

Electrochemistry

30 questions: 15 multiple choice, 15 structured.

1 Core Electrolysis [1]

Which statement is the correct definition of electrolysis?

- A The decomposition of an ionic compound, when molten or in aqueous solution, by the passage of an electric current
- B The breakdown of a compound using heat energy alone
- C The reaction of a metal with an acid to produce a salt and hydrogen
- D The process by which a metal ore is converted into the pure metal by heating with carbon

2 Core Electrolysis [1]

Molten zinc chloride is electrolysed using two graphite rods connected to a battery. What is the name given to the positive electrode?

- A cathode
- B anode
- C electrolyte
- D terminal

3 Core Electrolysis [1]

Molten lead(II) bromide is electrolysed using inert electrodes. Which pair correctly describes the two products and the electrode at which each forms?

- A lead at the anode, bromine at the cathode
- B hydrogen at the cathode, oxygen at the anode
- C lead at the cathode, bromine at the anode
- D lead at the cathode, oxygen at the anode

4**Core**

Electrolysis

[1]

In the electrolysis of any molten ionic compound, which statement is always true?

- A A non-metal element is always produced at the cathode
 - B Two different metals are produced, one at each electrode
 - C A metal, or hydrogen, is produced at the cathode, and a non-metal other than hydrogen is produced at the anode
 - D A metal is produced at the anode and a non-metal at the cathode
-

5**Core**

Electrolysis

[1]

Dilute sulfuric acid is electrolysed using platinum electrodes. What are the products at the cathode and at the anode respectively?

- A hydrogen; oxygen
- B oxygen; hydrogen
- C sulfur; oxygen
- D hydrogen; sulfur dioxide

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Molten lead(II) bromide is electrolysed in a school laboratory using two graphite electrodes connected to a power supply.

- (a) State which electrode – the anode or the cathode – is the negative electrode, and name the product that forms there. [2]

- (b) State the product that forms at the anode. [1]

- (c) Describe two observations that would confirm the identity of the product at the anode. [2]

- (d) State the name of the molten substance that is decomposed in this experiment. [1]

7**Core**

Electrolysis

[4]

Molten lithium chloride is held in a crucible and electrolysed using two carbon electrodes connected to a d.c. power supply.

- (a) Define the term *electrolysis*. [2]

- (b) State the name given to:

- (i) the electrode connected to the negative terminal of the power supply [1]

- (ii) the molten lithium chloride [1]

8**Core**

Electrolysis

[1]

Stainless steel cutlery is often electroplated with a thin layer of chromium. What are the main reasons for doing this?

- A to improve its appearance and increase its resistance to corrosion
- B to make the cutlery lighter and cheaper to produce
- C to increase its melting point so it can be sterilised at higher temperatures
- D to make the cutlery magnetic

9**Core**

Electrolysis

[5]

A steel spoon is to be electroplated with silver.

- (a) State two reasons why the spoon is electroplated with silver.

[2]

- (b) Describe how the spoon could be electroplated with silver. Your answer should name which electrode the spoon should be, what the other electrode should be made of, and a suitable electrolyte.

[3]

10**Core**

Electrolysis

[1]

Molten calcium bromide is electrolysed using inert electrodes. What are the products formed at the cathode and at the anode respectively?

- A bromine; calcium
- B calcium; oxygen
- C calcium; bromine
- D hydrogen; bromine

Aqueous copper(II) sulfate is electrolysed using two inert carbon electrodes. What is observed at the cathode?

- A a colourless gas is released
- B a pink/brown solid metal is deposited
- C a green solid metal is deposited
- D an orange-brown gas is released

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Aqueous copper(II) sulfate is electrolysed twice: once using two inert carbon electrodes, and once, separately, using two copper electrodes.

- (a) State the product formed at the cathode. This is the same in both experiments. [1]

- (b) With carbon electrodes, state the product formed at the anode. [1]

- (c) With copper electrodes, describe what happens at the anode instead. [2]

- (d) Explain why, when copper electrodes are used, the blue colour of the copper(II) sulfate solution stays roughly constant, but with carbon electrodes it gradually fades. [3]

Molten sodium chloride is electrolysed using inert electrodes connected to a battery. In the external circuit (the wires connecting the battery to the electrodes), in which direction do electrons flow?

- A from the cathode to the anode, through the wires
- B electrons do not flow in the external circuit; only ions move
- C from the cathode to the anode, through the electrolyte
- D from the anode to the cathode, through the wires

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14**Supplement**

Electrolysis

[6]

Molten magnesium chloride is electrolysed using inert graphite electrodes connected to a battery.

(a) Write the ionic half-equation for the reaction at the cathode.

[2]

(b) Write the ionic half-equation for the reaction at the anode.

[2]

(c) Describe how charge is carried:

(i) through the electrolyte

[1]

(ii) through the external circuit

[1]

Concentrated aqueous potassium bromide is electrolysed using inert electrodes. What is formed at the anode?

- A oxygen
- B hydrogen
- C bromine
- D potassium

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Two separate electrolysis experiments are carried out using inert electrodes: Experiment 1 uses a dilute aqueous solution of sodium iodide; Experiment 2 uses a concentrated aqueous solution of sodium iodide.

- (a) State the product formed at the cathode in both experiments, and explain why sodium metal is not formed there. [2]

- (b) State the product formed at the anode in Experiment 1 (dilute solution). [1]

- (c) State the product formed at the anode in Experiment 2 (concentrated solution). [1]

- (d) Explain, in terms of the ions present, why the anode product is different between the two experiments. [3]

Molten potassium chloride is electrolysed using inert electrodes. Which half-equation correctly represents the reaction at the anode?

- A $\text{K}^+ + \text{e}^- \rightarrow \text{K}$
- B $\text{Cl}_2 + 2\text{e}^- \rightarrow 2\text{Cl}^-$
- C $2\text{Cl}^- + 2\text{e}^- \rightarrow \text{Cl}_2$
- D $2\text{Cl}^- \rightarrow \text{Cl}_2 + 2\text{e}^-$

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18**Supplement**

Electrolysis

[6]

- (a) Molten lithium bromide is electrolysed using inert electrodes. Write balanced ionic half-equations for the reactions at:

- (i) the cathode [1]

- (ii) the anode [1]

- (b) Dilute sulfuric acid is electrolysed using inert electrodes. Write balanced ionic half-equations, including state symbols, for the reactions at:

- (i) the cathode [2]

- (ii) the anode [2]

19 **Core** Hydrogen–oxygen fuel cells

[1]

What is the only chemical product formed when a hydrogen–oxygen fuel cell operates?

- A water
 - B carbon dioxide
 - C water and carbon dioxide
 - D hydrogen peroxide
-

20 **Core** Hydrogen–oxygen fuel cells

[1]

Which two substances react together inside a hydrogen–oxygen fuel cell to generate electricity?

- A hydrogen and nitrogen
 - B hydrogen and oxygen
 - C methane and oxygen
 - D hydrogen and carbon dioxide
-

21 **Core** Electrolysis

[1]

Concentrated aqueous sodium chloride is electrolysed using inert carbon electrodes. What gas is produced at the anode?

- A oxygen
 - B chlorine
 - C hydrogen
 - D sodium vapour
-

22 **Core** Electrolysis

[1]

Molten strontium chloride is electrolysed using inert electrodes. What products form at the cathode and at the anode respectively?

- A chlorine; strontium
- B strontium; oxygen
- C hydrogen; chlorine
- D strontium; chlorine

23**Core**

Electrolysis

[5]

Dilute sulfuric acid is electrolysed in the laboratory using platinum electrodes.

- (a) Name the gas produced at the cathode and describe a test that would confirm its identity, including the result. [2]

- (b) Name the gas produced at the anode and describe a test that would confirm its identity, including the result. [2]

- (c) State the electrolyte used in this experiment. [1]

A car bumper made of steel is electroplated with a thin layer of chromium before sale.

- (a) State two reasons why the bumper is electroplated with chromium rather than left as bare steel.

[2]

- (b) Describe how the bumper could be electroplated with chromium. Your answer should name which electrode the bumper should be, a suitable material for the other electrode, and a suitable electrolyte.

[3]

Impure copper is purified using electrolysis. A block of impure copper is used as the anode and a thin strip of pure copper as the cathode. Both are dipped into aqueous copper(II) sulfate.

- (a) Write the ionic half-equation for the reaction at the cathode. [2]

- (b) Write the ionic half-equation for the reaction at the anode. [2]

- (c) Explain what happens to the mass of the anode and the mass of the cathode as electrolysis proceeds. [2]

- (d) Explain why the concentration of the copper(II) sulfate solution stays approximately constant during this process. [2]

In industry, concentrated aqueous sodium chloride (brine) is electrolysed continuously using inert electrodes. This is called the chlor-alkali process.

- (a) State the products formed at the cathode and at the anode. [2]

- (b) Write the ionic half-equation for the reaction at the anode. [2]

- (c) Name the solution that remains after electrolysis, and state one industrial use of it. [2]

- (d) Explain, in terms of the ions present, why chlorine rather than oxygen is formed at the anode, even though oxygen is normally the preferred product at a carbon anode in dilute aqueous solution. [2]

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Supplement

Electrolysis

[5]

Dilute sulfuric acid is electrolysed using inert platinum electrodes connected to a battery.

- (a) Describe how charge is carried through the dilute sulfuric acid (the electrolyte). [2]

- (b) Describe how charge is carried through the wires of the external circuit. [1]

- (c) State what happens to hydrogen ions when they reach the cathode. [2]

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Core

Hydrogen–oxygen fuel cells

[4]

A hydrogen–oxygen fuel cell is used to power the electric motor of an experimental car.

(a) State the two gases that are supplied to the fuel cell.

[1]

(b) State the only chemical product of the fuel cell reaction, and explain why the car's exhaust does not release carbon dioxide, unlike a petrol-engine car.

[3]

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Supplement

Hydrogen–oxygen fuel cells

[6]

- (a) State two advantages of using a hydrogen–oxygen fuel cell, rather than a petrol engine, to power a vehicle. [2]

- (b) State two disadvantages of using a hydrogen–oxygen fuel cell, rather than a petrol engine, to power a vehicle. [2]

- (c) Suggest one reason why hydrogen fuel cell vehicles are not yet as widely used as petrol-engine vehicles. [2]

A car manufacturer advertises its hydrogen fuel cell car as "100% pollution-free, with zero emissions."

- (a) Explain why this claim is accurate in terms of what comes out of the car's exhaust while it is being driven. [2]

- (b) Evaluate whether the claim that the car is "100% pollution-free" is a fair description of its overall environmental impact, considering how the hydrogen fuel might be produced. [4]
