

“Complex Stuff”

YEAR 13 UNIT 5 TEST 4

4.4 TRANSITION METALS

Answer all questions

Bonne Chance!

Name:.....

Mark for section A..... /37

Mark for section C..... /15

Total: /52

Grade.....

SECTION A

1. State what is meant by each of the following terms.

- (i) *Ligand*
-
- (ii) *Complex ion*
-
- (iii) *Co-ordination number*
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(3)
(Total 3 marks)

2. (a) State the origin of the colour of transition-metal complexes.

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.....

(2)

(b) Give **three** changes to a transition-metal complex which result in a change in colour.

Change 1

Change 2

Change 3

(3)

(c) You are provided with a 1.00 mol dm^{-3} solution of iron(III) ions and a visible-light spectrophotometer (colorimeter). Outline a plan for experiments using this solution and this apparatus which would enable you to determine the concentration of iron(III) ions in a solution of unknown concentration.

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(5)
(Total 10 marks)

3. (a) The ion $\text{C}_2\text{O}_4^{2-}$ can act as a bidentate ligand.

(i) Explain the meaning of the term *bidentate ligand*.

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(ii) Sketch the structure of the octahedral complex ion formed by Fe^{3+} ions which contains $\text{C}_2\text{O}_4^{2-}$ as the only ligand. Include the overall charge on the complex ion.

(5)

(b) The chloride ion can act as a monodentate ligand.

(i) Deduce the formula of the linear complex formed when an excess of concentrated hydrochloric acid is added to silver chloride.

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(ii) Explain why metal(II) ions do not usually form octahedral complexes when chloride ions are the only ligands.

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(2)

(Total 7 marks)

4. (a) Identify a reagent, or mixture of reagents, necessary to carry out each of the following conversions.

(i) $[\text{Cr}(\text{H}_2\text{O})_6]^{3+}(\text{aq}) \rightarrow \text{CrO}_4^{2-}(\text{aq})$

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(ii) $\text{VO}_2^+(\text{aq}) \rightarrow [\text{V}(\text{H}_2\text{O})_6]^{2+}(\text{aq})$

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(iii) $[\text{Ag}(\text{NH}_3)_2]^+(\text{aq}) \rightarrow \text{Ag}(\text{s})$

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(5)

(b) In an acidic solution, hydrogen peroxide, H_2O_2 , is oxidised to oxygen by manganate(VII) ions, which are reduced to Mn^{2+} ions.

- (i) Write half-equations for the reactions occurring and use these to deduce the overall equation for this reaction.

Half-equation for the oxidation of H_2O_2

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Half-equation for the reduction of manganate(VII) ions

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Overall equation

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- (ii) 20.0 cm^3 of an acidified solution of H_2O_2 was found to react with exactly 15.7 cm^3 of a $0.0180 \text{ mol dm}^{-3}$ solution of potassium manganate(VII). Calculate the concentration, in g dm^{-3} , of the solution of hydrogen peroxide. (If you have been unable to complete the overall equation in part (b)(i), assume that the mole ratio of manganate(VII) to H_2O_2 is 3:5. This is not the correct ratio.)

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(7)
(Total 12 marks)

5. The concentration of $\text{C}_2\text{O}_4^{2-}$ ions can be determined by titration in acidic solution using a standard solution of potassium manganate(VII). At room temperature, the reaction proceeds very slowly at first but becomes faster after some of the manganate(VII) ions have reacted.

(i) Suggest why this reaction is very slow at first.

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(ii) This is an example of an autocatalytic reaction. State the meaning of the term *autocatalytic* and identify the catalyst.

Meaning of the term autocatalytic

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Catalyst

(iii) Suggest how this catalyst might be involved in the reaction.

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(5)
(Total 5 marks)

SECTION B

6. (a) Describe an experiment to show that vanadium has several oxidation states.

(6)

- (b) Describe the essential features of catalysis and explain what is meant by the term *heterogeneous catalyst*. State an industrial process which uses vanadium(V) oxide as a heterogeneous catalyst and explain, with the help of equations, the mode of action of the catalyst.

(9)

(Total 15 marks)

[illegible]



