Name of the Student:_____
Max. Marks : 21 Marks **Time : 21 Minutes**

Q1.

This question is about electrode potentials and electrochemical cells.

(a) State the meaning of the term electrochemical series.

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(1)

The table below shows some electrode potentials.

	E^o **/ V**
$[Fe(H_2O)_6]^{2+}(aq) + 2\ e^- \rightarrow Fe(s) + 6\ H_2O(l)$	–0.44
$H^+(aq) + e^- \rightarrow \frac{1}{2}\ H_2(g)$	0.00
$[Co(NH_3)_6]^{3+}(aq) + e^- \rightarrow [Co(NH_3)_6]^{2+}(aq)$	+0.11
$[Fe(H_2O)_6]^{3+}(aq) + e^- \rightarrow [Fe(H_2O)_6]^{2+}(aq)$	+0.77
$VO_2^+(aq) + 2\ H^+(aq) + e^- \rightarrow VO^{2+}(aq) + H_2O(l)$	+1.00
$[Co(H_2O)_6]^{3+}(aq) + e^- \rightarrow [Co(H_2O)_6]^{2+}(aq)$	+1.81

(b) State **two** conditions needed for the following half-cell to have E^o = 0.00 V

$$H^+(aq) + e^- \rightarrow \frac{1}{2}H_2(g)$$

_____

_____

(1)

(c) Identify the weakest reducing agent in the table above.

_____

(1)

(d) Use half-equations from the table above to deduce an equation for the reduction of VO_2^+ to form VO^{2+} in aqueous solution by iron.

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(2)

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(e) Use data from the table above to explain why $[Co(H_2O)_6]^{3+}(aq)$ will undergo a redox reaction with $[Fe(H_2O)_6]^{2+}(aq)$

Give an equation for this reaction.

Explanation _____

_____

_____

Equation

_____

(2)

(f) Suggest why the **two** cobalt(III) complex ions in the table above have different electrode potentials.

_____

_____

_____

(1)

(Total 8 marks)

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Q2.

Standard electrode potentials are measured by comparison with the standard hydrogen electrode.

(a) State the substances and conditions needed in a standard hydrogen electrode.

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(3)

It is difficult to ensure consistency with the setup of a standard hydrogen electrode. A $Cu^{2+}(aq)$ / Cu(s) electrode (E^{o} = +0.34 V) can be used as a secondary standard.

A student does an experiment to measure the standard electrode potential for the $TiO^{2+}(aq)$ / Ti(s) electrode using the $Cu^{2+}(aq)$ / Cu(s) electrode as a secondary standard.

A suitable solution containing the acidified $TiO^{2+}(aq)$ ion is formed when titanium(IV) oxysulfate ($TiOSO_4$) is dissolved in 0.50 mol dm^{-3} sulfuric acid to make 50 cm^3 of solution.

(b) Describe an experiment the student does to show that the standard electrode potential for the $TiO^{2+}(aq)$ / Ti(s) electrode is −0.88 V

The student is provided with:
- the $Cu^{2+}(aq)$ / Cu(s) electrode set up ready to use
- solid titanium(IV) oxysulfate (M_r = 159.9)
- 0.50 mol dm^{-3} sulfuric acid
- a strip of titanium
- laboratory apparatus and chemicals.

Your answer should include details of:
- how to prepare the solution of acidified $TiO^{2+}(aq)$
- how to connect the electrodes
- measurements taken
- how the measurements should be used to calculate the standard electrode potential for the $TiO^{2+}(aq)$ / Ti(s) electrode.

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(6)

(c) Give the half-equation for the electrode reaction in the $TiO^{2+}(aq)$ / Ti(s) electrode in acidic conditions.

_____

(1)

(d) The table shows some electrode potential data.

Electrode reaction	$E^{\ominus}$ / V
$2\ H^+(aq) + 2\ e^- \rightarrow H_2(g)$	0.00
$Cu^{2+}(aq) + 2\ e^- \rightarrow Cu(s)$	+0.34
$NO_3^-(aq) + 4\ H^+(aq) + 3\ e^- \rightarrow NO(g) + 2\ H_2O(l)$	+0.96

Use the data in the table to explain why copper does **not** react with most acids but does react with nitric acid.

Give an equation for the reaction between copper and nitric acid.

Explanation _____

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_____

_____

_____

Equation _____

_____

(3)

(Total 13 marks)

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