

Name of the Student: _____

Max. Marks : 23 Marks

Time : 23 Minutes

Q1.

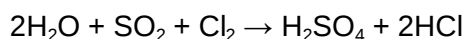
- (a) The term oxidation was used originally to describe a reaction in which a substance gained oxygen. The oxygen was provided by the oxidising agent. Later the definition of oxidation was revised when the importance of electron transfer was recognised.

An aqueous solution of sulfur dioxide was reacted in separate experiments as follows.

Reaction 1 with HgO



Reaction 2 with chlorine



- (i) In Reaction 1, identify the substance that donates oxygen and therefore is the oxidising agent.

- (ii) Show, by writing a half-equation, that this oxidising agent in reaction 1 is an electron acceptor.

- (iii) Write a half-equation for the oxidation process occurring in reaction 2.

- (iv) Write a half-equation for the reduction process occurring in reaction 2.

(4)

- (b) Use the standard electrode potential data given in the table below to answer the questions which follow.

	<i>E</i> / V
$\text{V}^{3+}(\text{aq}) + \text{e}^- \rightarrow \text{V}^{2+}(\text{aq})$	-0.26
$\text{SO}_4^{2-}(\text{aq}) + 4\text{H}^+(\text{aq}) + 2\text{e}^- \rightarrow \text{H}_2\text{SO}_3(\text{aq}) + \text{H}_2\text{O}(\text{l})$	+0.17
$\text{VO}^{2+}(\text{aq}) + 2\text{H}^+(\text{aq}) + \text{e}^- \rightarrow \text{V}^{3+}(\text{aq}) + \text{H}_2\text{O}(\text{l})$	+0.34
$\text{Fe}^{3+}(\text{aq}) + \text{e}^- \rightarrow \text{Fe}^{2+}(\text{aq})$	+0.77
$\text{VO}_2^+(\text{aq}) + 2\text{H}^+(\text{aq}) + \text{e}^- \rightarrow \text{VO}^{2+}(\text{aq}) + \text{H}_2\text{O}(\text{l})$	+1.00
$\text{MnO}_4^-(\text{aq}) + 8\text{H}^+(\text{aq}) + 5\text{e}^- \rightarrow \text{Mn}^{2+}(\text{aq}) + 4\text{H}_2\text{O}(\text{l})$	+1.52

Each of the above can be reversed under suitable conditions

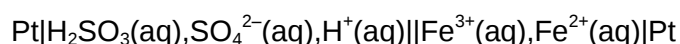
- (i) An excess of potassium manganate(VII) was added to a solution containing $V^{2+}(aq)$ ions. Determine the vanadium species present in the solution at the end of this reaction. State the oxidation state of vanadium in this species and write a half-equation for its formation from $V^{2+}(aq)$.

Vanadium species present at the end of the reaction _____

Oxidation state of vanadium in the final species _____

Half-equation _____

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



Calculate the e.m.f. of this cell and state, with an explanation, how this e.m.f. will change if the concentration of $Fe^{3+}(aq)$ ions is increased.

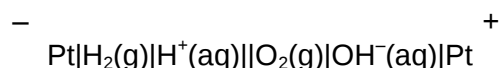
Cell e.m.f. _____

Change in cell e.m.f. _____

Explanation _____

(7)

- (c) Consider the cell below



- (i) Using half-equations, deduce an overall equation for the cell reaction.

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

(3)

- (d) Currently, almost all hydrogen is produced by the high-temperature reaction between methane, from North Sea gas, and steam. Give one economic and one environmental disadvantage of this method of producing hydrogen.

Economic disadvantage _____

Environmental disadvantage _____

(2)

- (e) Hydrogen can also be produced by the electrolysis of acidified water using electricity produced using solar cells. Give one reason why this method is not used on a large scale.

(1)

(Total 17 marks)

Q2.

Which one of the following statements is **not** correct?

- A The first ionisation energy of iron is greater than its second ionisation energy.
- B The magnitude of the lattice enthalpy of magnesium oxide is greater than that of barium oxide.
- C The oxidation state of iron in $[\text{Fe}(\text{CN})_6]^{3-}$ is greater than the oxidation state of copper in $[\text{CuCl}_2]^-$
- D The boiling point of C_3H_8 is lower than that of $\text{CH}_3\text{CH}_2\text{OH}$

(Total 1 mark)

Q3.

The vanadium does **not** have an oxidation state of +3 in

- A $[\text{V}(\text{H}_2\text{O})_6]^{3+}$
- B $[\text{V}(\text{C}_2\text{O}_4)_3]^{3-}$
- C $[\text{V}(\text{OH})_3(\text{H}_2\text{O})_3]$
- D $[\text{VCl}_4]^{3-}$

(Total 1 mark)

Q4.

The compound lithium tetrahydridoaluminate(III), LiAlH_4 , is a useful reducing agent. It behaves in a similar fashion to NaBH_4 . Carbonyl compounds and carboxylic acids are reduced to alcohols. However, LiAlH_4 also reduces water in a violent reaction so that it must be used in an organic solvent.

Which one of the following concerning the violent reaction between LiAlH_4 and water is **false**?

- A A gas is produced.
- B The activation energy for the reaction is relatively high.
- C The reaction has a negative free-energy change.
- D Aqueous lithium ions are formed.

(Total 1 mark)

Q5.

In which one of the following reactions is the role of the reagent stated correctly?

	Reaction	Role of reagent
A	$\text{TiO}_2 + 2\text{C} + 2\text{Cl}_2 \rightarrow \text{TiCl}_4 + 2\text{CO}$	TiO_2 is an oxidising agent
B	$\text{HNO}_3 + \text{H}_2\text{SO}_4 \rightarrow \text{H}_2\text{NO}_3^+ + \text{HSO}_4^-$	HNO_3 is a Brønsted-Lowry acid
C	$\text{CH}_3\text{COCl} + \text{AlCl}_3 \rightarrow \text{CH}_3\text{CO}^+ + \text{AlCl}_4^-$	AlCl_3 is a Lewis base
D	$2\text{CO} + 2\text{NO} \rightarrow 2\text{CO}_2 + \text{N}_2$	CO is a reducing agent

(Total 1 mark)

Q6.

Summarised directions for recording responses to multiple completion questions			
A (i), (ii) and (iii) only	B (i) and (iii) only	C (ii) and (iv) only	D (iv) alone

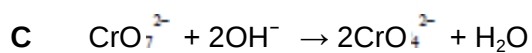
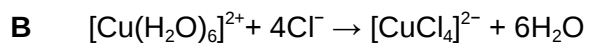
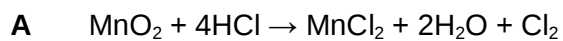
In which of the following conversions is the copper reduced?

- (i) $[\text{Cu}(\text{H}_2\text{O})_6]^{2+} \rightarrow [\text{CuCl}_4]^{2-}$
- (ii) $[\text{Cu}(\text{H}_2\text{O})_6]^{2+} \rightarrow \text{Cu}(\text{H}_2\text{O})_4(\text{OH})_2$
- (iii) $\text{Cu} \rightarrow \text{CuCl}_2$
- (iv) $[\text{Cu}(\text{H}_2\text{O})_6]^{2+} \rightarrow \text{CuCl}$

(Total 1 mark)

Q7.

In which one of the following reactions does the metal species undergo reduction?



(Total 1 mark)