TABLE 4A: STANDARD REDUCTION POTENTIALS
TABEL 4A: STANDAARD-REDUKSIEPOTENSIALE

Half-reactions/*Halfreaksies*			E^{θ} (V)
$F_2(g) + 2e^-$	$\rightleftharpoons$	$2F^-$	+ 2,87
$Co^{3+} + e^-$	$\rightleftharpoons$	Co^{2+}	+ 1,81
$H_2O_2 + 2H^+ + 2e^-$	$\rightleftharpoons$	$2H_2O$	+1,77
$MnO_4^- + 8H^+ + 5e^-$	$\rightleftharpoons$	$Mn^{2+} + 4H_2O$	+ 1,51
$C\ell_2(g) + 2e^-$	$\rightleftharpoons$	$2C\ell^-$	+ 1,36
$Cr_2O_7^{2-} + 14H^+ + 6e^-$	$\rightleftharpoons$	$2Cr^{3+} + 7H_2O$	+ 1,33
$O_2(g) + 4H^+ + 4e^-$	$\rightleftharpoons$	$2H_2O$	+ 1,23
$MnO_2 + 4H^+ + 2e^-$	$\rightleftharpoons$	$Mn^{2+} + 2H_2O$	+ 1,23
$Pt^{2+} + 2e^-$	$\rightleftharpoons$	Pt	+ 1,20
$Br_2(\ell) + 2e^-$	$\rightleftharpoons$	$2Br^-$	+ 1,07
$NO_3^- + 4H^+ + 3e^-$	$\rightleftharpoons$	$NO(g) + 2H_2O$	+ 0,96
$Hg^{2+} + 2e^-$	$\rightleftharpoons$	$Hg(\ell)$	+ 0,85
$Ag^+ + e^-$	$\rightleftharpoons$	Ag	+ 0,80
$NO_3^- + 2H^+ + e^-$	$\rightleftharpoons$	$NO_2(g) + H_2O$	+ 0,80
$Fe^{3+} + e^-$	$\rightleftharpoons$	Fe^{2+}	+ 0,77
$O_2(g) + 2H^+ + 2e^-$	$\rightleftharpoons$	H_2O_2	+ 0,68
$I_2 + 2e^-$	$\rightleftharpoons$	$2I^-$	+ 0,54
$Cu^+ + e^-$	$\rightleftharpoons$	Cu	+ 0,52
$SO_2 + 4H^+ + 4e^-$	$\rightleftharpoons$	$S + 2H_2O$	+ 0,45
$2H_2O + O_2 + 4e^-$	$\rightleftharpoons$	$4OH^-$	+ 0,40
$Cu^{2+} + 2e^-$	$\rightleftharpoons$	Cu	+ 0,34
$SO_4^{2-} + 4H^+ + 2e^-$	$\rightleftharpoons$	$SO_2(g) + 2H_2O$	+ 0,17
$Cu^{2+} + e^-$	$\rightleftharpoons$	Cu^+	+ 0,16
$Sn^{4+} + 2e^-$	$\rightleftharpoons$	Sn^{2+}	+ 0,15
$S + 2H^+ + 2e^-$	$\rightleftharpoons$	$H_2S(g)$	+ 0,14
$2H^+ + 2e^-$	**$\rightleftharpoons$**	**$H_2(g)$**	**0,00**
$Fe^{3+} + 3e^-$	$\rightleftharpoons$	Fe	– 0,06
$Pb^{2+} + 2e^-$	$\rightleftharpoons$	Pb	– 0,13
$Sn^{2+} + 2e^-$	$\rightleftharpoons$	Sn	– 0,14
$Ni^{2+} + 2e^-$	$\rightleftharpoons$	Ni	– 0,27
$Co^{2+} + 2e^-$	$\rightleftharpoons$	Co	– 0,28
$Cd^{2+} + 2e^-$	$\rightleftharpoons$	Cd	– 0,40
$Cr^{3+} + e^-$	$\rightleftharpoons$	Cr^{2+}	– 0,41
$Fe^{2+} + 2e^-$	$\rightleftharpoons$	Fe	– 0,44
$Cr^{3+} + 3e^-$	$\rightleftharpoons$	Cr	– 0,74
$Zn^{2+} + 2e^-$	$\rightleftharpoons$	Zn	– 0,76
$2H_2O + 2e^-$	$\rightleftharpoons$	$H_2(g) + 2OH^-$	– 0,83
$Cr^{2+} + 2e^-$	$\rightleftharpoons$	Cr	– 0,91
$Mn^{2+} + 2e^-$	$\rightleftharpoons$	Mn	– 1,18
$A\ell^{3+} + 3e^-$	$\rightleftharpoons$	$A\ell$	– 1,66
$Mg^{2+} + 2e^-$	$\rightleftharpoons$	Mg	– 2,36
$Na^+ + e^-$	$\rightleftharpoons$	Na	– 2,71
$Ca^{2+} + 2e^-$	$\rightleftharpoons$	Ca	– 2,87
$Sr^{2+} + 2e^-$	$\rightleftharpoons$	Sr	– 2,89
$Ba^{2+} + 2e^-$	$\rightleftharpoons$	Ba	– 2,90
$Cs^+ + e^-$	$\rightleftharpoons$	Cs	- 2,92
$K^+ + e^-$	$\rightleftharpoons$	K	– 2,93
$Li^+ + e^-$	$\rightleftharpoons$	Li	– 3,05

Increasing strength of oxidising agents/*Toenemende sterkte van oksideermiddels*

Increasing strength of reducing agents/*Toenemende sterkte van reduseermiddels*

TABLE 4B: STANDARD REDUCTION POTENTIALS
TABEL 4B: STANDAARD-REDUKSIEPOTENSIALE

Increasing strength of oxidising agents/*Toenemende sterkte van oksideermiddels* ↓

Increasing strength of reducing agents/*Toenemende sterkte van reduseermiddels* ↑

Half-reactions/*Halfreaksies*			E^{θ} (V)
$Li^+ + e^-$	$\rightleftharpoons$	Li	− 3,05
$K^+ + e^-$	$\rightleftharpoons$	K	− 2,93
$Cs^+ + e^-$	$\rightleftharpoons$	Cs	− 2,92
$Ba^{2+} + 2e^-$	$\rightleftharpoons$	Ba	− 2,90
$Sr^{2+} + 2e^-$	$\rightleftharpoons$	Sr	− 2,89
$Ca^{2+} + 2e^-$	$\rightleftharpoons$	Ca	− 2,87
$Na^+ + e^-$	$\rightleftharpoons$	Na	− 2,71
$Mg^{2+} + 2e^-$	$\rightleftharpoons$	Mg	− 2,36
$A\ell^{3+} + 3e^-$	$\rightleftharpoons$	$A\ell$	− 1,66
$Mn^{2+} + 2e^-$	$\rightleftharpoons$	Mn	− 1,18
$Cr^{2+} + 2e^-$	$\rightleftharpoons$	Cr	− 0,91
$2H_2O + 2e^-$	$\rightleftharpoons$	$H_2(g) + 2OH^-$	− 0,83
$Zn^{2+} + 2e^-$	$\rightleftharpoons$	Zn	− 0,76
$Cr^{3+} + 3e^-$	$\rightleftharpoons$	Cr	− 0,74
$Fe^{2+} + 2e^-$	$\rightleftharpoons$	Fe	− 0,44
$Cr^{3+} + e^-$	$\rightleftharpoons$	Cr^{2+}	− 0,41
$Cd^{2+} + 2e^-$	$\rightleftharpoons$	Cd	− 0,40
$Co^{2+} + 2e^-$	$\rightleftharpoons$	Co	− 0,28
$Ni^{2+} + 2e^-$	$\rightleftharpoons$	Ni	− 0,27
$Sn^{2+} + 2e^-$	$\rightleftharpoons$	Sn	− 0,14
$Pb^{2+} + 2e^-$	$\rightleftharpoons$	Pb	− 0,13
$Fe^{3+} + 3e^-$	$\rightleftharpoons$	Fe	− 0,06
$2H^+ + 2e^-$	**$\rightleftharpoons$**	**$H_2(g)$**	**0,00**
$S + 2H^+ + 2e^-$	$\rightleftharpoons$	$H_2S(g)$	+ 0,14
$Sn^{4+} + 2e^-$	$\rightleftharpoons$	Sn^{2+}	+ 0,15
$Cu^{2+} + e^-$	$\rightleftharpoons$	Cu^+	+ 0,16
$SO_4^{2-} + 4H^+ + 2e^-$	$\rightleftharpoons$	$SO_2(g) + 2H_2O$	+ 0,17
$Cu^{2+} + 2e^-$	$\rightleftharpoons$	Cu	+ 0,34
$2H_2O + O_2 + 4e^-$	$\rightleftharpoons$	$4OH^-$	+ 0,40
$SO_2 + 4H^+ + 4e^-$	$\rightleftharpoons$	$S + 2H_2O$	+ 0,45
$Cu^+ + e^-$	$\rightleftharpoons$	Cu	+ 0,52
$I_2 + 2e^-$	$\rightleftharpoons$	$2I^-$	+ 0,54
$O_2(g) + 2H^+ + 2e^-$	$\rightleftharpoons$	H_2O_2	+ 0,68
$Fe^{3+} + e^-$	$\rightleftharpoons$	Fe^{2+}	+ 0,77
$NO_3^- + 2H^+ + e^-$	$\rightleftharpoons$	$NO_2(g) + H_2O$	+ 0,80
$Ag^+ + e^-$	$\rightleftharpoons$	Ag	+ 0,80
$Hg^{2+} + 2e^-$	$\rightleftharpoons$	$Hg(\ell)$	+ 0,85
$NO_3^- + 4H^+ + 3e^-$	$\rightleftharpoons$	$NO(g) + 2H_2O$	+ 0,96
$Br_2(\ell) + 2e^-$	$\rightleftharpoons$	$2Br^-$	+ 1,07
$Pt^{2+} + 2e^-$	$\rightleftharpoons$	Pt	+ 1,20
$MnO_2 + 4H^+ + 2e^-$	$\rightleftharpoons$	$Mn^{2+} + 2H_2O$	+ 1,23
$O_2(g) + 4H^+ + 4e^-$	$\rightleftharpoons$	$2H_2O$	+ 1,23
$Cr_2O_7^{2-} + 14H^+ + 6e^-$	$\rightleftharpoons$	$2Cr^{3+} + 7H_2O$	+ 1,33
$C\ell_2(g) + 2e^-$	$\rightleftharpoons$	$2C\ell^-$	+ 1,36
$MnO_4^- + 8H^+ + 5e^-$	$\rightleftharpoons$	$Mn^{2+} + 4H_2O$	+ 1,51
$H_2O_2 + 2H^+ + 2e^-$	$\rightleftharpoons$	$2H_2O$	+1,77
$Co^{3+} + e^-$	$\rightleftharpoons$	Co^{2+}	+ 1,81
$F_2(g) + 2e^-$	$\rightleftharpoons$	$2F^-$	+ 2,87

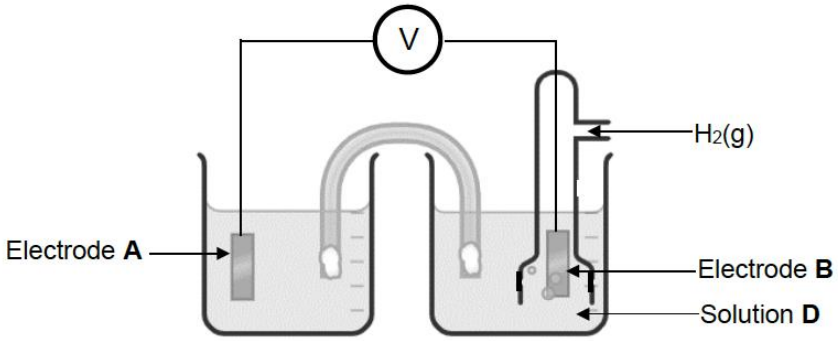
GALVANIC CELLS

DBEMAY/ JUNE 2025

QUESTION 8 (Start on a new page.)

The simplified diagram below shows a cell that can be used to measure the standard electrode potential of the half-reaction represented by the equation below.

$$Fe^{3+}(aq) + e^- \rightleftharpoons Fe^{2+}(aq)$$



8.1 For solution **D**, write down the NAME or FORMULA of the ions needed. (1)

8.2 Write down the initial reading on the voltmeter. (1)

8.3 Which electrode, **A** or **B**, is the cathode? (1)

8.4 Explain the answer to QUESTION 8.3 in terms of the relative strengths of the reducing agents. (3)

8.5 Write down the:

8.5.1 NAME or FORMULA of the metal used as electrode **A** (1)

8.5.2 Half-reaction that occurs at electrode **B** (2)

8.5.3 Cell notation for this cell (3)

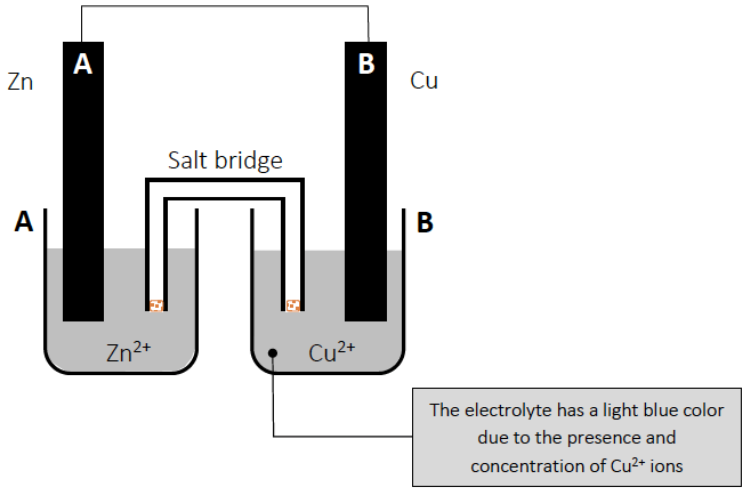
8.6 Give a reason why the voltmeter reading drops to zero after the cell has operated for some time. (1)

[13]

QUESTION 8 [GALVANIC CELLS]

8.1 Define the term: GALVANIC CELL (2)

Consider the following cell:



8.2 Write down the half-reaction at the:

8.2.1 Anode (2)

8.2.2 Cathode (2)

8.3 Write down the cell notation of this cell. (3)

8.4 The solution of the electrolyte at **B** is light blue in colour due to the concentration of the Cu^{2+} ions. Will the colour of the electrolyte change as the reaction proceeds? (3)

Write only YES or NO and give a reason for your answer.

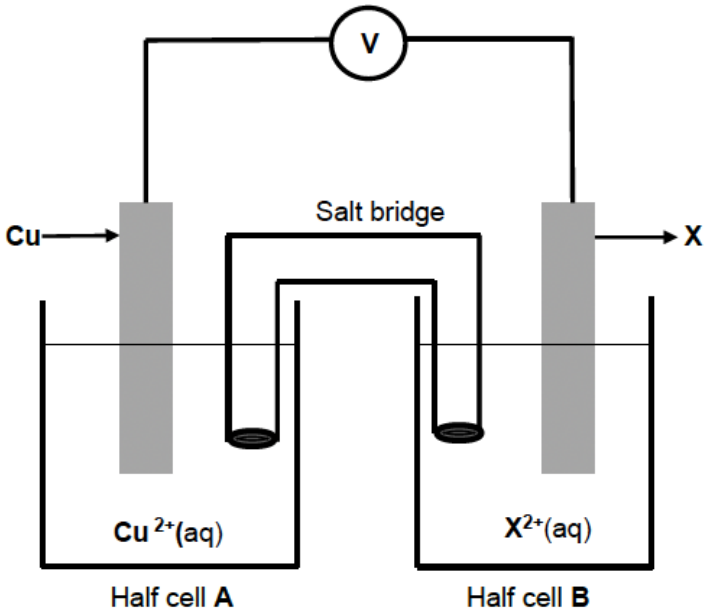
8.5 Calculate the initial emf of the cell. (3)

8.6 Over time, the value of the emf calculated in question 8.5 decreases because the rates of the two half-reactions are in equilibrium. We then say that the cell is "flat". (2)

In which beaker (**A** or **B**) must the ion concentration be increased to increase the emf of the cell again?

QUESTION 8 (Start on a new page.)

The galvanic cell is set up under standard conditions as shown below. Metal **X** CORRODES as the reaction proceeds.



8.1 Define the term *galvanic cell*. (2)

8.2 State ONE function of the salt bridge. (1)

8.3 Which electrode is the CATHODE? Write only **X** or **Cu**.

Give a reason for your answer. (2)

8.4 Write down the:

8.4.1 Half reaction that takes place in half cell **B** to obtain a voltmeter reading of 0,47 V. Show ALL your calculations (6)

8.4.2 Overall (net) balanced equation for the cell reaction. (3)

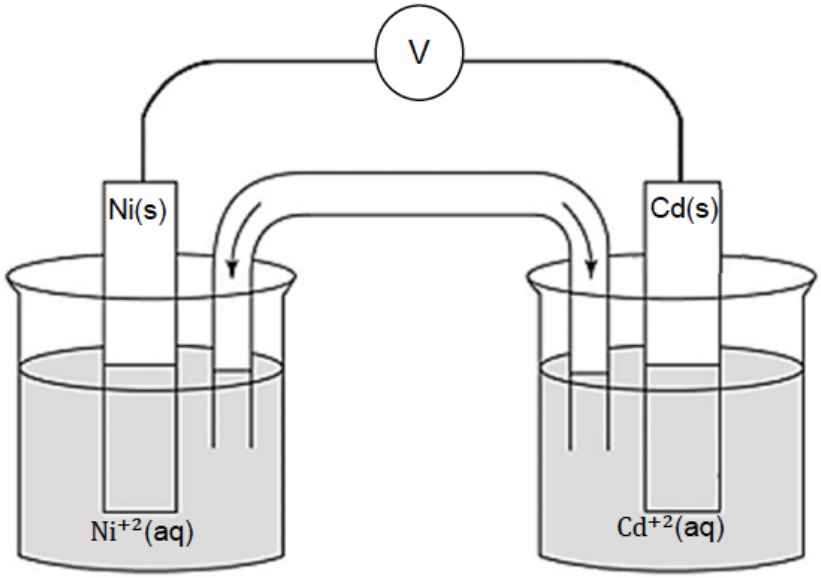
8.5 The voltmeter is replaced with an ammeter.

8.5.1 How does the mass lost by the anode compare to mass gained by the cathode? Choose from GREATER THAN, LESS THAN or EQUAL TO. (1)

8.5.2 Explain the answer to QUESTION 8.5.1. (2)
[17]

QUESTION 8 (Start on a new page.)

8.1 A galvanic cell is constructed as shown in the diagram below.



8.1.1 Which electrode is cathode? Write only NICKEL or CADMIUM. (1)

8.1.2 Write down the equation for the oxidation half-reaction of this cell. (2)

8.1.3 How will the reading on the voltmeter be affected if the concentration of the nickel ions is increased after the cell has reached equilibrium?

Choose from INCREASE, DECREASE or REMAIN THE SAME.

Give a reason for the answer. (2)

8.2 Consider the following standard electrochemical cell:

$$Cu(s)|Cu^{2+}(aq)(1mol \cdot dm^{-3}) \parallel Ag^{1+}(aq)(1mol \cdot dm^{-3})|Ag(s)$$

Initially each half cell contains 200 cm^3 electrolyte.

The cell is connected to a circuit and allowed to produce current until the concentration of the electrolyte in the cathode half-cell is reduced to 0,5 $mol \cdot dm^{-3}$.

The cell is then disconnected.

8.2.1 Write a balanced equation for the net ionic cell reaction. (3)

8.2.2 Calculate the concentration of the electrolyte in the anode half-cell when the cell is disconnected. (7)

[15]

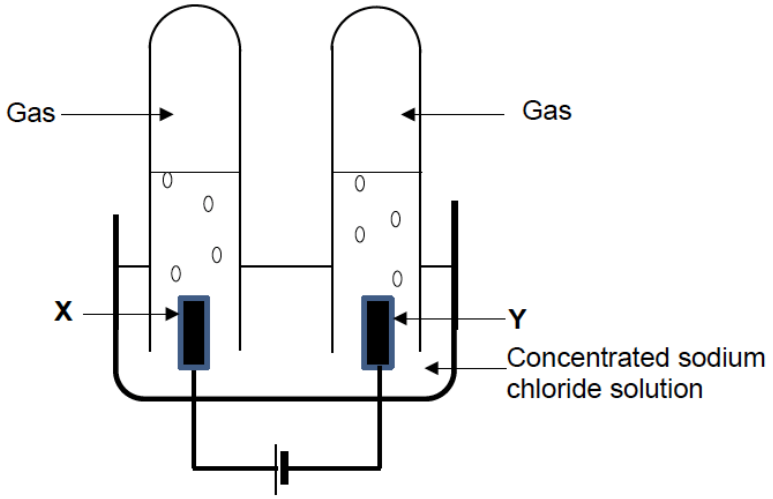
ELECTROLYTIC CELLS

DBE MAY/ JUNE 2025

QUESTION 9 (Start on a new page.)

The simplified diagram below represents an electrolytic cell used to demonstrate the electrolysis of a concentrated sodium chloride solution, NaCℓ(aq).

X and **Y** are carbon electrodes.



9.1 Define the term *electrolysis.* (2)

9.2 Write down the reduction half-reaction for this cell. (2)

9.3 What is the direction of the electron flow in the external circuit? Choose from **X** to **Y** or **Y** to **X**. (1)

9.4 Calculate the number of electrons transferred through the external circuit when 300 cm^3 gas is collected at electrode **X**.

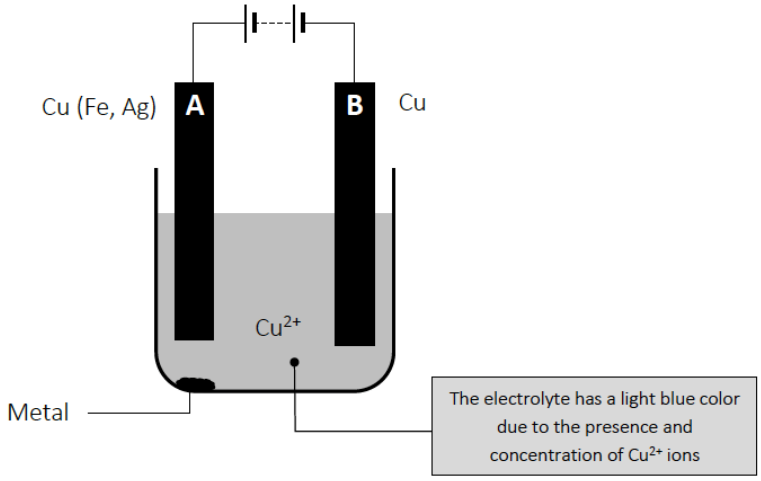
Take the molar gas volume as 24 $dm^3 \cdot mol^{-1}$. (4)
[9]

WEST COAST EDUCATION DISTRICT SEPTEMBER 2024

QUESTION 9 [ELECTOLYTIC CELLS]

9.1 Define the term: ELECTROLYSIS (2)

In the cell below, impure copper is purified at electrode **A** during electrolysis and deposited on electrode **B**. Electrode **A** also contains iron and silver.



9.2 Write down the half-reaction at the:

9.2.1 Anode (2)

9.2.2 Cathode (2)

9.3 Which metal (Fe or Ag) will:

9.3.1 Release ions along with Cu^{2+} ions into the electrolyte? (2)

9.3.2 Settling at the bottom of the beaker? (2)

9.4 Why will only pure copper deposit on electrode **B**, even if there are also another metal's ions, as mentioned in question 9.3.1, in the electrolyte? (2)

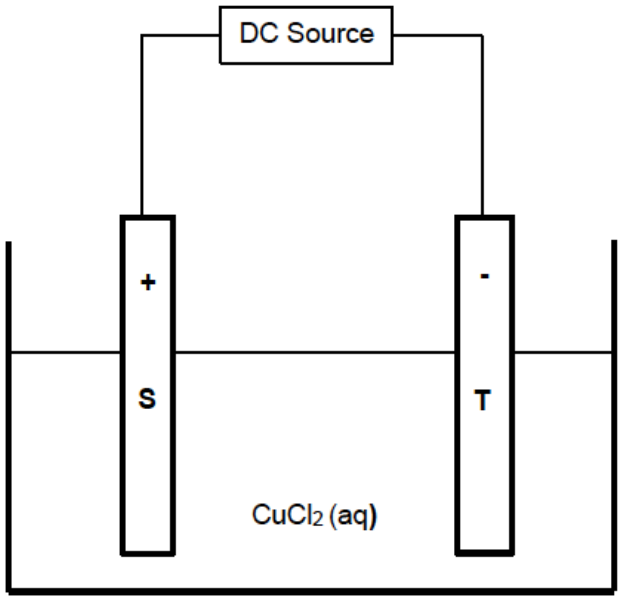
HINT: Refer to the strength of oxidizing agents in your answer.

9.5 Calculate the charge needed to deposit 100 mol of Cu on electrode **B**. (4)

NORTH WEST SEPTEMBER 2024

QUESTION 9 (Start on a new page.)

The diagram below represents the electrolytic cell, where the carbon rods are used as electrodes and a concentrated copper(II)chloride ($CuCl_2$) is used as an electrolyte.



9.1 Define the term *electrolysis.* (2)

9.2 In which direction will electrons flow in the external circuit? Choose from **S** to **T** or **T** to **S**. (1)

9.3 At which electrode is chlorine gas formed? Write only **S** or **T**. (1)

9.4 Write down the half reaction that supports your answer in QUESTION 9.3. (2)

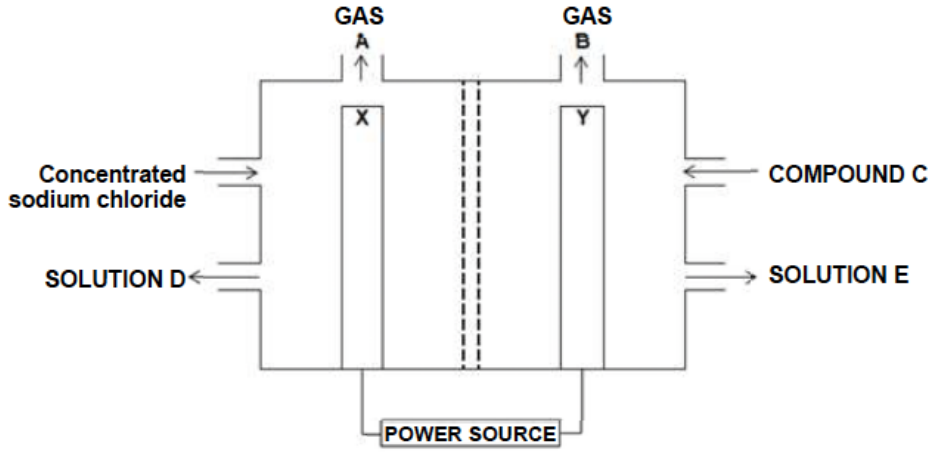
Electrode **S** and **T** are now replaced with copper electrodes.

9.5 Explain why chlorine gas is NOT formed as mentioned in QUESTION 9.3? (3)
[9]

GAUTENG SEPTEMBER 2024

QUESTION 9 (Start on a new page.)

Electrolysis is generally used in industry to produce chemicals through the decomposition of compounds.The simplified diagram below represents an electrolytic cell used in the electrolysis of a concentrated sodium chloride solution.



9.1 Define the term *anode* in terms of oxidation or reduction. (1)

9.2 Which electrode, **X** or **Y**, is connected to the positive terminal of the power source? Give a reason for the answer. (2)

9.3 Write down the NAME or CHEMICAL FORMULA of:

9.3.1 Gas **A** (1)

9.3.2 Compound **C** (1)

9.4 Write down the equation for the half-reaction that takes place at the cathode of the cell. (2)

9.5 Refer to the relative strength of the oxidising agents to explain the answer to QUESTION 9.4. (3)
[10]