



1. Define oxidation.

2. What is the oxidation state of oxygen in  $\text{H}_2\text{O}_2$  (hydrogen peroxide)?

a. What is the oxidation state of sulfur in  $\text{H}_2\text{SO}_4$  (Sulfuric Acid)?

b. What is the oxidation state of Nitrogen  $\text{NO}_3^-$  (Nitrate Ion)?

c. What is the oxidation state of chromium in  $\text{Cr}_2\text{O}_7^{2-}$  (Dichromate Ion)?

d. what is the oxidation state of carbon in  $\text{CO}_2$  (Carbon Dioxide)

e. What is the oxidation state of iron in  $\text{Fe}_2\text{O}_3$  (Iron(III) Oxide)

f. What is the oxidation state of phosphorus in  $\text{PO}_4^{3-}$  (Phosphate Ion)

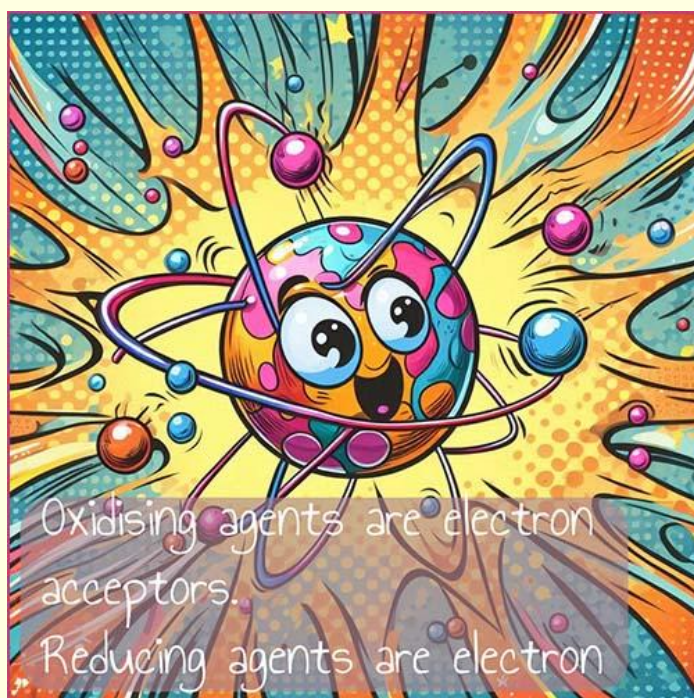
3. Which of the following is a useful reducing agent?

a)  $\text{Cl}_2$

b)  $\text{MnO}_4^-$

c)  $\text{H}_2$

d)  $\text{H}_2\text{O}_2$



in

4. State the colour change observed when acidified potassium dichromate ( $K_2Cr_2O_7$ ) is reduced.
5. Write the half-equation for the reduction of acidified potassium permanganate ( $MnO_4^-$ ) to  $Mn^{2+}$ .
6. Explain what is meant by the term 'oxidising agent'.
7. Write the balanced chemical equation for the displacement reaction between zinc metal and copper (II) sulfate solution, including all the state symbols.
- a. Write two half equations for this displacement reaction, one half-equation to show the reduction reaction taking place and one to show the oxidation reaction.
- b. Explain why this displacement reaction is also a redox reaction.
8. Acidified potassium permanganate ( $KMnO_4$ ) will oxidise hydrogen peroxide ( $H_2O_2$ ). The permanganate ion is reduced to form  $Mn^{2+}$  ions while the hydrogen peroxide is oxidised to form oxygen gas.
- a. Write half-equations to show the oxidation and reduction reactions taking place.
- b. Write an overall equation for this redox reaction.
9. Write the oxidation and reduction half-equations for the reaction of zinc with hydrochloric acid ( $HCl$ ), to form zinc chloride and hydrogen gas and then combine them into a full redox equation.

10. For the reaction of potassium permanganate ( $\text{KMnO}_4$ ) with iron(II) sulfate ( $\text{FeSO}_4$ ) in acidic solution:

a) Write the balanced ionic equation.

b) Identify the oxidising and reducing agents.

c) State the colour changes observed during the reaction.

## Answers

1. Define oxidation.

Answer: Oxidation is the loss of electrons or an increase in the oxidation state of an element in a chemical reaction.

2. What is the oxidation state of oxygen in  $\text{H}_2\text{O}_2$  (hydrogen peroxide)?

Hydrogen (H) has an oxidation state of +1.

Molecule has no charge

Answer: The oxidation state of oxygen in  $\text{H}_2\text{O}_2$  is -1.

a. What is the oxidation state of sulfur in  $\text{H}_2\text{SO}_4$  (Sulfuric Acid)?

Hydrogen (H) has an oxidation state of +1.

Oxygen (O) has an oxidation state of -2.

Answer: The oxidation state of sulfur in  $\text{H}_2\text{SO}_4$  is +6.

b. What is the oxidation state of Nitrogen in  $\text{NO}_3^-$  (Nitrate Ion)?

Oxygen (O) has an oxidation state of -2.

Answer: The oxidation state of nitrogen in  $\text{NO}_3^-$  is +5.

c. What is the oxidation state of chromium in  $\text{Cr}_2\text{O}_7^{2-}$  (Dichromate Ion)?

Oxygen (O) has an oxidation state of -2.

Molecule has a charge of -2

Answer: The oxidation state of chromium in  $\text{Cr}_2\text{O}_7^{2-}$  is +6.

d. what is the oxidation state of carbon in  $\text{CO}_2$  (Carbon Dioxide)

Oxygen (O) has an oxidation state of -2.

Answer: The oxidation state of carbon in  $\text{CO}_2$  is +4.

e. What is the oxidation state of iron in  $\text{Fe}_2\text{O}_3$  (Iron(III) Oxide)

Oxygen (O) has an oxidation state of -2.

Molecule has no charge

Answer: The oxidation state of iron in  $\text{Fe}_2\text{O}_3$  is +3.

f. What is the oxidation state of phosphorus in  $\text{PO}_4^{3-}$  (Phosphate Ion)

Oxygen (O) has an oxidation state of -2.

Molecule has a charge of -3

Answer: The oxidation state of phosphorus in  $\text{PO}_4^{3-}$  is +5.

3. Which of the following is a useful reducing agent?

a)  $\text{Cl}_2$                       b)  $\text{MnO}_4^-$                       c)  $\text{H}_2$                       d)  $\text{H}_2\text{O}_2$

Answer: c)  $\text{H}_2$

4. State the colour change observed when acidified potassium dichromate ( $\text{K}_2\text{Cr}_2\text{O}_7$ ) is reduced.

Answer: The colour changes from orange to green.

5. Write the half-equation for the reduction of acidified potassium permanganate ( $\text{MnO}_4^-$ ) to  $\text{Mn}^{2+}$ .

Answer:

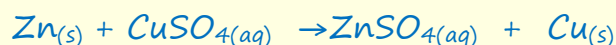


6. Explain what is meant by the term 'oxidising agent'.

Answer: An oxidising agent is a substance that causes another substance to lose electrons and itself gains electrons in the process, undergoing reduction. An oxidising agent is an electron acceptor; a reducing agent is an electron donor.

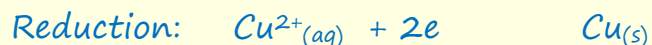
7. Write the balanced chemical equation for the displacement reaction between zinc metal and copper (II) sulfate solution, including all the state symbols.

Answer:



a. Write two half equations for this displacement reaction, one half-equation to show the reduction reaction taking place and one to show the oxidation reaction.

Answer:



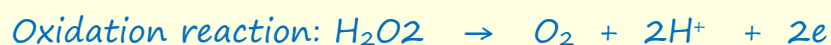
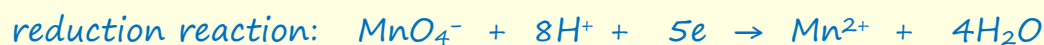
b. Explain why this displacement reaction is also a redox reaction.

Answer: The copper ions are reduced and the zinc metal is oxidised, a redox reaction is where one substance is oxidised and another is reduced, which is exactly what is happening here.

8. Acidified potassium permanganate ( $\text{KMnO}_4$ ) will oxidise hydrogen peroxide ( $\text{H}_2\text{O}_2$ ). The permanganate ion is reduced to form  $\text{Mn}^{2+}$  ions while the hydrogen peroxide is oxidised to form oxygen gas.

a. Write half-equations to show the oxidation and reduction reactions taking place.

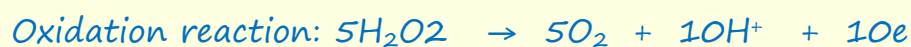
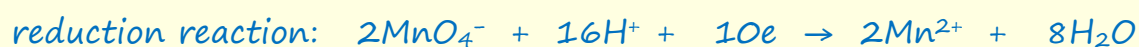
Answer:



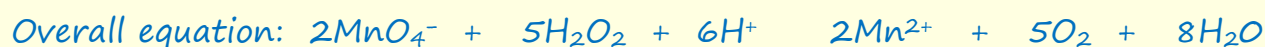
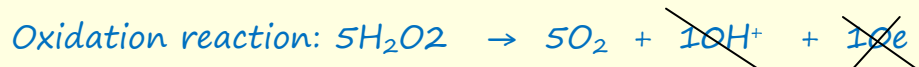
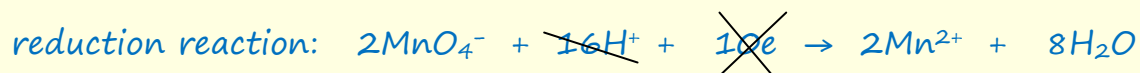
b. Write an overall equation for this redox reaction.

Answer:

Ignore the spectator ions, the  $\text{K}^+$  ion from the permanganate and the sulfate ion ( $\text{SO}_4^{2-}$ ) from the dilute sulfuric acid. To balance the electrons multiply the reduction half-equation by x2 and the oxidation half-equation by x5, this will give 10 electrons in each half-equation.



Now cancel out the electrons which appear on both sides of the two half-equations and also cancel out  $10\text{H}^+$  ions on the reactant side to leave  $6\text{H}^+$  ions. This gives:



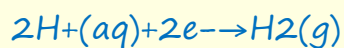
9. Write the oxidation and reduction half-equations for the reaction of zinc with hydrochloric acid (HCl), to form zinc chloride and hydrogen gas and then combine them into a full redox equation.

Answer:

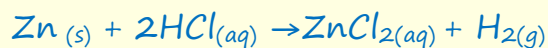
Oxidation half-equation:



Reduction half-equation:



Full redox equation:

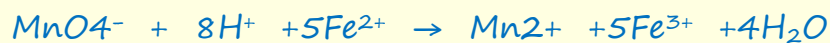


10. For the reaction of potassium permanganate ( $\text{KMnO}_4$ ) with iron(II) sulfate ( $\text{FeSO}_4$ ) in acidic solution:

- Write the balanced ionic equation.
- Identify the oxidising and reducing agents.
- State the colour changes observed during the reaction.

Answer:

a) Balanced ionic equation:



b) Oxidising agent:  $\text{MnO}_4^{-}$ , Reducing agent:  $\text{Fe}^{2+}$

c) Colour change: Purple  $\text{MnO}_4^{-}$  solution turns colourless as  $\text{Mn}^{2+}$  is formed.