

IB Chemistry HL - R3.2

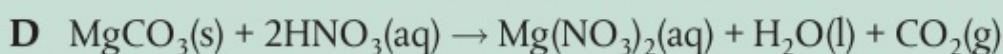
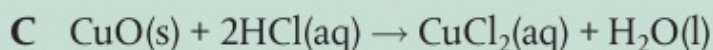
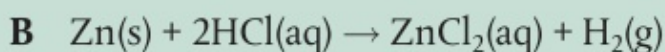
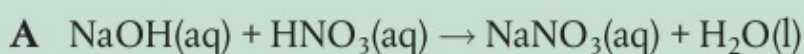
Electron transfer reactions

Exercises + Practice questions

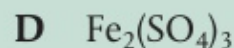
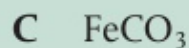
Official answers appended at the end

Exercise

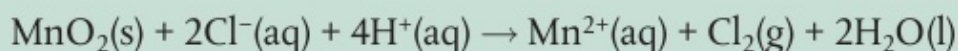
Q1. Which equation represents a redox reaction?



Q2. The oxidation state of iron is the same in all the following compounds except which one?



Q3. Identify the correct descriptions of the redox reaction between manganese(IV) oxide and the chloride ions:



I. H^+ is the reducing agent.

II. MnO_2 undergoes reduction

III. $\text{Cl}^-\text{(aq)}$ is the reducing agent

A I and II only

B I and III only

C II and III only

D I, II and III

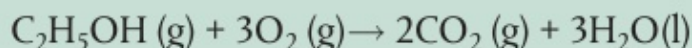
Q4. Assign oxidation states to all elements in the following compounds.

- (a) CH_4 (b) CuSO_4 (c) C_2H_4 (d) CO
(e) $\text{K}_2\text{Cr}_2\text{O}_7$ (f) K_2CrO_4 (g) H_2O_2 (h) C_4H_{10}

Q5. Use oxidation states to deduce which species is oxidized and which is reduced in the following reactions.

- (a) $\text{Sn}^{2+}(\text{aq}) + 2\text{Fe}^{3+}(\text{aq}) \rightarrow \text{Sn}^{4+}(\text{aq}) + 2\text{Fe}^{2+}(\text{aq})$
(b) $2\text{FeCl}_2(\text{aq}) + \text{Cl}_2(\text{aq}) \rightarrow 2\text{FeCl}_3(\text{aq})$
(c) $2\text{H}^+(\text{aq}) + \text{S}_2\text{O}_3^{2-}(\text{aq}) \rightarrow \text{S}(\text{s}) + \text{SO}_2(\text{g}) + \text{H}_2\text{O}(\text{l})$
(d) $2\text{H}_2\text{O}_2(\text{aq}) \rightarrow 2\text{H}_2\text{O}(\text{l}) + \text{O}_2(\text{g})$
(e) $\text{I}_2(\text{aq}) + \text{SO}_3^{2-}(\text{aq}) + \text{H}_2\text{O}(\text{l}) \rightarrow 2\text{I}^-(\text{aq}) + \text{SO}_4^{2-}(\text{aq}) + 2\text{H}^+(\text{aq})$

Q6. The combustion of ethanol is a redox reaction.



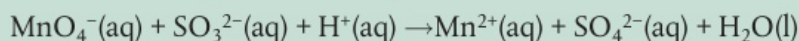
- (a) Assign oxidation states to carbon in $\text{C}_2\text{H}_5\text{OH}$ and comment on your answer.
(b) Discuss the application of the different definitions of oxidation and reduction in analysing the reaction.

Q7. Identify the oxidizing agents and the reducing agents in the following reactions.

- (a) $\text{H}_2(\text{g}) + \text{Cl}_2(\text{g}) \rightarrow 2\text{HCl}(\text{g})$
(b) $2\text{Al}(\text{s}) + 3\text{PbCl}_2(\text{s}) \rightarrow 2\text{AlCl}_3(\text{s}) + 3\text{Pb}(\text{s})$
(c) $\text{Cl}_2(\text{aq}) + 2\text{KI}(\text{aq}) \rightarrow 2\text{KCl}(\text{aq}) + \text{I}_2(\text{aq})$
(d) $\text{CH}_4(\text{g}) + 2\text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) + 2\text{H}_2\text{O}(\text{l})$

Exercise

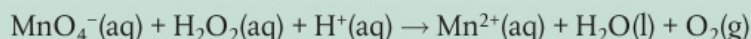
Q8. Consider the following unbalanced equation:



Deduce the amount of MnO_4^- which reacts with 1 mol of SO_3^{2-} ions.

- A** 0.40 mol **B** 3 mol **C** 1.50 mol **D** 7 moles

Q9. Consider the following unbalanced equation:



Deduce the amount of $\text{H}_2\text{O}_2(\text{aq})$ which reacts with 1 mol of $\text{MnO}_4^-(\text{aq})$.

- A** 0.40 mol **B** 1.25 mol **C** 2.50 mol **D** 5 moles

Q10. Deduce the half-equations of oxidation and reduction for the following reactions.

- (a) $\text{Ca}(\text{s}) + 2\text{H}^+(\text{aq}) \rightarrow \text{Ca}^{2+}(\text{aq}) + \text{H}_2(\text{g})$
 (b) $2\text{Fe}^{2+}(\text{aq}) + \text{Cl}_2(\text{aq}) \rightarrow 2\text{Fe}^{3+}(\text{aq}) + 2\text{Cl}^-(\text{aq})$
 (c) $\text{Sn}^{2+}(\text{aq}) + 2\text{Fe}^{3+}(\text{aq}) \rightarrow \text{Sn}^{4+}(\text{aq}) + 2\text{Fe}^{2+}(\text{aq})$
 (d) $\text{Cl}_2(\text{aq}) + 2\text{Br}^-(\text{aq}) \rightarrow 2\text{Cl}^-(\text{aq}) + \text{Br}_2(\text{aq})$

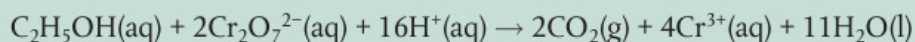
Q11. Write balanced equations for the following reactions that occur in acidic solutions.

- (a) $\text{I}^-(\text{aq}) + \text{HSO}_4^-(\text{aq}) \rightarrow \text{I}_2(\text{aq}) + \text{SO}_2(\text{g})$
 (b) $\text{I}_2(\text{aq}) + \text{OCl}^-(\text{aq}) \rightarrow \text{IO}_3^-(\text{aq}) + \text{Cl}^-(\text{aq})$
 (c) $\text{MnO}_4^-(\text{aq}) + \text{H}_2\text{SO}_3(\text{aq}) \rightarrow \text{SO}_4^{2-}(\text{aq}) + \text{Mn}^{2+}(\text{aq})$

Q12. A bag of 'road salt', used to melt ice and snow from roads, contains a mixture of calcium chloride, CaCl_2 , and sodium chloride, NaCl . A 2.765 g sample of the mixture was analysed by first converting all the calcium into calcium oxalate, CaC_2O_4 . This was then dissolved in H_2SO_4 and titrated with $0.100 \text{ mol dm}^{-3}$ KMnO_4 solution. The titration required 24.65 cm^3 of $\text{KMnO}_4(\text{aq})$ and produced $\text{Mn}^{2+}(\text{aq})$, $\text{CO}_2(\text{g})$, and $\text{H}_2\text{O}(\text{l})$.

- (a) What would be observed at the equivalence point of the titration?
 (b) Write the half-equation for the oxidation reaction, starting with $\text{C}_2\text{O}_4^{2-}$.
 (c) Write the half-equation for the reduction reaction, starting with MnO_4^- .
 (d) Write the overall equation for the redox reaction.
 (e) Determine the number of moles of $\text{C}_2\text{O}_4^{2-}$.
 (f) Deduce the number of moles of Ca^{2+} in the original sample.
 (g) What was the percentage by mass of CaCl_2 in the road salt?

Q13. Alcohol levels in blood can be determined by a redox titration with potassium dichromate, $\text{K}_2\text{Cr}_2\text{O}_7$, according to the following equation:



- (a) Determine the alcohol percentage in the blood by mass if a 10.000 g sample of blood requires 9.25 cm^3 of $0.0550 \text{ mol dm}^{-3}$ $\text{K}_2\text{Cr}_2\text{O}_7$ solution to reach equivalence.
 (b) Describe the change in colour that would be observed during the titration.

Exercise

Q14. Use the activity series on the previous page to predict what happens when zinc powder is added to an aqueous solution of sodium chloride.

- A** $\text{Cl}_2(\text{g})$ is produced **B** $\text{Na}(\text{s})$ is produced
C $\text{ZnCl}_2(\text{aq})$ is produced **D** No reaction

Q15. Consider the following reactions of three unidentified metals P, Q and R.

1. $\text{P}(\text{s}) + 2\text{QCl}(\text{aq}) \rightarrow \text{P}(\text{s}) + 2\text{QCl}(\text{aq})$
2. $\text{R}(\text{s}) + 2\text{QCl}(\text{aq}) \rightarrow \text{R}(\text{s}) + 2\text{QCl}(\text{aq})$
3. $\text{R}(\text{s}) + 2\text{P}(\text{s}) \rightarrow \text{no reaction}$

Deduce the order of **increasing** reactivity of the metals.

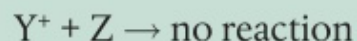
- A** $\text{P} < \text{Q} < \text{R}$ **B** $\text{P} < \text{R} < \text{Q}$ **C** $\text{R} < \text{P} < \text{Q}$ **D** $\text{Q} < \text{R} < \text{P}$

Q16. Use the activity series given to predict if a reaction occurs between the following reactants, and write equations where relevant.

- (a) $\text{CuCl}_2 + \text{Ag}$ (b) $\text{Fe}(\text{NO}_3)_2 + \text{Al}$
(c) $\text{NaI} + \text{Br}_2$ (d) $\text{KCl} + \text{I}_2$

Q17. An activity series can be deduced from observing displacement reactions.

- (a) Use the following reactions to deduce the order of reactivity of the elements W, X, Y and Z, putting the most reactive first.



- (b) Which of the following reactions would you expect to occur according to the activity series you established in part (a)?

