

### 5.4 EXERCISE 3 – Variable oxidation states and catalysis

1. Describe what happens when the following species are acidified and then treated with zinc and account for all your observations:
  - a) ammonium vanadate (V)
  - b) potassium chromate (VI)
2. Describe what happens when the following species are treated with sodium hydroxide and hydrogen peroxide and account for all your observations:
  - a) cobalt (II) chloride
  - b) chromium (III) chloride
3. Describe what happens when cobalt chloride is treated with concentrated ammonia solution and then left to stand in air. Account for all your observations.
4. Describe two ways in which the concentration of  $\text{Fe}^{2+}$  in a sample could be determined by titration. In each case write an equation for the reaction occurring during the titration.
5.
  - a) Write an equation for a reaction catalysed by the following substances and explain why they are important:
    - i)  $\text{V}_2\text{O}_5$
    - ii) Fe
    - iii) Ni
    - iv) Rh
  - b) Give two examples of catalyst poisoning
  - c) Explain why a ceramic support is used for Rh in example (i) (iv)
  - d) Explain why Fe is a better catalyst than W and Ag.
6. Explain how the following reaction can be catalysed by both  $\text{Fe}^{2+}$  and  $\text{Fe}^{3+}$  ions:
$$\text{S}_2\text{O}_8^{2-}(\text{aq}) + 2\text{I}^-(\text{aq}) \rightarrow 2\text{SO}_4^{2-}(\text{aq}) + \text{I}_2(\text{aq})$$
For each ion, write two equations to show the catalysed pathway and explain why both are faster than the uncatalysed reaction.
7.
  - a) Write an equation for the reaction which occurs during the titration between ethanedioic acid ( $\text{H}_2\text{C}_2\text{O}_4$ ) and  $\text{KMnO}_4$ .
  - b) Explain why the reaction is slow initially but quite fast close to the end-point.