

Name of the Student: _____

Max. Marks : 28 Marks

Time : 28 Minutes

Q1.

This question is about vanadium compounds and ions.

- (a) Use data from Table 4 to identify the species that can be used to reduce VO_2^+ ions to VO^{2+} in aqueous solution and no further.

Explain your answer.

Electrode half-equation	$E^\ominus / \text{V}$
$\text{VO}_2^+(\text{aq}) + 2\text{H}^+(\text{aq}) + \text{e}^- \rightarrow \text{VO}^{2+}(\text{aq}) + \text{H}_2\text{O}(\text{l})$	+1.00
$\text{VO}^{2+}(\text{aq}) + 2\text{H}^+(\text{aq}) + \text{e}^- \rightarrow \text{V}^{3+}(\text{aq}) + \text{H}_2\text{O}(\text{l})$	+0.34
$\text{Cl}_2(\text{aq}) + 2\text{e}^- \rightarrow 2\text{Cl}^-(\text{aq})$	+1.36
$\text{Fe}^{3+}(\text{aq}) + \text{e}^- \rightarrow \text{Fe}^{2+}(\text{aq})$	+0.77
$\text{Zn}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Zn}(\text{s})$	-0.76

Reagent _____

Justification _____

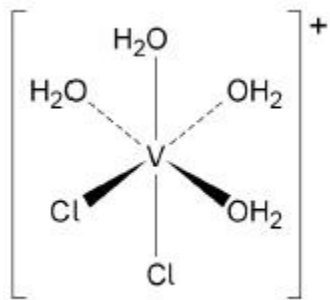
(2)

- (b) Give the oxidation state of vanadium in $[\text{VO}(\text{H}_2\text{O})_5]^{2+}$

(1)

- (c) The $[\text{V}(\text{H}_2\text{O})_4\text{Cl}_2]^+$ ion exists as two isomers. One isomer is shown.

Draw the structure of the other isomer and state the type of isomerism.



Type of isomerism _____

(2)

- (d) Heating NH_4VO_3 produces vanadium(V) oxide, water and one other product.

Give an equation for the reaction.

(1)

- (e) Vanadium(V) oxide is the catalyst used in the manufacture of sulfur trioxide.

Give **two** equations to show how the catalyst is used and regenerated.

(1)

(Total 7 marks)

Q13.

The table shows some electrode half-equations and their standard electrode potentials.

Electrode half-equation	E° / V
$\text{Cl}_2(\text{g}) + 2\text{e}^- \rightarrow 2\text{Cl}^-(\text{aq})$	+1.36
$\text{NO}_3^-(\text{aq}) + 4\text{H}^+(\text{aq}) + 3\text{e}^- \rightarrow \text{NO}(\text{aq}) + 2\text{H}_2\text{O}(\text{aq})$	+0.96
$\text{Fe}^{3+}(\text{aq}) + \text{e}^- \rightarrow \text{Fe}^{2+}(\text{aq})$	+0.77
$\text{Cu}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Cu}(\text{s})$	+0.34
$\text{SO}_4^{2-}(\text{aq}) + 4\text{H}^+(\text{aq}) + 2\text{e}^- \rightarrow \text{SO}_2(\text{g}) + 2\text{H}_2\text{O}(\text{aq})$	+0.17
$2\text{H}^+(\text{aq}) + 2\text{e}^- \rightarrow \text{H}_2(\text{g})$	0.00
$\text{Fe}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Fe}(\text{s})$	-0.44

- (a) Deduce the oxidation state of nitrogen in NO_3^- and in NO

Nitrogen in NO_3^- _____

Nitrogen in NO _____

(2)

- (b) State the weakest reducing agent in the table.

(1)

- (c) Use data from the table to identify an acid that will oxidise copper.

Explain your choice of acid.

Use these data to suggest a possible equation for the reaction.

Calculate the EMF of the cell that has the same overall reaction.

(4)

(Total 7 marks)

Q14.

This question is about the element iodine and its compounds.

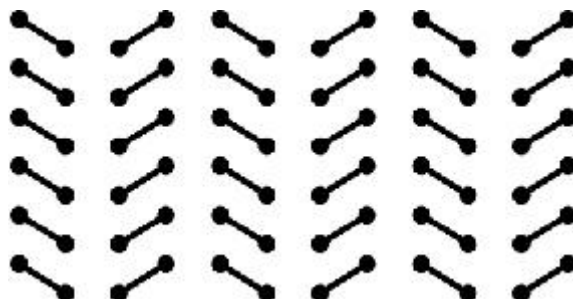
- (a) Iodine is in Group 7 of the Periodic Table.

Complete the electron configuration of an iodine atom.

[Kr] _____

(1)

- (b) Part of the structure of an iodine crystal is shown in the diagram.



Use your knowledge of structure and bonding to explain why the melting point of iodine is low (113.5 °C) and why that of hydrogen iodide is very low (–50.8 °C).

(6)

- (c) State why iodine does **not** conduct electricity.

(1)

- (d) Deduce an equation for the formation of hydrogen iodide from its elements.

(1)

- (e) The triiodide ion is formed when an iodine molecule is bonded to an iodide ion.

What is the formula of ammonium triiodide?

Tick (✓) **one** box.

NH₃I₃

☐

NH₃I₄

☐

NH₄I

☐



(1)

- (f) Draw the shape of the IF_3 molecule and the shape of the IF_4^- ion. Include any lone pairs of electrons that influence each shape.

(2)

- (g) Deduce the oxidation state of iodine in the following species.

$\text{Ba}(\text{IO}_3)_2$ _____

$[\text{H}_4\text{IO}_6]^-$ _____

(2)

(Total 14 marks)