

# Electrolysis [S]

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1. The electrolysis of a molten binary salt produces its constituent elements.
  - a. Define the term *electrolysis*: **[2]**
  
  
  
  
  
  
  
  
  
  
  - b. The electrolysis of molten iron(III) chloride produces elemental iron and chlorine.
    - i. Write a balanced equation, including state symbols, for the overall process: **[3]**
  
  
  
  
  
  
  
    - ii. Write the half-equation for the anode: **[3]**
  
  
  
  
  
  
  
    - iii. Write the half-equation for the cathode: **[3]**
  
  
  
  
  
  
  
  - c. Calculate the volume of chlorine gas that can be produced by the electrolysis of molten lead(II) chloride for 300 seconds at a current of 0.1A. The faraday constant is 96,000 coulombs per mole. **[4]**
  
  
  
  
  
  
  
  
  
  
2. The electrolysis of a dilute sulphuric acid solution was originally used to determine the chemical formula of water.
  - a. What ions are present in the solution due to the sulphuric acid? **[2]**
  
  
  
  
  
  
  
  
  
  
  - b. What ions are present in the solution due to the water? **[2]**

c. Write half-equations for the process occurring at each electrode: **[6]**

d. Determine the charge, in coulombs, required to produce 20cm<sup>3</sup> of oxygen gas: **[3]**

e. Suggest a reason for the inclusion of sulphuric acid in this experiment: **[1]**

3. The electrolysis of brine (saturated sodium chloride solution) is very important in industry.

a. Name the gases produced at the:

i. Anode: **[1]**

ii. Cathode: **[1]**

b. What is the purpose of the partially permeable membrane? **[2]**

c. Suggest why it is very important to have the anode made of a chemically inert substance: **[1]**

4. Fill in the following table with the *formulae* of the electrolysis products: **[15]**

KBr(l)		Na <sub>2</sub> SO <sub>4</sub> (aq)	
Pb(NO <sub>3</sub> ) <sub>2</sub> (aq)		MgI <sub>2</sub> (l)	
CaCl <sub>2</sub> (aq)		Zn(OH) <sub>2</sub> (aq)	

# Electrolysis [S]

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1. The electrolysis of a molten binary salt produces its constituent elements.

a. Define the term *electrolysis*: [2]

**breaking down a compound [1]**

**using electricity [1]**

b. The electrolysis of molten iron(III) chloride produces elemental iron and chlorine.

i. Write a balanced equation, including state symbols, for the overall process: [3]



ii. Write the half-equation for the anode: [3]



iii. Write the half-equation for the cathode: [3]



c. Calculate the volume of chlorine gas that can be produced by the electrolysis of molten lead(II) chloride for 300 seconds at a current of 0.1A. The faraday constant is 96,000 coulombs per mole. [4]

$$\text{charge passed} = 300 * 0.1 = 30 \text{ coulombs [1]}$$

$$\text{moles e}^- = 30/96000 = 3.125 \times 10^{-4} \text{ moles [1]}$$

$$\text{moles Cl}_2 = 3.125 \times 10^{-4} / 2 = 1.5625 \times 10^{-4} \text{ moles (2:1 ratio) [1]}$$

$$\text{vol Cl}_2 = 1.5625 \times 10^{-4} \times 24000 = 3.75\text{cm}^3 \text{ [1]}$$

2. The electrolysis of a dilute sulphuric acid solution was originally used to determine the chemical formula of water.

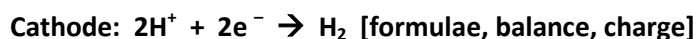
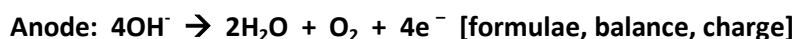
a. What ions are present in the solution due to the sulphuric acid? [2]

**H<sup>+</sup> [1] and SO<sub>4</sub><sup>2-</sup> [1] (allow HSO<sub>4</sub><sup>-</sup>)**

b. What ions are present in the solution due to the water? [2]

**H<sup>+</sup> [1] and OH<sup>-</sup> [1]**

c. Write half-equations for the process occurring at each electrode: [6]



d. Determine the charge, in coulombs, required to produce  $20\text{cm}^3$  of oxygen gas: [3]

**moles  $\text{O}_2 = 20/24000 = 8.333 \times 10^{-4}$  mol [1]**

**moles  $\text{e}^- = 4 * 8.333 \times 10^{-4} = 3.333 \times 10^{-3}$  mol [1]**

**charge =  $3.333 \times 10^{-3} * 96000 = 320$  coulombs [1]**

e. Suggest a reason for the inclusion of sulphuric acid in this experiment: [1]

**it facilitates the conducting of electricity [1]**

3. The electrolysis of brine (saturated sodium chloride solution) is very important in industry.

a. Name the gases produced at the:

i. Anode: [1]

**chlorine [1]**

ii. Cathode: [1]

**hydrogen [1]**

b. What is the purpose of the partially permeable membrane? [2]

**it prevents  $\text{Cl}_2$  at the anode from reacting with the  $\text{OH}^-$  ions [1]**

**the bleach/HOCl formed would contaminate the  $\text{NaOH(aq)}$  produced [1]**

c. Suggest why it is very important to have the anode made of a chemically inert

substance: [1]

**the chlorine produced there may react with it otherwise [1]**

4. Fill in the following table with the *formulae* of the electrolysis products: [15]

KBr(l)	<b>K [1] and <math>\text{Br}_2</math> [1]</b>	$\text{Na}_2\text{SO}_4(\text{aq})$	<b><math>\text{H}_2</math> [1] and <math>\text{H}_2\text{O}</math> [1] and <math>\text{O}_2</math> [1]</b>
$\text{Pb}(\text{NO}_3)_2(\text{aq})$	<b>Pb [1] and <math>\text{H}_2\text{O}</math> [1] and <math>\text{O}_2</math> [1]</b>	$\text{MgI}_2(\text{l})$	<b>Mg [1] and <math>\text{I}_2</math> [1]</b>
$\text{CaCl}_2(\text{aq})$	<b><math>\text{H}_2</math> [1] and <math>\text{Cl}_2</math> [1]</b>	$\text{Zn}(\text{OH})_2(\text{aq})$	<b>Zn [1] and <math>\text{H}_2\text{O}</math> [1] and <math>\text{O}_2</math> [1]</b>