19.1 Electrochemical Cells

Question Paper

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

Time allowed: 70

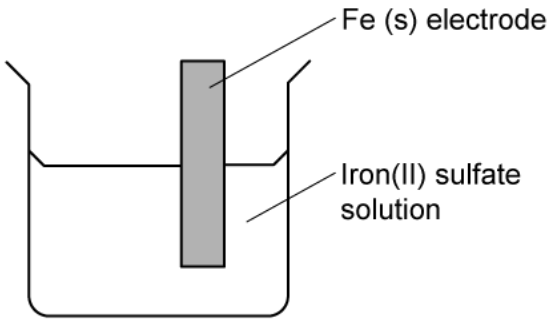
Score: /55

Percentage: /100

Question 1a

a)

The image below shows a half cell that can be used to calculate the standard electrode potential of the Fe^{2+} / Fe reaction.



State the half equation, including state symbols, that represents this half cell.

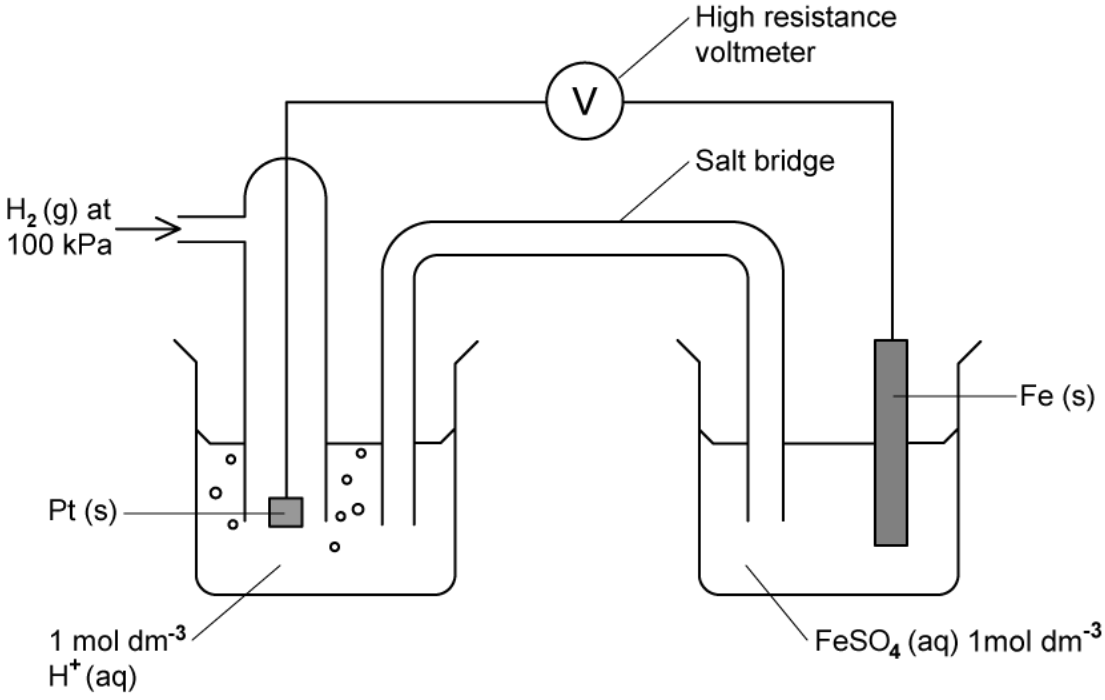
[1]

[1 mark]

Question 1b

b)

The electrochemical cell that is used to measure the standard electrode potential of the Fe^{2+} / Fe electrode is shown below.



State the cell representation for the electrochemical cell set up using the standard hydrogen electrode and the Fe^{2+} / Fe electrode.

[3 marks]

Question 1c

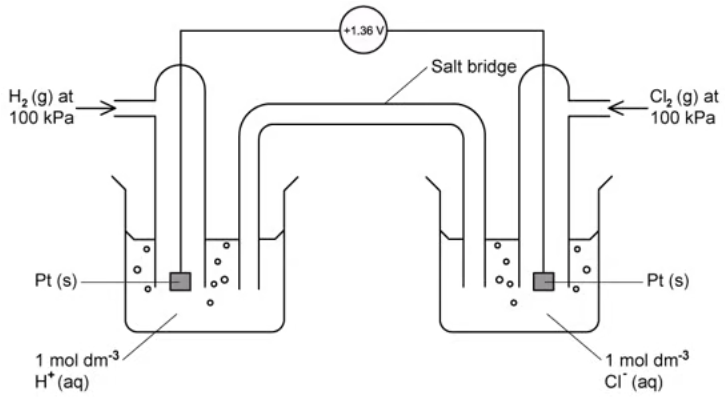
c)
Explain why platinum is used as the electrode for the standard hydrogen electrode.

[2]

[2 marks]

Question 1d

d)
The image shows the electrochemical cell used to measure the standard electrode potential, $E^{\ominus}$, for the Cl_2 / Cl^- half cell.



i)
Write the conventional cell representation for this electrochemical cell.

[3]

ii)
Determine the standard electrode potential, $E^{\ominus}$, for the Cl_2 / Cl^- half cell.

[1]

[4 marks]

Question 2a

a)
State the equation that is required to determine the electromotive force (EMF).

[1]

[1 mark]

Question 2b

b)
Use section 24 of the data booklet to calculate the electromotive force, in volts, of the following cells.

i)
$Zn(s) | Zn^{2+}(aq) || Cu^{2+}(aq) | Cu(s)$

[1]

ii)
$Mg(s) | Mg^{2+}(aq) || Ag^{+}(aq) | Ag(s)$

[1]

iii)
$Pt(s) | Fe^{2+}(aq), Fe^{3+}(aq) || Cl_2(g), 2Cl^{-}(aq) | Pt(s)$

[1]

[3 marks]

Question 2c

c)
A voltaic cell is constructed using the Ag / Ag^+ half cell and Pb / Pb^{2+}. Use section 24 of the data booklet to state the following. Include state symbols in your equations.

Half equation for the Ag / Ag^+ half cell ……..

[1]

Half equation for the Pb / Pb^{2+} half cell ……..

[1]

Overall equation for the voltaic cell ……..

[2]

[4 marks]

Question 2d

d)
Use section 24 of the data booklet to determine the electromotive force of the voltaic cell outlined in part c).

[1]

[1 mark]

Question 3a

a)
Use section 24 of the data booklet to answer the following questions about the electrolysis of **dilute** sodium chloride solution using inert electrodes.

i)
State the equations to generate the ions present in solution.

[2]

ii)
Predict the product at the anode.

[2]

iii)
Predict the product at the cathode.

[2]

[6 marks]

Question 3b

b)
Use section 24 of the data booklet to predict the products at the anode and cathode for the electrolysis of copper sulfate with inert electrodes.

i)
State the equations to generate the ions present in solution.

[2]

ii)
Predict the product at the anode.

[2]

iii)
Predict the product at the cathode.

[2]

[6 marks]

Question 3c

c)
Use your answer to part b) to write an overall equation for the electrolysis of copper sulfate using inert electrodes.

[3]

[3 marks]

Question 3d

d)
The inert electrodes for the electrolysis of copper sulfate are replaced by copper electrodes. State the half equations that occur at the anode and cathode that occur with copper electrodes.

[2]

[2 marks]

Question 4a

a)
State the equation which can be used to determine charge in coulombs, C.

[1]

[1 mark]

Question 4b

b)
During the electrolysis of silver nitrate a current of 0.10 amps is run for ten minutes. Use section 2 and 6 of the data booklet to determine the following.

i)
The number of coulombs.

[1]

ii)
The number of Faradays.

[1]

iii)
The half equation for the formation of silver metal from silver ions.

[1]

iv)
The amount of silver, in moles.

[1]

v)
The mass of silver, in grams, deposited after ten minutes.

[1]

[5 marks]

Question 4c

c)
A solution of copper sulfate, $CuSO_4$ (aq), is electrolysed for 20 mins at a current of 1.50 A. Use sections 2 and 6 of the data booklet to determine the following.

i)
The number of coulombs.

[1]

ii)
The number of Faradays.

[1]

iii)
The half equation for the formation of copper metal from copper ions.

[1]

iv)
The amount of copper, in moles.

[1]

v)
The mass of copper, in grams, deposited after ten minutes.

[1]

[5 marks]

Question 4d

d)
A student sets up apparatus to electroplate a metal spoon with copper. The student chose to use copper as the anode and the spoon as the cathode. Is the student correct to do so?

[1]

[1 mark]

Question 5a

a)
State the value above which the value for the standard electrode potential, E^{θ}_{cell} value , indicates a reaction is spontaneous.

[1]

[1 mark]

Question 5b

b)
The spontaneous reaction between zinc and copper in a voltaic cell is shown below

$Ni(s) + Cu^{2+}(aq) \rightarrow Ni^{2+}(aq) + Cu(s) \quad E^{\theta}_{cell} = +0.60\ V$

Use sections 1 and 2 of the data booklet to determine the free energy change, ΔG^{θ}, for the reaction in $kJ\ mol^{-1}$.

[2 marks]

Question 5c

c) Use section 24 of the data booklet to determine if the reaction shown is spontaneous at standard conditions

$$Pb(s) + Mg^{2+}(aq) \rightarrow Pb^{2+}(aq) + Mg(s)$$

[4]

[4 marks]