The Electrolysis of Solutions

Answer all the questions below then check your answers

1. What is an electrolyte?

2. Fill in the gaps to complete the sentence below:

   During electrolysis, positive ions move to the _____ and negative ions move to the _____.

3. Which ion is discharged at the cathode during the electrolysis of copper(II) sulfate solution?

   A. Cu^{2+} B. SO_4^{2-} C. H^+ D. OH^-

4. Write the half-equation for the reduction of copper ions (Cu^{2+}) at the cathode.

5. What is produced at the anode during the electrolysis of sodium chloride solution?

   A. Chlorine gas B. Hydrogen gas C. Sodium metal

   D. Oxygen gas

6. Predict the products at the anode and cathode during the electrolysis of potassium nitrate (KNO_3) solution.

b. Write ion-electron half equations to show how the products at the anode and cathode are formed.

7. Explain the process of electrolysis of sodium sulfate (Na_2SO_4) solution and write the equations for the reactions occurring at the anode and cathode.

   During the electrolysis of sodium sulfate solution, hydrogen is a less reactive metal than sodium and so is more easily reduced than the sodium, sulfate ions are not discharged as less energy is needed to discharge hydroxide ions or water molecules

8. Predict the products of electrolysis for a solution containing $CuSO_4$ and explain why these products are formed.

9. Complete the table below to show the products formed at the anode and cathode when the various solutions are electrolysed.

Solution	Anode Product	Cathode Product
Sodium chloride		
Potassium sulfate		
Copper(II) bromide		
Sodium nitrate		
Calcium chloride		
Sodium carbonate		

Answers

1. What is an electrolyte?

   Answer: An electrolyte is a solution that conducts electricity, it contains free moving ions dissolved in water.

2. Fill in the gaps to complete the sentence below:

   During electrolysis, positive ions move to the _____ and negative ions move to the _____.

   Answer: cathode, anode

3. Which ion is discharged at the cathode during the electrolysis of copper(II) sulfate solution?

   A. Cu^{2+} B. SO_4^{2-} C. H^+ D. OH^-

   Answer: A. Cu^{2+}

4. Write the half-equation for the reduction of copper ions (Cu^{2+}) at the cathode.

   Answer: $Cu^{2+} + 2e^- \rightarrow Cu$

5. What is produced at the anode during the electrolysis of sodium chloride solution?

   A. Chlorine gas B. Hydrogen gas C. Sodium metal

   D. Oxygen gas

   Answer: A. Chlorine gas

6. Predict the products at the anode and cathode during the electrolysis of potassium nitrate (KNO_3) solution.

Answer:

At the anode: Oxygen gas (O_2)

At the cathode: Hydrogen gas (H_2)

b. Write ion-electron half equations to show how the products at the anode and cathode are formed.

At the cathode: $2H_2O + 2e \rightarrow H_2 + 2OH^-$

Or $2H^+ + 2e \rightarrow H_2$

At the anode: $2H_2O \rightarrow O_2 + 4H^+ + 4e$

Or $4OH^- \rightarrow O_2 + 2H_2O + 4e$

7. Explain the process of electrolysis of sodium sulfate (Na_2SO_4) solution and write the equations for the reactions occurring at the anode and cathode.

During the electrolysis of sodium sulfate solution, hydrogen is a less reactive metal than sodium and so is more easily reduced than the sodium, sulfate ions are not discharged as less energy is needed to discharge hydroxide ions or water molecules.

At the cathode: $2H_2O + 2e \rightarrow H_2 + 2OH^-$

Or $2H^+ + 2e \rightarrow H_2$

At the anode: $2H_2O \rightarrow O_2 + 4H^+ + 4e$

Or $4OH^- \rightarrow O_2 + 2H_2O + 4e$

8. Predict the products of electrolysis for a solution containing $CuSO_4$ and explain why these products are formed.

Answer:

At the cathode: Cu^{2+} ions gain electrons to form copper metal.

Equation: $Cu^{2+} + 2e^- \rightarrow Cu$

At the anode: Water molecules lose electrons to form oxygen gas and hydrogen ions or hydroxide ions are oxidised to form oxygen gas.

Equation: $4OH^- \rightarrow O_2 + 2H_2O + 4e^-$

Or $2H_2O \rightarrow O_2 + 4H^+ + 4e$

Copper is less reactive than hydrogen, so copper ions are reduced at the cathode. Sulfate ions are not discharged; instead, water or hydroxide ions are oxidised at the anode.

9. Complete the table below to show the products formed at the anode and cathode when the various solutions are electrolysed.

Solution	Anode Product	Cathode Product
Sodium chloride	Chlorine gas (Cl_2)	chlorine gas (Cl_2)
Potassium sulfate	Oxygen gas (O_2)	Hydrogen gas (H_2)
Copper(II) bromide	bromine gas (Br_2)	Copper metal (Cu)
Sodium nitrate	Oxygen gas (O_2)	Hydrogen gas (H_2)
Calcium chloride	Oxygen gas (O_2)	chlorine gas (Cl_2)
Sodium carbonate	Oxygen gas (O_2)	Hydrogen gas (H_2)