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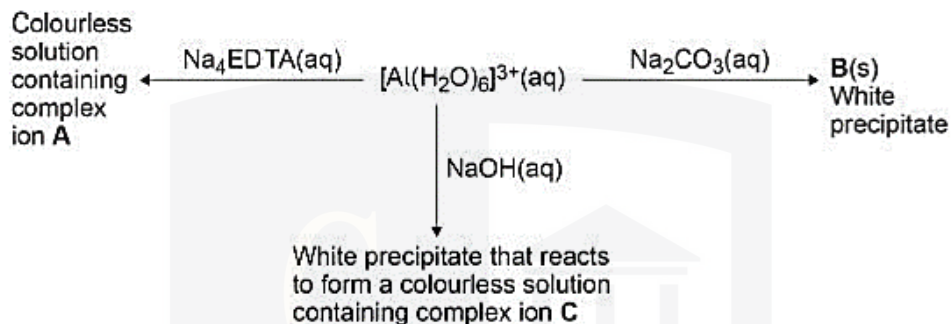
INORGANIC CHEMISTRY II

Level & Board	AQA (A-LEVEL)
TOPIC:	REACTIONS OF IONS IN AQUEOUS SOLUTION
PAPER TYPE:	QUESTION PAPER - 3
TOTAL QUESTIONS	10
TOTAL MARKS	44

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Reactions of Ions in Aqueous Solution - 3

1. Some reactions of the $[\text{Al}(\text{H}_2\text{O})_6]^{3+}(\text{aq})$ ion are shown.



(a) Give the formula of the white precipitate B.

State one other observation when $\text{Na}_2\text{CO}_3(\text{aq})$ is added to a solution containing $[\text{Al}(\text{H}_2\text{O})_6]^{3+}(\text{aq})$ ions.

Give an equation for this reaction.

(3)

(b) Give the formula of the complex ion C.

State one condition needed for the formation of C from $[\text{Al}(\text{H}_2\text{O})_6]^{3+}(\text{aq})$ and $\text{NaOH}(\text{aq})$.

Give an equation for this reaction.

(3)

(c) Deduce the formula of the complex ion A.

(1)

(d) Explain, with the use of an equation, why a solution containing $[\text{Al}(\text{H}_2\text{O})_6]^{3+}$ has a pH < 7

(3)

2. A sample of solid chromium(III) hydroxide displays amphoteric character when treated separately with dilute hydrochloric acid and with dilute aqueous sodium hydroxide.

Write an ionic equation for each of these reactions.

Include the formula of each complex ion formed.

Describe the changes that you would observe in each reaction.

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(5)

3. A green solution, X, is thought to contain $[\text{Fe}(\text{H}_2\text{O})_6]^{2+}$ ions.

The presence of these ions can be confirmed by reacting separate samples of solution X with aqueous ammonia and with aqueous sodium carbonate.

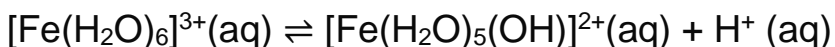
Write equations for each of these reactions and describe what you would observe.

(4)

4. Iron(II) sulfate is used to kill weeds in garden lawns. It is a by-product of the manufacture of steel.

When a lawn is treated with iron(II) sulfate, the iron(II) ions are oxidised to form iron(III) ions.

Iron(III) ions are acidic in aqueous solution as shown by the following equation.



In an experiment, a calibrated pH meter was used to measure the pH of an iron(III) salt in solution.

At 20 °C the pH of a 0.100 mol dm⁻³ solution of iron(III) sulfate was found to be 1.62.

(a) Explain briefly why a pH meter should be calibrated before use.

(1)

(b) Write an expression for the equilibrium constant, K_a , for the dissociation of iron(III) ions in aqueous solution.

(1)

(c) Use your answer from part (b) to calculate the value of K_a for this reaction at 20 °C.

Give your answer to the appropriate precision.
Show your working.

(4)

(d) Name the substance that is most likely to oxidise the iron(II) ions when iron(II) sulfate is used as a weed killer.

(1)

(e) Suggest a value for the pH of a 0.100 mol dm⁻³ solution of iron(II) sulfate.

(1)

5. Diaminoethane ($\text{H}_2\text{NCH}_2\text{CH}_2\text{NH}_2$), like ammonia, can react as a base and as a ligand.

Write an equation for the reaction that occurs between an aqueous solution of aluminium chloride and an excess of aqueous diaminoethane.

Describe the appearance of the aluminium-containing reaction product.

(3)

6. State what is observed when an excess of aqueous ammonia reacts with an aqueous iron(II) salt. Write an equation for this reaction.

(4)

7. When a solution of $[\text{Ti}(\text{H}_2\text{O})_4\text{Cl}_2]^+$ ion is diluted with water, a substitution reaction occurs and the pink $[\text{Ti}(\text{H}_2\text{O})_6]^{3+}$ ion is formed.

(a) Explain what is meant by the term substitution reaction.

(1)

(b) Construct an equation for this reaction.

(1)

(c) What change to the titanium ion is responsible for the colour change in the reaction?

(1)

8. State how the co-ordination number of cobalt(II) ions in aqueous solution changes when an excess of chloride ions is added. Give a reason for the change.

(2)

9. Give the formula of the cobalt complex present in an aqueous solution of cobalt(II) sulphate and state its colour.

(2)

10. When a large excess of concentrated aqueous ammonia is added to an aqueous solution of cobalt(II) sulphate, a new cobalt(II) complex is formed.

(a) Give the formula of the new cobalt(II) complex and state its colour.

(1)

(b) Write an equation for the formation of this new complex.

(2)



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