



LIMPOPO

PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA

DEPARTMENT OF EDUCATION

VHEMBE WEST PRE-TRIAL
EXAMINATION

GRADE 12

PHYSICAL SCIENCES: CHEMISTRY (P2)

26 AUGUST 2022

MARKS: 150

TIME: 3 hours

This question paper consists of 16 pages and 1 page data sheet.

Other DATA sheets must be provided by the school.

INSTRUCTIONS AND INFORMATION

1. Write your NAME in the appropriate space on the ANSWER BOOK.
2. This question paper consists of TEN questions. Answer ALL the questions in the ANSWER BOOK.
3. Start EACH question on a NEW page in the ANSWER BOOK.
4. Number the answers correctly according to the numbering system used in this question paper.
5. Leave ONE line between two subquestions, e.g. between QUESTION 2.1 and QUESTION 2.2.
6. You may use a non-programmable calculator.
7. You may use appropriate mathematical instruments.
8. Show ALL formulae and substitutions in ALL calculations.
9. Round off your FINAL numerical answers to a minimum of TWO decimal places.
10. Give brief motivations, discussions, etc. where required.
11. You are advised to use the attached DATA SHEETS.
12. Write neatly and legibly.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Various options are provided as possible answers to the following questions. Each question has only ONE correct answer. Choose the answer and write only the letter (A–D) next to the question numbers (1.1-1.10) in the ANSWER BOOK, e.g. 1.11 E.

1.1 Which ONE of the following compounds has the HIGHEST vapour pressure?

- A Methane
- B Propane
- C Pentane
- D Heptane (2)

1.2 When $\text{CH}_3\text{CH}_2\text{CH}_3$ is converted to $\text{CH}_3\text{CH}=\text{CH}_2$, the type of reaction is ...

- A substitution.
- B addition.
- C elimination.
- D oxidation. (2)

1.3 An alkane burns completely in oxygen. Which ONE of the following represents the CORRECT ratio of the products of combustion, CO_2 : H_2O ?

- A $n: 2n - 1$
- B $n: 2n + 1$
- C $n: n + 1$
- D $n: n - 1$ (2)

- 1.4 If $y = \frac{\Delta n}{\Delta t}$ applies to chemical reactions, where Δn = change is the number of moles and Δt = time interval, then y probably represents the ...

A equilibrium constant.

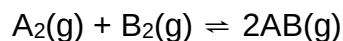
B yield of products.

C heat of reaction.

D rate of reaction.

(2)

- 1.5 Consider the following hypothetical reaction having reached equilibrium at a constant high temperature in a closed container:



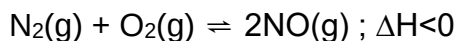
The pressure on the system is then INCREASED by decreasing the volume of the container. A new equilibrium is reached at the **same temperature**.

Which ONE of the following is CORRECT regarding the concentration of $\text{A}_2(\text{g})$ and the number of moles of $\text{AB}(\text{g})$?

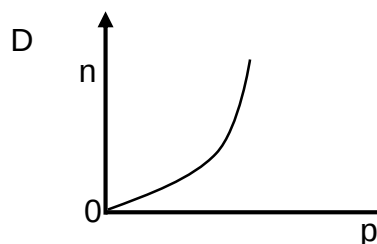
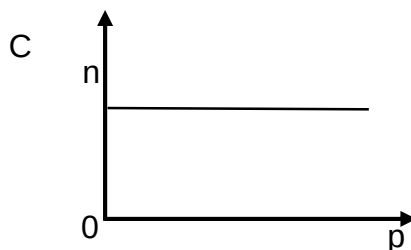
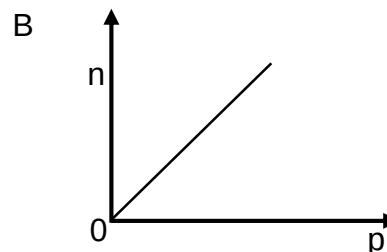
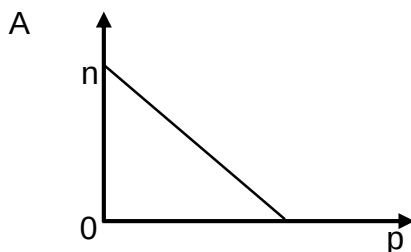
	CONCENTRATION OF $\text{A}(\text{g})$	NUMBER OF MOLES OF $\text{AB}(\text{g})$
A	Decreases	Increases
B	Increases	Stays constant
C	Decreases	Decreases
D	Stays constant	Stays constant

(2)

1.6 The following reaction reaches equilibrium in a closed vessel:



Which ONE of the graphs below CORRECTLY shows the relationship between the pressure (P) in the container and the amount (n) of NO(g) in the equilibrium mixture?



(2)

1.7 A H_2SO_4 solution of concentration $0,001 \text{ mol} \cdot \text{dm}^{-3}$ can BEST be described as a ...

- A concentrated solution of a strong acid.
- B dilute solution of a strong acid.
- C concentrated solution of a weak acid.
- D dilute solution of a weak acid.

(2)

1.8 Which ONE of the following solutions has the LOWEST pH?

- A 100 cm³ of a 0,2 mol·dm⁻³ H₂SO₄
- B 100 cm³ of a 0,2 mol·dm⁻³ CH₃COOH
- C 100 cm³ of a 0,2 mol·dm⁻³ HCl
- D 100 cm³ of a 0,2 mol·dm⁻³ (COOH)₂ (2)

1.9 Which ONE of the following will reduce Sn²⁺ to Sn?

- A Zn
- B Ag
- C Hg
- D Pb (2)

1.10 Which ONE of the following statements is CORRECT for an ELECTROLYTIC CELL?

- A The cell reaction is exothermic.
 - B The cell reaction is endothermic.
 - C The cell reaction is spontaneous.
 - D The heat of reaction is negative. (2)
- [20]**

QUESTION 2 (Start on a new page)

The letters **P** to **W** in the table below represent eight organic compounds.

P	$\begin{array}{c} \text{Br} \\ \\ \text{H}_3\text{C}-\text{CH}-\text{CH}_2-\text{CH}_2-\text{C}-\text{CH}_3 \\ \\ \text{CH}_3 \end{array}$	Q	$\text{H}_3\text{C}-\text{CH}=\text{CH}-\text{CH}_3$
R	But-1-ene	S	$\text{H}_3\text{C}-\text{CH}_2-\text{CH}_2-\text{CH}_2-\text{CHO}$
T	Pentan-3-one	U	4,4-dimethylhex-2-yne
V	Hexane	W	$\text{H}_3\text{C}-\text{CH}_2-\text{CH}_2-\text{CH}_2-\text{COOH}$

2.1 Write down the LETTER that represents a compound that:

- 2.1.1 Is an aldehyde (1)
- 2.1.2 Has the general formula $\text{C}_n\text{H}_{2n}\text{O}_2$ (1)
- 2.1.3 Is a FUNCTIONAL (GROUP) ISOMER of compound **T** (1)
- 2.1.4 Is a POSITIONAL ISOMER of compound **Q** (1)
- 2.1.5 Is a CHAIN ISOMER of 2,2-dimethylbutane (1)

2.2 Write down the:

- 2.2.1 SYSTEMATIC (IUPAC) name of compound **P** (3)
- 2.2.2 STRUCTURAL FORMULA of compound **U** (3)

2.3 For compound **S**, write down the:

- 2.3.1 *Homologous series* to which it belongs (1)
- 2.3.2 *Structural formula* of its functional group (1)
- 2.3.3 *Structural formula* of its chain isomer (2)

2.4 For compound **V**, write down:

2.4.1 The *general formula* for the homologous series to which it belongs (1)

2.4.2 A balanced equation, using MOLECULAR FORMULAE, for its complete combustion (3)
[19]

QUESTION 3 (Start on a new page)

Three compounds are used to investigate one of the factors that influences boiling points.

The results obtained are shown in the table below.

	COMPOUND	MOLECULAR MASS (g·mol ⁻¹)	BOILING POINT (°C)
X	Ethyl ethanoate	88	77
Y	Pentan-1-ol	88	137
Z	Butanoic acid	88	165

3.1 Define the term *boiling point* of a substance. (2)

3.2 Write down the DEPENDENT VARIABLE for this investigation. (1)

3.3 Is this a fair investigation? State only YES or NO.
Refer to the data in the table and give a reason for the answer. (2)

3.4 Write down the:

3.4.1 HOMOLOGOUS SERIES to which compound **X** belongs (1)

3.4.2 GENERAL FORMULA of the homologous series to which compound **Y** belongs (1)

3.4.3 NAME of the **functional group** of the homologous series to which compound **Z** belongs (1)

3.5 Refer to the intermolecular forces present in compounds **Y** and **Z**, and FULLY explain the difference in boiling points, as shown in the table. (4)
[12]

QUESTION 4 (Start on a new page)

The flow diagram below represents two pathways by which **1-bromobutane** can be converted into *alcohols*.



A, **B** and **C** are organic reactions.

4.1 State the *difference* between the KOH solution used in reaction **A** and the one used in reaction **B**. (2)

4.2 4.2.1 Write down the condensed STRUCTURAL FORMULA and IUPAC name of alcohol **X**. (3)

4.2.2 What TYPE of SUBSTITUTION reaction is this? (1)

4.3.1 Write down the *condensed structural formula* and IUPAC name of alkene **Y**. (4)

4.3.2 What TYPE of ELIMINATION reaction is this (reaction **B**)? (1)

4.4.1 What TYPE of ADDITION reaction is reaction **C**? (1)

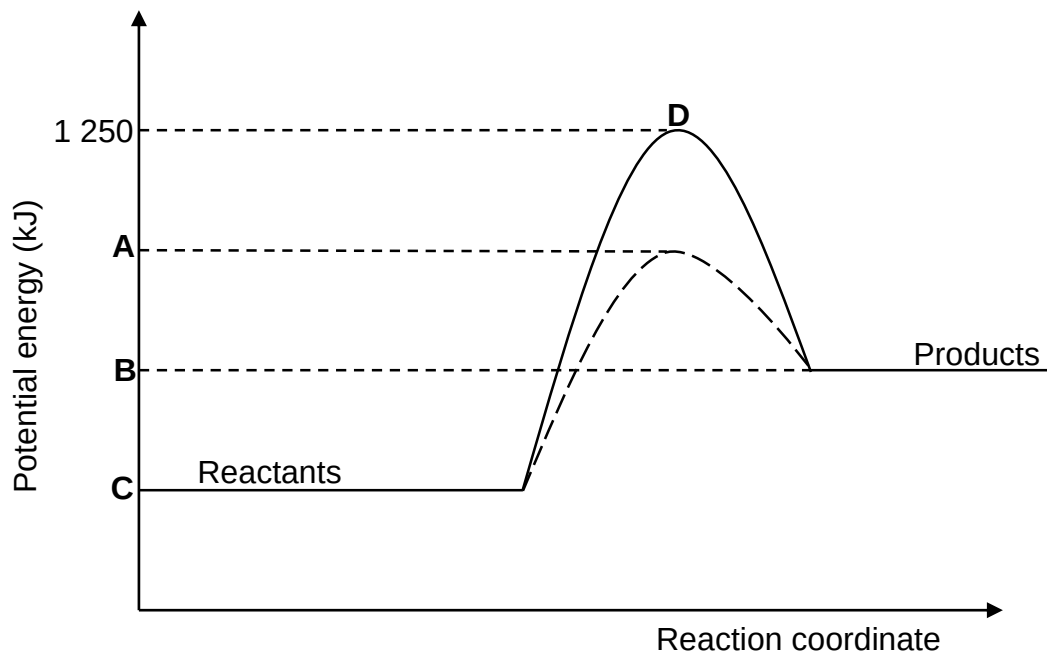
4.4.2 Write down the CHEMICAL FORMULA of the catalyst used in reaction **C**. (1)

4.4.3 Write down the IUPAC name of alcohol **Z**. (2)

4.5 Alcohol **Z** and alkene **Y** can **each** be converted into a bromobutane. Compare the conditions under which these 2 reactions will occur. (2)
[17]

QUESTION 5 (Start on a new page)

5.1 The graph below shows an energy level diagram for a chemical reaction.



5.1.1 Define the term *activation energy* in words. (2)

5.1.2 Is this reaction EXOTHERMIC or ENDOTHERMIC? (1)

5.1.3 Write down the NAME of the compound represented by **D** on the graph. (1)

The following information is given:

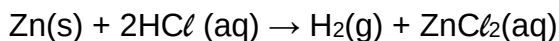
- The activation energy *without a catalyst* is **800 kJ**.
- The activation energy *with a catalyst* is **490 kJ**.
- The energy released in the formation of products in the uncatalysed reaction is **520 kJ**.

Calculate the value of EACH of the following:

5.1.4 **C**, as shown on the graph (2)

5.1.5 ΔH (2)

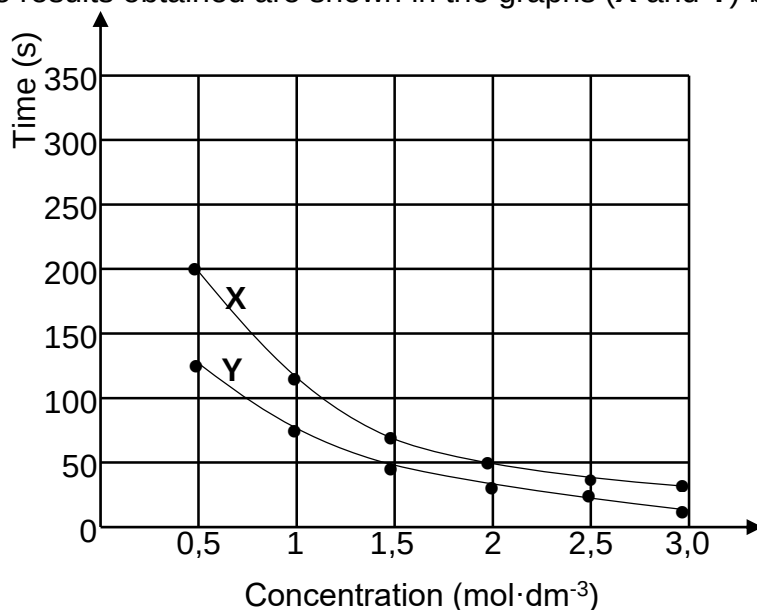
- 5.2 A grade 12 class carried out an experiment on the rate of reaction between zinc metal and EXCESS hydrochloric acid (HCl). The reaction which takes place is represented by the following equation:



Group **A** reacted zinc **granules** with $3 \text{ mol}\cdot\text{dm}^{-3}$ HCl and measured the time taken to collect 100 cm^3 of H_2 gas. They repeated the experiment a number of times but changed the concentration of the acid to $2,5 \text{ mol}\cdot\text{dm}^{-3}$; $2 \text{ mol}\cdot\text{dm}^{-3}$; $1,5 \text{ mol}\cdot\text{dm}^{-3}$; $1 \text{ mol}\cdot\text{dm}^{-3}$ and $0,5 \text{ mol}\cdot\text{dm}^{-3}$.

Group **B** performed the same experiment but used the same mass of **powdered** zinc. Excess HCl acid was used in all the experiments.

The results obtained are shown in the graphs (X and Y) below.

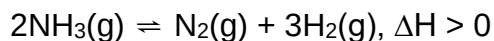


- 5.2.1 Write down, for this experiment, the **dependent variable**. (1)
- 5.2.2 Which graph (X or Y) was obtained from the results of group **A**? (1)
- 5.2.3 Use the collision theory to explain the answer in QUESTION 5.2.2 (3)
- 5.2.4 Calculate the mass of zinc needed to produce 100 cm^3 of H_2 (g) at 25°C . Assume the molar gas volume is $24,04 \text{ dm}^3$ at 25°C . (4)

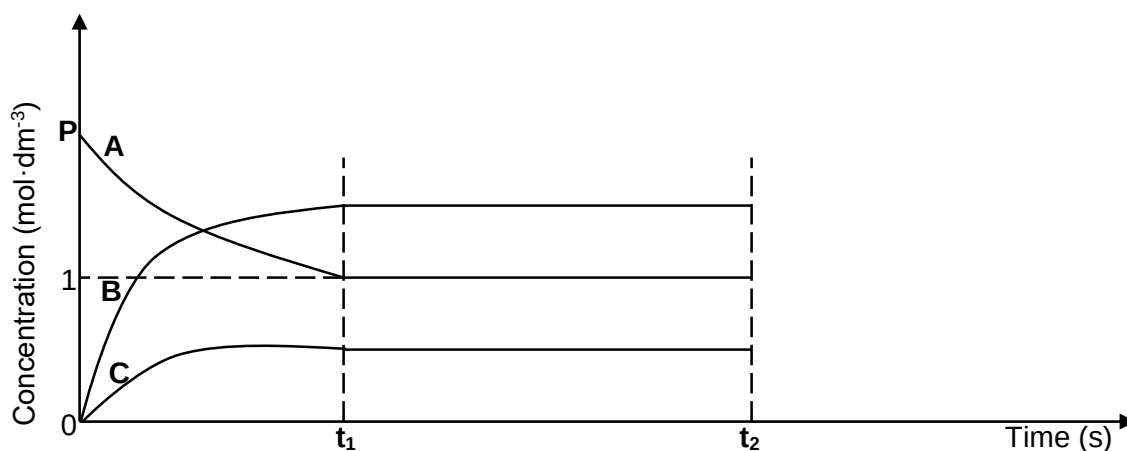
[17]

QUESTION 6 (Start on a new page)

5 moles of ammonia is pumped into a sealed 2 dm³ container at 500°C. The following reaction takes place:



The graph below shows the concentrations of H₂(g), N₂(g) and NH₃(g) versus time during the reaction.



- 6.1 Write down the value of **P**. (1)
- 6.2 Explain what is meant by a *closed system* as applied in chemistry. (2)
- 6.3 State the meaning of the “*double arrow*” in the equation. (1)
- 6.4 Ammonia has a characteristic odour (smell). As the reaction proceeds, what happens to the **strength of the odour** during the following time intervals? (State only INCREASES, DECREASES or STAYS THE SAME)
Explain the answer in EACH case.
- 6.4.1 **0 to t₁** (2)
- 6.4.2 **t₁ to t₂** (2)
- 6.5 Identify, by NAME, substance **B** shown on the graph. (1)

- 6.6 Fully explain why the concentrations of the substances remain constant from t_1 to t_2 . (3)
- 6.7 Calculate the equilibrium constant, K_c , at 500°C . (6)
- 6.8 Describe ONE method that can be used to increase the K_c value in QUESTION 6.7 above. (1)
- [19]

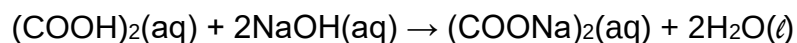
QUESTION 7 (Start on a new page)

As a class project, Grade 12 learners are asked to determine the amount of inert (unreactive) impurities in a contaminated sample of anhydrous oxalic acid ($\text{H}_2\text{C}_2\text{O}_4$).

- 7.1 Define the term *weak acid*. (2)
- 7.2 Is the K_a value of oxalic acid HIGHER or LOWER? (1)
- 7.3 Classify oxalic acid as a WEAK ACID or a STRONG ACID. (1)

One group of learners prepares a standard solution of sodium hydroxide (NaOH) by diluting 50 cm^3 of $1,63\text{ mol}\cdot\text{dm}^{-3}$ solution in a 1 dm^3 volumetric flask. They prepare a solution of the contaminated oxalic acid by dissolving $0,25\text{ g}$ of the oxalic acid in 75 cm^3 of water. The acid solution is then titrated against the sodium hydroxide solution. The titration requires 40 cm^3 of the sodium hydroxide solution to reach the endpoint.

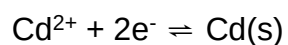
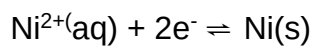
The neutralisation reaction that takes place is:



- 7.4 Is the salt $(\text{COONa})_2$ ACIDIC, NEUTRAL or BASIC/ALKALINE? (1)
- 7.5 Define the term *endpoint* of a titration. (2)
- 7.6 Calculate the **percentage purity** of the oxalic acid sample. (9)
- [16]

QUESTION 8 (Start on a new page)

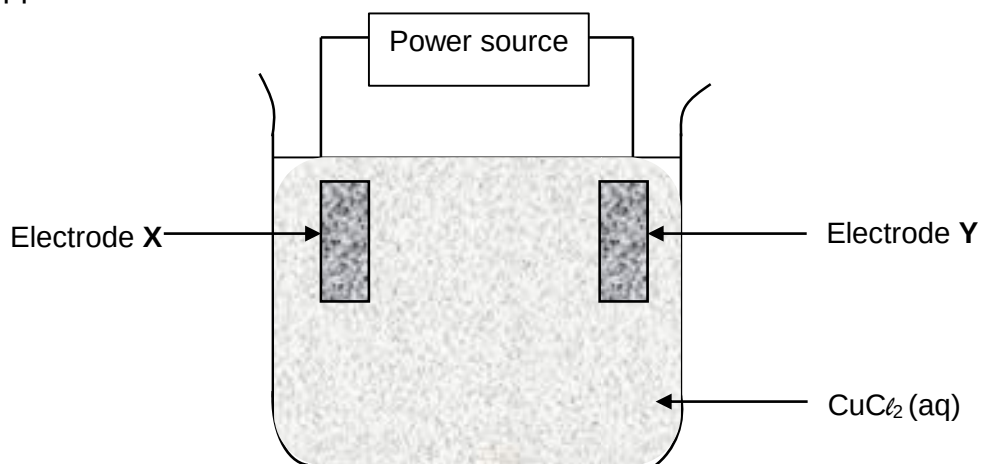
Consider a GALVANIC cell based on the following half-reactions:



- 8.1 Define the term *galvanic cell*. (2)
- 8.2 Use the equations for the half-reactions to write a balanced *net ionic equation* for the overall cell reaction. (3)
- 8.3 Construct the **cell notation** for this cell. (3)
- 8.4 State the polarity (NEGATIVE or POSITIVE) of the Cd electrode. (1)
- 8.5 Calculate the value of the emf of this cell under standard conditions. (4)
- [13]**

QUESTION 9 (Start on a new page)

The diagram below represents an electrochemical cell that is used for the refining of copper.



One of the electrodes consists of *pure copper* and the other of *impure copper*.

9.1 When the cell is allowed to operate, it is found that the mass of electrode **X** **increases** over time.

9.1.1 Define the term *electrolyte*. (2)

9.1.2 Is electrode **X** the CATHODE or ANODE of the cell? (1)

9.1.3 Write down a half-reaction to justify the answer to QUESTION 9.1.2 above. (2)

9.2 State whether electrode **Y** is connected to the POSITIVE terminal or the NEGATIVE terminal of the power source. (1)

9.3 The impure copper contains *zinc* and *silver*. State what will happen to the:

9.3.1 Silver that is in the impure copper (1)

9.3.2 Zinc that is in the impure copper (1)

9.4 Refer to the *relative strength of oxidising agents* to explain why zinc in the impure copper will not be deposited on the pure copper electrode. (2)

9.5 After the purification of the impure copper was completed, it was found that $3,75 \times 10^{-2}$ mol of copper was formed. Calculate the percentage of copper that was present in the impure sample if the initial mass of the impure copper was 4 g. (4)

Electrodes **X** and **Y** are now replaced with *graphite* (C) electrodes.

9.6 State what will be observed at electrode **Y** (now graphite). (1)

9.7 Describe what will happen to the blue colour of the electrolyte as the reaction proceeds/progresses. (2)

[17]

GRAND TOTAL: **[150]**

DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 2 (CHEMISTRY)

TABLE 1: PHYSICAL CONSTANTS

NAME	SYMBOL	VALUE
Standard pressure	P^θ	$1,013 \times 10^5 \text{ Pa}$
Molar gas volume at STP	V_m	$22,4 \text{ dm}^3 \cdot \text{mol}^{-1}$
Standard temperature	T^θ	273 K
Charge on electron	e	$-1,6 \times 10^{-19} \text{ C}$
Avogadro's constant	N_A	$6,02 \times 10^{23} \text{ mol}^{-1}$

TABLE 2: FORMULAE

$n = \frac{m}{M}$	$n = \frac{N}{N_A}$
$c = \frac{n}{V} \quad \text{OR} \quad c = \frac{m}{MV}$	$n = \frac{V}{V_m}$
$\frac{C_b V_b}{C_a V_a} = \frac{n_b}{n_a}$	$\text{pH} = -\log[\text{H}_3\text{O}^+]$
$K_w = [\text{H}_3\text{O}^+][\text{OH}^-] = 1 \times 10^{-14} \text{ at } 298 \text{ K}$	
$E_{\text{cell}}^\theta = E_{\text{cathode}}^\theta - E_{\text{anode}}^\theta$ Or $E_{\text{cell}}^\theta = E_{\text{reduction}}^\theta - E_{\text{oxidation}}^\theta$ Or $E_{\text{cell}}^\theta = E_{\text{oxidising agent}}^\theta - E_{\text{reducing agent}}^\theta$	