Practice Question Set For A-Level
Subject : Chemistry
Paper-1 Topic: Physical 1_Electrode Potentials And Electrochemical Cells

Name of the Student:_____
Max. Marks : 26 Marks **Time : 26 Minutes**

Q1.

Use the standard electrode potential data given in the table below, where appropriate, to answer the questions which follow.

	$E^{\ominus}$/V
$V^{3+}(aq) + e^- \rightarrow V^{2+}(aq)$	–0.26
$SO_4^{2-}(aq) + 4H^+(aq) + 2e^- \rightarrow H_2SO_3(aq) + H_2O$	+0.17
$VO^{2+}(aq) + 2H^+(aq) + e^- \rightarrow V^{3+}(aq) + H_2O(l)$	+0.34
$O_2(g) + 2H^+(aq) + 2e^- \rightarrow H_2O_2(aq)$	+0.68
$Fe^{3+}(aq) + e^- \rightarrow Fe^{2+}(aq)$	+0.77
$VO_2^+(aq) + 2H^+(aq) + e^- \rightarrow VO^{2+}(aq) + H_2O(l)$	+1.00
$2IO_3^-(aq) + 12H^+(aq) + 10e^- \rightarrow I_2(aq) + 6H_2O(l)$	+1.19
$MnO_4^-(aq) + 8H^+(aq) + 5e^- \rightarrow Mn^{2+}(aq) + 4H_2O(l)$	+1.52

Each of the above can be reversed under suitable conditions.

(a) The cell represented below was set up under standard conditions.

$Pt \mid H_2SO_3(aq), SO_4^{2-}(aq), \| Fe^{3+}(aq), Fe^{2+}(aq) \mid Pt$

(i) Calculate the e.m.f. of this cell.

_____

(ii) Write a half-equation for the oxidation process occurring at the negative electrode of this cell.

_____

(2)

(b) The cell represented below was set up under standard conditions.

$Pt \mid H_2O_2(aq), O_2(g) \| IO_3^-(aq), I_2(aq) \mid Pt$

(i) Write an equation for the spontaneous cell reaction.

_____

_____

_____

(ii) Give **one** reason why the e.m.f. of this cell changes when the electrodes are connected and a current flows.

_____

(iii) State how, if at all, the e.m.f. of this standard cell will change if the surface area of each platinum electrode is doubled.

_____

(iv) State how, if at all, the e.m.f. of this cell will change if the concentration of IO_3^- ions is increased. Explain your answer.

Change, if any, in e.m.f. of cell _____

Explanation _____

_____

(7)

(c) An excess of acidified potassium manganate(VII) was added to a solution containing $V^{2+}(aq)$ ions. Use the data given in the table to determine the vanadium species present in the solution at the end of this reaction. State the oxidation state of vanadium in this species and write a half-equation for its formation from $V^{2+}(aq)$.

Vanadium species present at end of reaction _____

Oxidation state of vanadium in final species _____

Half-equation _____

(3)

(Total 12 marks)

Q2.

Where appropriate, use the standard electrode potential data in the table below to answer the questions which follow.

							$E^{\ominus}$/V
$Zn^{2+}(aq)$	+	$2e^-$	→	$Zn(s)$			–0.76
$V^{3+}(aq)$	+	e^-	→	$V^{2+}(aq)$			–0.26
$SO_4^{2-}(aq) + 2H^+(aq)$	+	$2e^-$	→	$SO_3^{2-}(aq)$	+	$H_2O(l)$	+0.17
$VO^{2+}(aq) + 2H^+(aq)$	+	e^-	→	$V^{3+}(aq)$	+	$H_2O(l)$	+0.34
$Fe^{3+}(aq)$	+	e^-	→	$Fe^{2+}(aq)$			+0.77
$VO_2^+(aq) + 2H^+(aq)$	+	e^-	→	$VO^{2+}(aq)$	+	$H_2O(l)$	+1.00
$Cl_2(aq)$	+	$2e^-$	→	$2Cl^-(aq)$			+1.36

(a) From the table above select the species which is the most powerful reducing agent.

_____

(1)

(b) From the table above select

(i) a species which, in acidic solution, will reduce $VO_2^+(aq)$ to $VO^{2+}(aq)$ but will **not** reduce $VO^{2+}(aq)$ to $V^{3+}(aq)$,

_____

(ii) a species which, in acidic solution, will oxidise $VO^{2+}(aq)$ to $VO_2^+(aq)$.

_____

(2)

(c) The cell represented below was set up under standard conditions.

$Pt|Fe^{2+}(aq), Fe^{3+}(aq)||Tl^{3+}(aq), Tl^+(aq)|Pt$ Cell e.m.f. = + 0.48 V

(i) Deduce the standard electrode potential for the following half-reaction.

$Tl^{3+}(aq) + 2e^- \rightarrow Tl^+(aq)$

_____

_____

(ii) Write an equation for the spontaneous cell reaction.

_____

(3)

(d) After acidification, 25.0 cm^3 of a solution of hydrogen peroxide reacted exactly with 16.2 cm^3 of a 0.0200 mol dm^{-3} solution of potassium manganate(VII). The overall equation for

the reaction is given below.

$$2MnO_4^- + 6H^+ + 5H_2O_2 \rightarrow 2Mn^{2+} + 8H_2O + 5O_2$$

(i) Use the equation for this reaction to determine the concentration, in g dm^{-3}, of the hydrogen peroxide solution.

(ii) Calculate the maximum volume of oxygen, measured at a pressure of 98 kPa and a temperature of 298 K, which would be evolved in this reaction.

(8)

(Total 14 marks)