c

c)
Explain why the salt bridge connecting the silver and aluminum electrodes cannot be made with potassium chloride solution.

[2]

[2 marks]

Question 1d

d)
The silver half cell is replaced with a magnesium half cell. Deduce the reading on the voltmeter.

[2]

[2 marks]

Question 2a

a)
Use section 24 of the data booklet and the information below to determine if the following reaction is feasible at 298 K.

$$2KMnO_4(aq) + 5H_2O_2(aq) + 6HCl(aq) \rightarrow 2MnCl_2(aq) + 8H_2O(l) + 5O_2(g) + 2KCl(aq)$$

$O_2(g) + 2H^+ + 2e^- \rightleftharpoons H_2O_2 \quad E^\theta = 0.68\ V$

[2]

[2 marks]

Question 2b

b)
The reaction of copper oxide and sulfuric acid is shown below. Use section 24 of the data booklet to explain why the reaction is thermodynamically feasible.

$$CuO(aq) + H_2SO_4(aq) \rightarrow CuSO_4(aq) + H_2O(l)$$

[2]

[2 marks]

Question 2c

c)
Suggest a reason why the reaction does not occur despite being thermodynamically feasible.

[1]

[1 mark]

Question 3a

a)
A student set up a electrolytic cell using a concentrated sodium chloride solution using a current of 6 amps.

State the half-equations occurring at the electrodes during the electrolysis of the concentrated aqueous solution of sodium chloride.

Cathode .....

Anode .....

[2]

[2 marks]

Question 3b

b)
Use section 2 of the data booklet to determine the time, in minutes, to produce 2.00 dm^3 of gas at the **anode** at standard temperature and pressure. State your answer to 2 significant figures.

[3]

[3 marks]

Question 3c

c)
The student changed the electrolyte to a very dilute sodium chloride solution. State what change would occur at the anode and give the half equation for the process.

[2]

[2 marks]

Question 3d

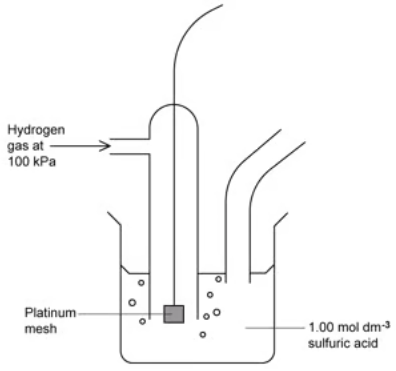
d)
In a different electrolysis experiment, copper sulfate solution was electrolysed using graphite electrodes. Using section 24 of the data booklet explain how the products at the anode and cathode are produced.

[3]

[3 marks]

Question 4a

a)
Explain why the following does not represent the standard hydrogen electrode.



[2]

[2 marks]

Question 4b

b)

The standard electrode potential for $Zn^{2+}(aq) + 2e^- \rightarrow Zn(s)$ is −0.76 V. State the meaning of the minus sign in the value of −0.76 V.

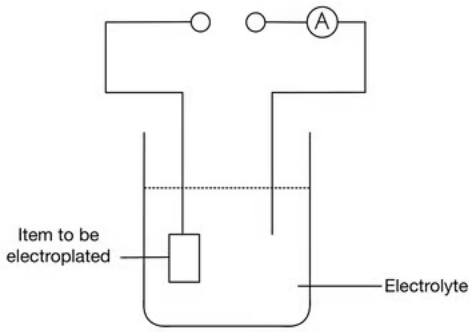
[1]

[1 mark]

Question 4c

c)

Zinc coating on metals serves as physical protection which prevents rust from affecting the underlying metal surface. This is achieved by electroplating.



i)

Suggest a suitable solution to act as the electrolyte during zinc electroplating.

[1]

ii)

Complete the diagram by labelling the polarity of the power source by using a + and - sign.

[1]

[2 marks]

Question 4d

d)

Use sections 2 and 6 of the data booklet to determine the length of time, in hours, a 0.1 A current required to deposit 1.0 g of zinc on the item to be electroplated. State your answer to 2 significant figures.

[3]

[3 marks]

Question 5a

a)

Using section 24 of the data booklet deduce the full equation for the $Cr_2O_7^{2-}(aq)$ / $Cr^{3+}(aq)$ and $Br_2(l)$ / $Br^-(aq)$ cell.

[1]

[1 mark]

Question 5b

b)

Determine the value for $E^{\ominus}$cell value for the cell outlined in part a).

[1]

[1 mark]

Question 5c

c)

Use your answer to part b) and sections 1 and 2 of the data booklet to determine whether the reaction in part a) reaction is spontaneous.

[1]

[1 mark]

Question 5d

d)

An electrochemical cell has a free energy change of -144.75 kJ mol^{-1}. Use the information in the table to determine the cell representation of the electrochemical cell.

Electrode half-equation	$E^{\ominus}$ / V
$Ag^{+}(aq) + e^{-} \rightleftharpoons Ag(s)$	+0.80
$Li^{+}(aq) + e^{-} \rightleftharpoons Li(s)$	-3.04
$ClO_2(aq) + e^{-} \rightleftharpoons ClO_2^{-}(aq)$	+0.95
$H_2O(l) + e^{-} \rightleftharpoons ½H_2(g) + OH^{-}(aq)$	-0.83
$Fe^{3+}(aq) + e^{-} \rightleftharpoons Fe^{2+}(aq)$	+0.77

[2]

[2 marks]