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CHEMISTRY

PHYSICAL CHEMISTRY II

Level & Board	AQA (A-LEVEL)
TOPIC:	ELECTRODE POTENTIALS AND CELLS
PAPER TYPE:	QUESTION PAPER - 2
TOTAL QUESTIONS	10
TOTAL MARKS	37

Electrode Potentials and Cells - 2

1. The half-equations for two electrodes used to make an electrochemical cell are shown below.

$ClO_3^-(aq) + 6H^+(aq) + 6e^- \rightarrow Cl^-(aq) + 3H_2O(l)$ $E^o = +1.45$ V

$SO_4^{2-}(aq) + 2H^+(aq) + 2e^- \rightarrow SO_3^{2-}(aq) + H_2O(l)$ $E^o = +0.17$ V

(a) Write the conventional representation for the cell using platinum contacts.

(2)

(b) Write an overall equation for the cell reaction and identify the oxidising and reducing agents.

(3)

2. For a redox reaction to be thermodynamically feasible, E_{cell} must be

A. positive
B. negative
C. greater than +0.3 V
D. more negative than –0.3 V

(1)

3. Define the term standard electrode potential.

(2)

4. In a standard hydrogen electrode

A. The hydrogen gas is at one atmosphere pressure
B. A solution of 1 mol dm^{-3} sulfuric acid is used
C. A temperature of 273 K is maintained
D. A piece of shiny platinum foil is used

(1)

5. Consider the half reaction

$Fe^{2+} + 2e^- \rightarrow Fe \qquad E^o = -0.44\ V$

(a) Define the term standard electrode potential with reference to this electrode.

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(3)

(b) Explain, with the aid of an equation, why the value of E^o suggests that iron will react with an aqueous solution of an acid to give Fe^{2+} ions and hydrogen gas.

(3)

(c) State why E^o values cannot predict that a reaction will occur, only that it is possible.

(1)

6. Which of the following is always proportional to E_{cell} for a chemical reaction?

A. ΔH_r
B. ΔS_{system}
C. $\Delta S_{surroundings}$
D. ΔS_{total}

(1)

7. The table shows some standard electrode potential data.

Electrode half-equation	E^o / V
$Cl_2(g) + 2e^- \longrightarrow 2Cl^-(aq)$	+1.36
$Ag^+(aq) + e^- \longrightarrow Ag(s)$	+0.80
$Fe^{3+}(aq) + e^- \longrightarrow Fe^{2+}(aq)$	+0.77
$Sn^{2+}(aq) + 2e^- \longrightarrow Sn(s)$	−0.14
$Fe^{2+}(aq) + 2e^- \longrightarrow Fe(s)$	−0.44

(a) Use data from the table to deduce the species that is the best oxidising agent.

(1)

(b) Write the conventional representation for the cell used to measure the standard electrode potential for the conversion of tin(II) ions to tin.

(2)

(c) A cell was made by connecting two half-cells with a salt bridge.

One half-cell consisted of silver in a solution of silver nitrate solution and the other consisted of tin in a solution of tin(II) nitrate solution.

Calculate the EMF of this cell and write a half-equation for the reaction that occurs at the negative electrode.

(2)

(d) Use data from the table above to write an equation for the reaction of silver(I) ions with iron(II) ions.

(1)

8. The standard electrode potential for the electrode system based on the equation below is +1.51 V.

$MnO_4^-(aq) + 8H^+(aq) + 5e^- \rightleftharpoons Mn^{2+}(aq) + 4H_2O(l)$

Which of the following statements about the electrode system is correct?

A. The electrode potential at pH 5 is +1.51 V.
B. Mn2+(aq) is acting as an oxidising agent.
C. Changing the concentration of $Mn^{2+}(aq)$ would cause a change in the electrode potential.
D. The electrode used in this half-cell is made of manganese.

(1)

9. In a test, aqueous iron(III) ions are reduced to aqueous iron(II) ions by iodide ions.

This reaction could be used to provide electrical energy in a cell.

(a) The standard electrode potential for the reduction of iron(III) ions into iron(II) ions can be measured by connecting a suitable electrode to a standard hydrogen electrode.

Draw a clearly labelled diagram to show the components and reagents, including their concentrations, in this Fe(III)/Fe(II) electrode.

Do not draw the salt bridge or the standard hydrogen electrode.

(3)

(b) A salt bridge is used to complete the cell.

This could be prepared using potassium nitrate solution and filter paper.

State the purpose of the salt bridge.

State one essential requirement of the soluble ionic compound used to make the salt bridge.

(2)

10. One cell that has been used to provide electrical energy is the Daniell cell. This cell uses copper and zinc.

(a) The conventional representation for the Daniell cell is

Zn(s) | Zn2+(aq) | | Cu2+(aq) | Cu(s)

The e.m.f. of this cell under standard conditions is +1.10 V.

Deduce the half-equations for the reactions occurring at the electrodes.

(2)

(b) A Daniell cell was set up using 100 cm^3 of a 1.0 mol dm^{-3} copper(II) sulfate solution.

The cell was allowed to produce electricity until the concentration of the copper(II) ions had decreased to 0.50 mol dm^{-3} .

Calculate the decrease in mass of the zinc electrode. Show your working.

(3)

(c) You are provided with the Daniell cell referred to in part (b), including a zinc electrode of known mass.

Briefly outline how you would carry out an experiment to confirm your answer to part (b).

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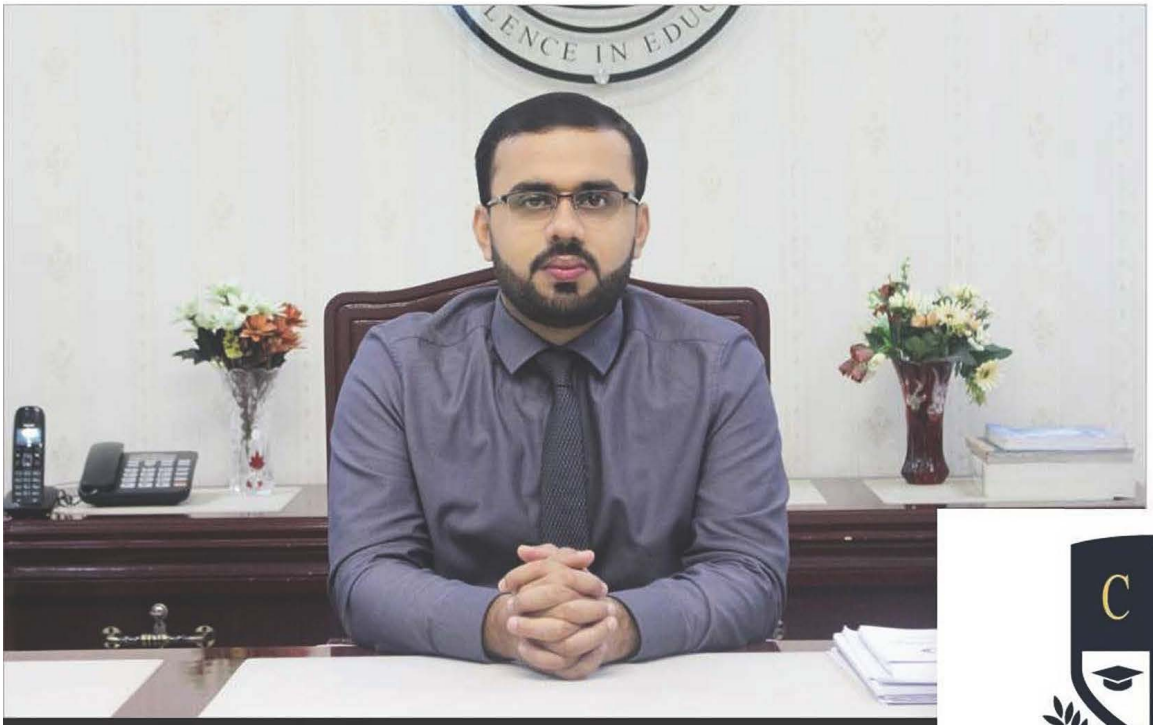
(3)



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