Western Cape
Government
FOR YOU

Eden & Central Karoo Education District
West Coast Education District

PHYSICAL SCIENCES

CHEMISTRY REVISION

8 November 2024

NOTHING IN LIFE IS TO BE FEARED, IT IS ONLY TO BE UNDERSTOOD.
NOW IS THE TIME TO UNDERSTAND MORE, SO THAT WE MAY FEAR LESS.

MARIE CURIE

STUDY TIPS :

1. Work with a study plan. Resting regularly is just as important as spending hours with your books!
2. Review one topic at a time. Do the questions in previous papers which are only about that specific topic alone. Make key notes that you can memorize. Know your laws & definitions.
3. You don't always have to start learning from chapter 1. Start with the last topic or the topic with which you still have challenges.
4. Leave one paper for a trial run. Write the paper on Sunday as if you were sitting in the exam room. You don't have to sit through it for three hours. See if you can answer the paper from start to finish. The idea is not that you have to mark the answers afterwards, but rather how you feel when you're done.
5. Read through the exam guidelines. This is the examiner's "demarcation". Check that you have reviewed everything that the examiner considers important.

EXAM TIPS FOR MONDAY

1. Arrive prepared at the exam room. Stationery, calculator, admission letter, ID.
2. Use the 10 minutes before 9:00 and READ through the question paper. You may not write anything yet, but you can read through a question and in the meantime identify the questions that are easy and the routine questions.
3. Decide in which order you will answer the question paper.
4. Question 1 is usually the question that throws off your time management. Leave the question until last. Write the numbers 1.1 to 1.10 for the time being and come back later when you are sure you have enough time and can work through the questions comfortably.
5. Do not leave blanks in question 1. If you don't know and you guess an answer you have at least a 25% chance.
6. Sit and work for the full three hours.

EXAM TIPS TO GET EXTRA MARKS

1. Know your laws & definitions WORD-FOR-WORD. The examiner sometimes doubts whether you know your work if you start to explain things in your own words.

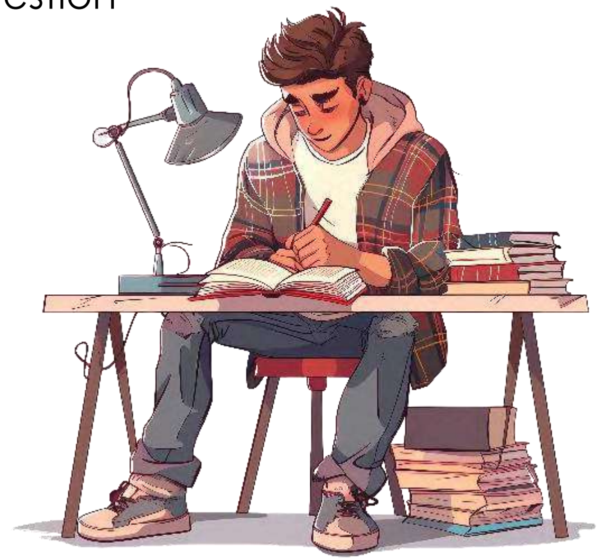
2. Write the formulas exactly as they appear on the formula sheet. Do not try to change the subject of the formula in your mind.

3. You will only get a mark for the formula if you have at least tried some form of substitution. Even if the substitution is completely wrong, you still get the formula mark!

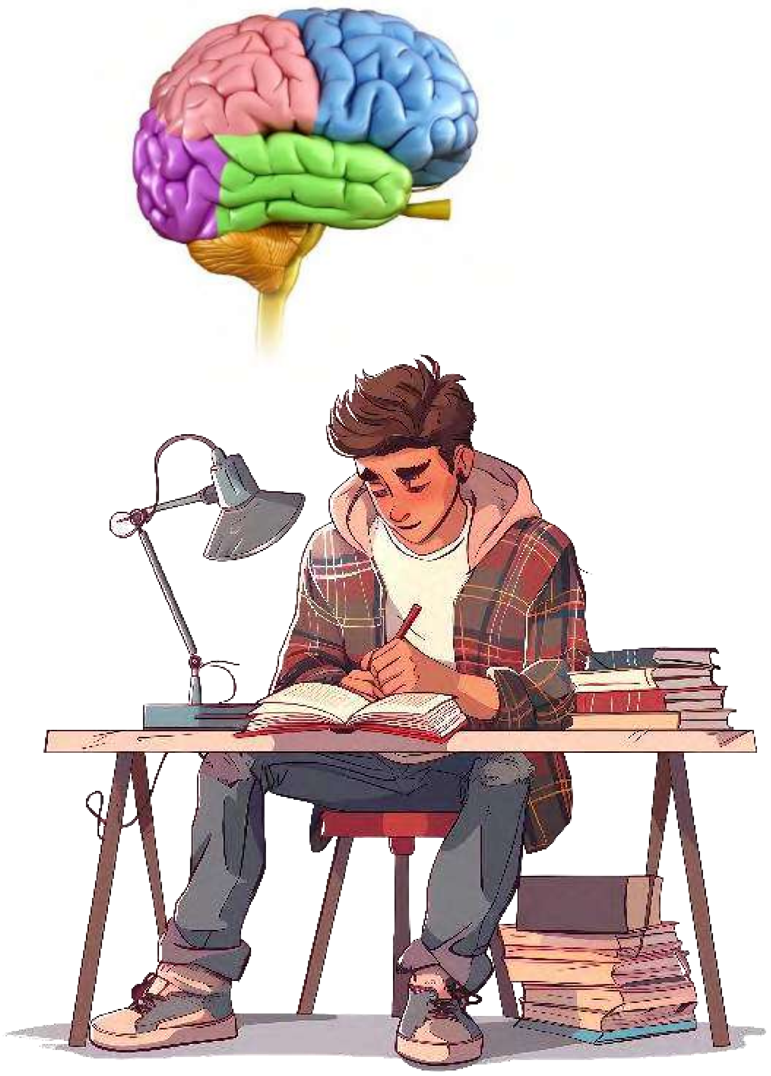
4. The examiner marks along with the error. If you are therefore not sure whether you have done a calculation correctly, do not just stop and leave the question open. Substitute your answer in the following sub question if that is what the question requires. The examiner will take a calculator and mark your answer along with your error.

5. Add all sketches, graphs, diagrams as neatly as possible with labels.

6. If you have to explain something, do it step by step and logically.
   Like what you learned to do in class.
   For example:
   ❶ Compare the boiling points of two compounds.
   ❷ Predict the reaction that is favored on the basis of Le Chatelier's principle.



4 COGNITIVE LEVELS IN PHYSICAL SCIENCES



1

* Laws
* Definitions
* Theory
* Captions
* Recognize
* Name

15%

2

* Simple routine Graphs
* Draw Free Body Diagrams
* Recognize data in a different format
* Simple SI Conversions
* Simple application of theory

40%

3

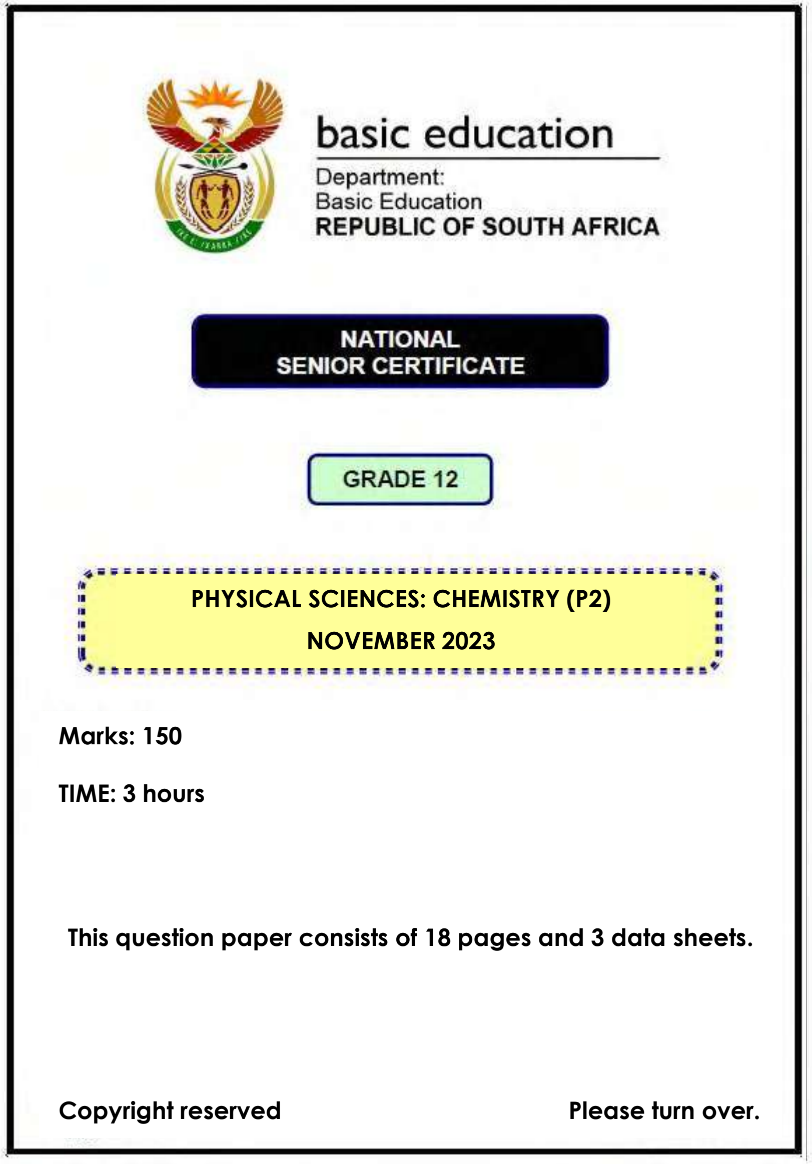
* Calculations
* Algebraic applications
* Draw Graphs (new situations & interpretations)
* Compare situations (Before & After)
* Interpret diagrams
* Quantitative chemistry & Stoichiometry

35%

4

10%

* Design steps and strategies to solve complex problems.
* Calculations (Two separate systems that have common factors)
* Appreciation for applying theory in new situation.



basic education
Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL
SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: CHEMISTRY (P2)
NOVEMBER 2023

Marks: 150

TIME: 3 hours

This question paper consists of 18 pages and 3 data sheets.

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Please turn over.

Question 1 – Multiple choice questions

Question 2 – Organic Molecules

Question 3 – Organic IMK

Question 4 – Organic Reactions

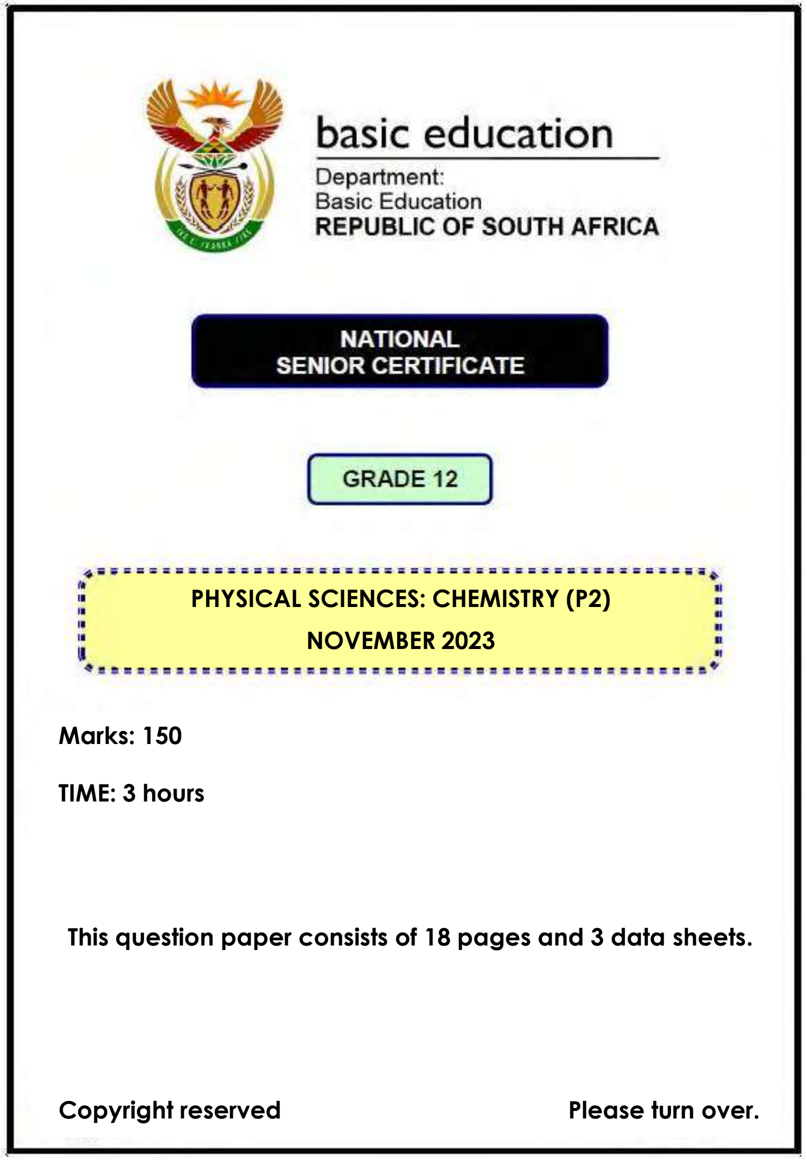
Question 5 – Reaction rate

Question 6 – Chemical Equilibrium

Question 7 – Acid-Base Reactions

Question 8 – Galvanic Cells

Question 9 – Electrolytic Cells



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INSTRUCTIONS AND INFORMATION

1. Write down your examination number and center number in the appropriate spaces on the ANSWER BOOK.
2. This paper consists of 10 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 paper.
5. Leave ONE line open between two sub-questions, e.g. between QUESTION 2.1 and QUESTION 2.2.
6. You may use a non-programmable calculator.
7. You may use appropriate mathematical tools.
8. Show ALL formulas and substitutions in ALL calculations.
9. Round your final numerical answers to a minimum of TWO decimal places.
10. Give short (concise) motivations, discussions, etc. where necessary.
11. You are advised to use the attached DETAIL SHEETS.
12. Write neatly and legibly.

ORGANIC MOLECULES

Make sure you know the correct wording of all definitions!

TYPES OF FORMULAS:
Molecular Formula
Structure Formula
Condensed Formula

FUNCTIONAL GROUPS:
Hydroxyl group
Carbonyl group
Carboxyl group

ISOMERS:
Structural Isomers
Positional Isomers
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IUPAC

SUBSTITUENTS	
x2	di-
x3	tri-
x4	tetra-

HYDROCARBONS	
ALKANES	C_nH_{2n+2}
ALKENES	C_nH_{2n}
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HALOGEN COMPOUNDS
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PREFIXES	
x1 C	Meth-
x2 C	Eth-
x3 C	Prop-
x4 C	But-
x5 C	Pent-
x6 C	Hex-
x7 C	Hept-
x8 C	Oct-

QUESTION 2

NSC 2023

The letters A to H in the table below represent eight organic compounds.

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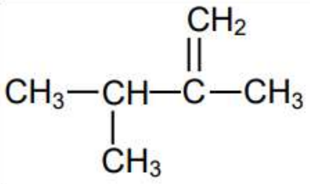
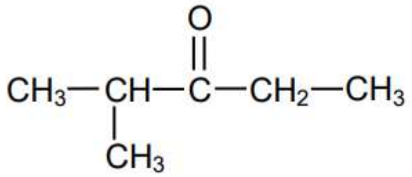
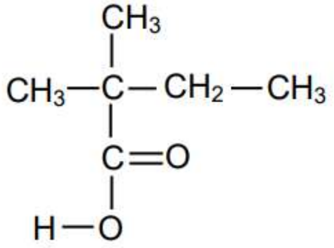
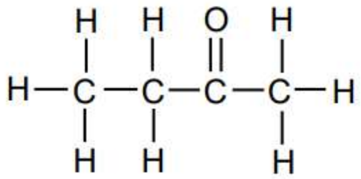
E	 $CH_3-\underset{\displaystyle CH_3}{\underset{\mid}{CH}}-\overset{\displaystyle CH_2}{\overset{\parallel}{C}}-CH_3$	**F**	 $CH_3-\underset{\displaystyle CH_3}{\underset{\mid}{CH}}-\overset{\displaystyle O}{\overset{\parallel}{C}}-CH_2-CH_3$
G		**H**	

2.1 Define the term organic compound.

2.2 Write down the IUPAC name of compound: 2.2.1 E ; 2.2.2 H

2.3 Write down the:
2.3.1 STRUCTURAL formula of compound B
2.3.2 STRUCTURAL formula of compound C
2.3.3 General formula of the homologous series to which compound E belongs
2.3.4 STRUCTURAL formula of the FUNCTIONAL group of compound F
2.3.5 IUPAC name of the alcohol needed to produce compound B

2.4 Write down the letter(s) of the compound(s) that:
2.4.1 Is a FUNCTIONAL isomer of compound G
2.4.2 Are CHAIN isomers of each other

IUPAC RULES

1. The **SUFFIXES** (–on ; -ene ; -yn ; -anol ; anoic acid ; -anal ; -anone) indicate the HOMOLOGOUS SERIES to which the molecule belongs.

2. The **PREFIXES** (met-; et-; prop-; but-; pent-; hex-; hept- and oct-) indicate the NUMBER OF CARBONS in the parent chain.

4. The **POSITION OF THE FUNCTIONAL GROUP** must be indicated in the middle of the name of the parent chain.

5. Carbons in the parent chain are numbered so that the **SMALLEST NUMBER** is used in the IUPAC name.

6. The **FUNCTIONAL GROUP GETS PREFERRED** and the carbon it is attached to is given the smallest possible numerical value first.

7. The **POSITION** of the **FUNCTIONAL GROUP** is always indicated in the IUPAC name if two or more positional isomers exist. Eg: pantan-2-one.

8. When naming **HALOALKANES**, neither the branching nor the halogens take priority over the other. The IUPAC rule regarding the smallest numbering of carbons and alphabetical order is in question.

9. **BRANCHES** from the parent chain are indicated with the suffix (–yl). The specific carbon in the parent chain where the branch is attached must be indicated in front of the IUPAC name.

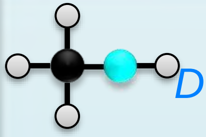
10. **MORE THAN ONE SUBSTITUENT OF THE SAME KIND** is indicated by the prefixes (di-, tri- or tetra-). The specific carbons in the parent chain to which each substituent is attached must be indicated in front of the IUPAC name.

11. The names of branches are indicated in **ALPHABETICAL ORDER** in the IUPAC name. Ignore the prefixes in this rule.

12. There MUST be a **COMMA** between any two numbers in the molecule's name.

13. There MUST be a **HYPHEN** between any word and a number.

14. The carbons are numbered in such a way that the IUPAC name always indicates the **SMALLEST POSSIBLE COMBINATION OF NUMBERS**.



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IUPAC

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x2	di-
x3	tri-
x4	tetra-

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PREFIXES	
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x4 C	But-
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x6 C	Hex-
x7 C	Hept-
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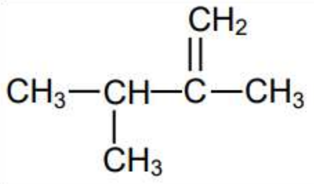
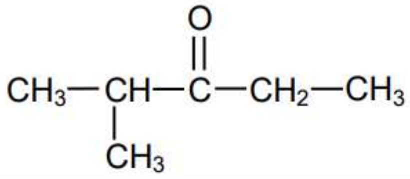
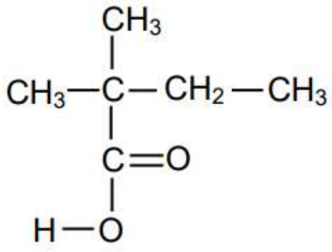
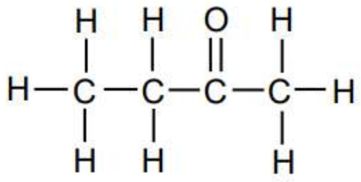
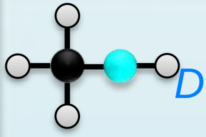
E	 $CH_3-\underset{CH_3}{CH}-\overset{CH_2}{\overset{\|}{C}}-CH_3$	**F**	 $CH_3-\underset{CH_3}{CH}-\overset{O}{\overset{\|}{C}}-CH_2-CH_3$
G	 $CH_3-\overset{CH_3}{\underset{\underset{H-O}{C=O}}{C}}-CH_2-CH_3$	**H**	 $H-\underset{H}{\overset{H}{C}}-\underset{H}{\overset{H}{C}}-\overset{O}{\overset{\|}{C}}-\underset{H}{\overset{H}{C}}-H$

2.1 Define the term organic compound.

ORGANIC COMPOUND: Molecule/compound containing carbon(atoms).



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I U P A C

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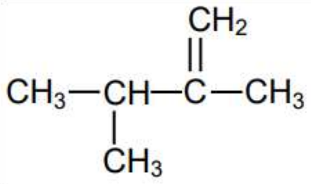
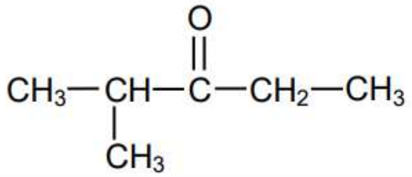
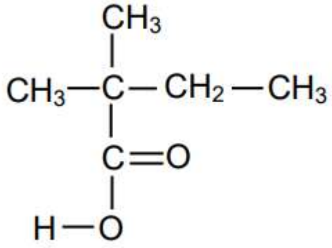
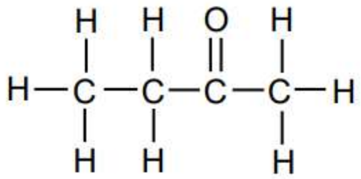
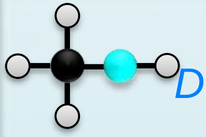
E	 $CH_3-\underset{CH_3}{\underset{\mid}{CH}}-\overset{CH_2}{\overset{\parallel}{C}}-CH_3$	**F**	 $CH_3-\underset{CH_3}{\underset{\mid}{CH}}-\overset{O}{\overset{\parallel}{C}}-CH_2-CH_3$
G		**H**	

2.2 Write down the IUPAC name of compound: 2.2.1 E ; 2.2.2 H

2.2.1 2,3-dimethylbut-1-one

2.2.2 Butane-2-one / 2-butanone / butanone



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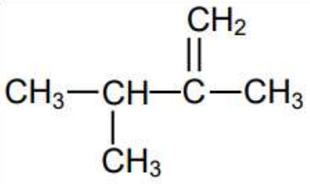
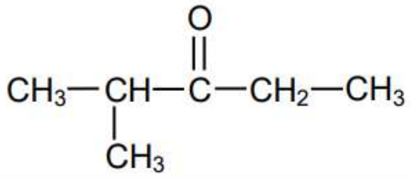
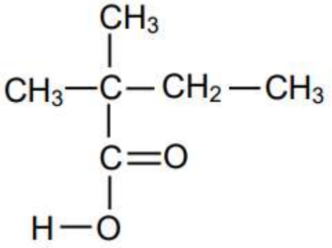
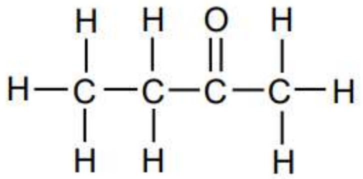
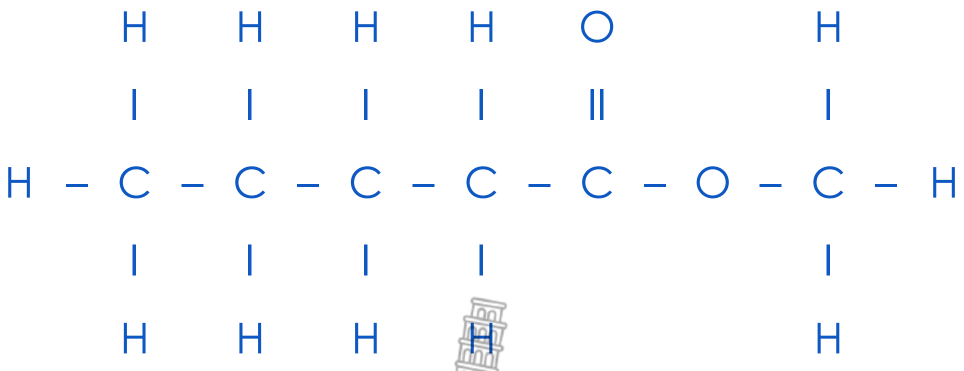
E		**F**	
G		**H**	

2.3 Write down the:
2.3.1 STRUCTURAL formula of compound B



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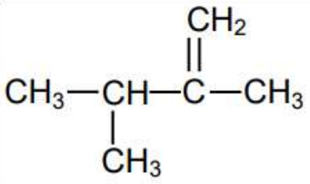
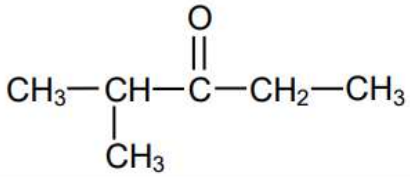
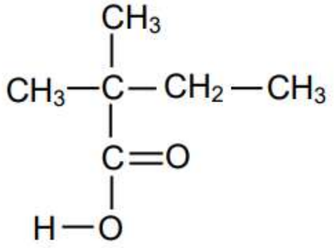
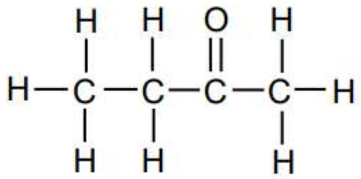
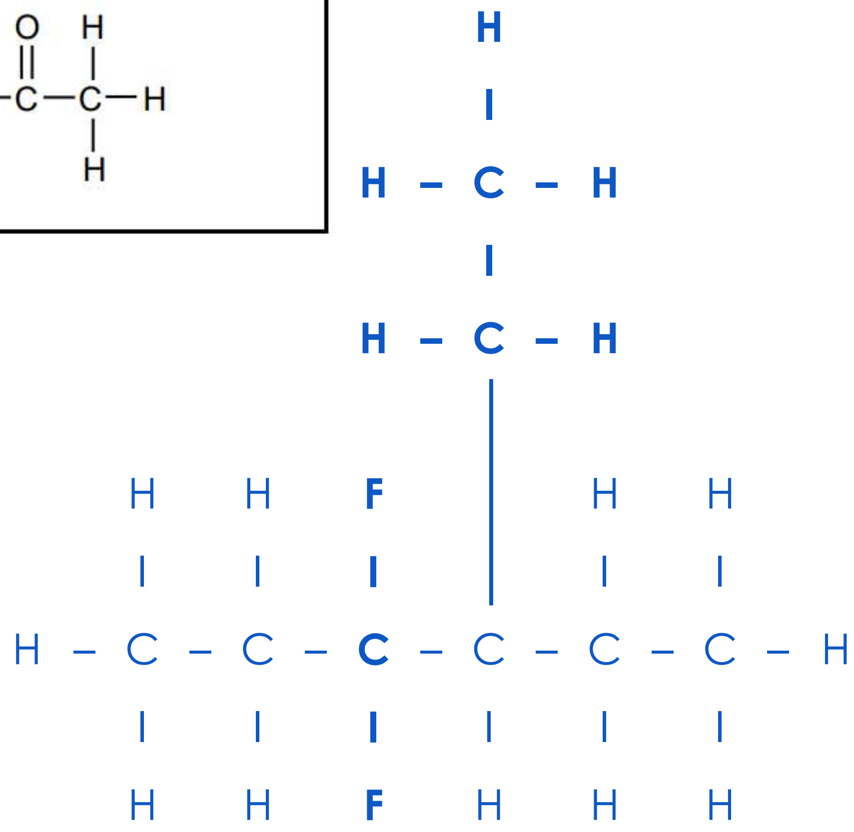
E	 $CH_3-CH(CH_3)-C(=CH_2)-CH_3$	**F**	 $CH_3-CH(CH_3)-C(=O)-CH_2-CH_3$
G	 $CH_3-C(CH_3)(COOH)-CH_2-CH_3$	**H**	 $H-CH_2-CH_2-C(=O)-CH_2-H$

2.3 Write down the:
2.3.2 STRUCTURAL formula of compound C



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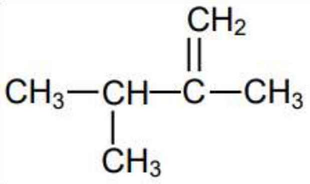
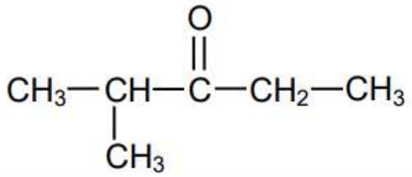
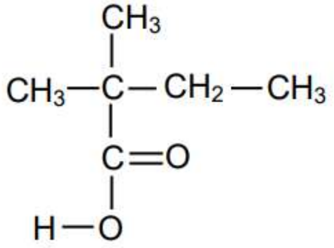
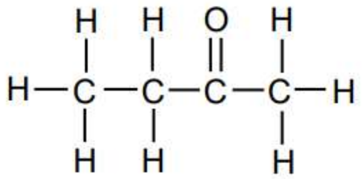
x7 C	Hept-
x8 C	Oct-

QUESTION 2

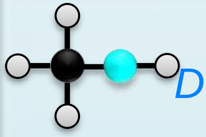
NSC 2023

The letters A to H in the table below represent eight organic compounds.

A	Heptanoic acid	**B**	$CH_3(CH_2)_3COOCH_3$
C	4-ethyl-3,3-difluorohexane	**D**	Hexanoic acid
E		**F**	
G		**H**	

2.3 Write down the:
2.3.3 General formula of the homologous series to which compound E belongs

2.3.3 C_nH_{2n}



ORGANIC MOLECULES

Make sure you know the correct wording of all definitions!

TYPES OF FORMULAS:
Molecular Formula
Structure Formula
Condensed Formula

FUNCTIONAL GROUPS:
Hydroxyl group
Carbonyl group
Carboxyl group

ISOMERS:
Structural Isomers
Positional Isomers
Functional Isomers

HALOGEN COMPOUNDS
HALOALAKNES
HALOALKENES
HALOALKYNES

OXYGEN COMPOUNDS
ALCOHOLS
CARBOXYLIC ACIDS
ALDEHYDES
KETONES

IUPAC

SUBSTITUENTS	
x2	di-
x3	tri-
x4	tetra-

HYDROCARBONS	
ALKANES	C_nH_{2n+2}
ALKENES	C_nH_{2n}
ALKYNES	C_nH_{2n-2}

PREFIXES	
x1 C	Meth-
x2 C	Eth-
x3 C	Prop-
x4 C	But-
x5 C	Pent-
x6 C	Hex-
x7 C	Hept-
x8 C	Oct-

QUESTION 2

NSC 2023

The letters A to H in the table below represent eight organic compounds.

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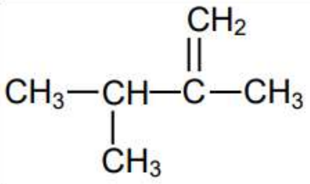
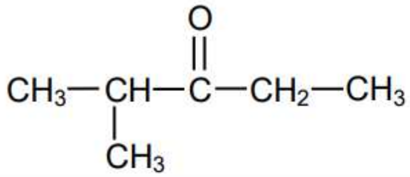
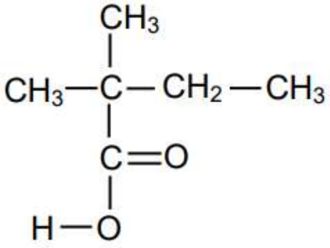
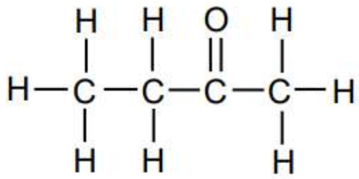
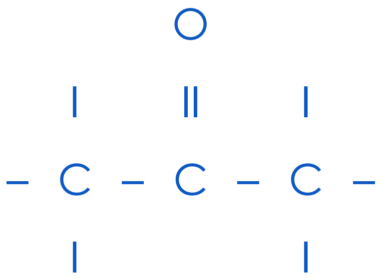
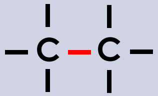
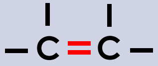
E		**F**	
G		**H**	

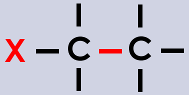
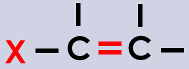
2.3 Write down the:
2.3.4 STRUCTURAL formula of the FUNCTIONAL group of compound F

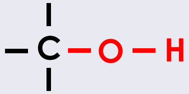
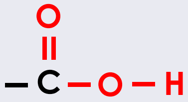
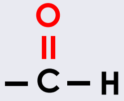
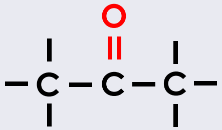
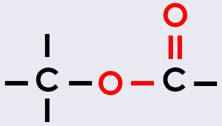


$$\begin{array}{ccccccc} & & & O & & & \\ & | & & \| & & | & \\ - & C & - & C & - & C & - \\ & | & & & & | & \end{array}$$

FUNCTIONAL GROUPS

Alkanes	Alkenes	Alkynes
 $-\overset{\mid}{\underset{\mid}{C}}-\overset{\mid}{\underset{\mid}{C}}-$	 $-\overset{\mid}{C}=\overset{\mid}{C}-$	$-C\equiv C-$

Haloalkanes	Haloalkenes	Haloalkynes
 $X-\overset{\mid}{\underset{\mid}{C}}-\overset{\mid}{\underset{\mid}{C}}-$	 $X-\overset{\mid}{C}=\overset{\mid}{C}-$	$X-C\equiv C-$

Alcohols	Carboxylic acids	Aldehydes	Ketones	Esters
Hydroxyl group	Carboxyl group	Formyl group	Carbonyl group	
 $-\overset{\mid}{\underset{\mid}{C}}-O-H$	 $-\overset{\overset{O}{\parallel}}{C}-O-H$	 $-\overset{\overset{O}{\parallel}}{C}-H$	 $-\overset{\mid}{\underset{\mid}{C}}-\overset{\overset{O}{\parallel}}{C}-\overset{\mid}{\underset{\mid}{C}}-$	 $-\overset{\mid}{\underset{\mid}{C}}-O-\overset{\overset{O}{\parallel}}{C}-$

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I U P A C

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x2	di-
x3	tri-
x4	tetra-

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ALKANES	C_nH_{2n+2}
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x4 C	But-
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x6 C	Hex-
x7 C	Hept-
x8 C	Oct-

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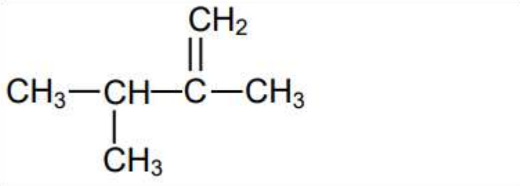
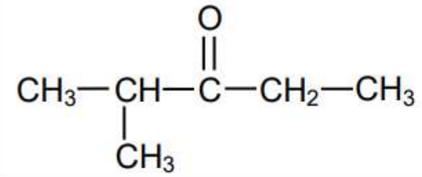
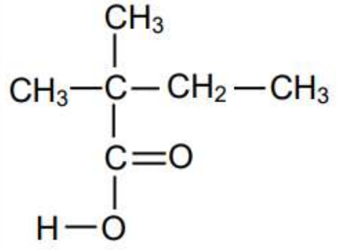
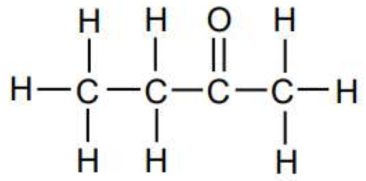
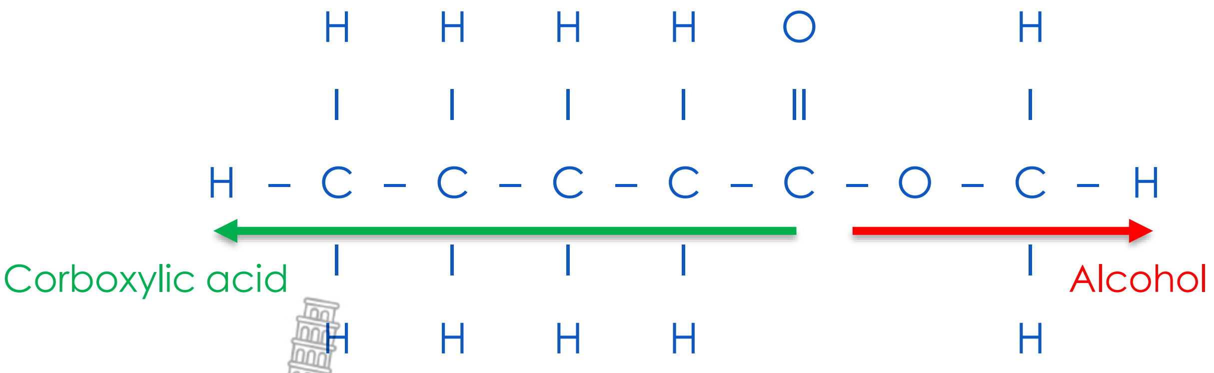
NSC 2023

The letters A to H in the table below represent eight organic compounds.

A	Heptanoic acid	**B**	$CH_3(CH_2)_3COOCH_3$
C	4-ethyl-3,3-difluorohexane	**D**	Hexanoic acid
E	 $CH_3-\underset{CH_3}{\underset{\vert}{CH}}-\overset{CH_2}{\overset{\Vert}{C}}-CH_3$	**F**	 $CH_3-\underset{CH_3}{\underset{\vert}{CH}}-\overset{O}{\overset{\Vert}{C}}-CH_2-CH_3$
G		**H**	

2.3 Write down the:
2.3.5 IUPAC name of the alcohol needed to produce compound B

2.3.5 Methanol



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I U P A C

SUBSTITUENTS	
x2	di-
x3	tri-
x4	tetra-

HYDROCARBONS	
ALKANES	C_nH_{2n+2}
ALKENES	C_nH_{2n}
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HALOGEN COMPOUNDS
HALOALAKNES
HALOALKENES
HALOALKYNES

OXYGEN COMPOUNDS
ALCOHOLS
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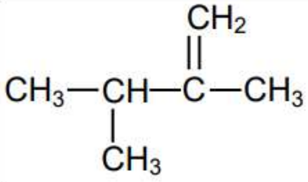
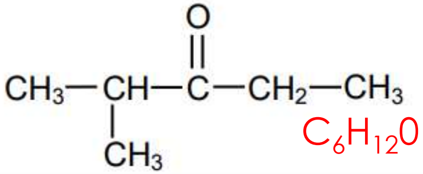
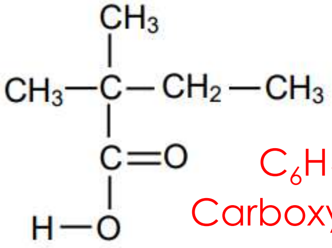
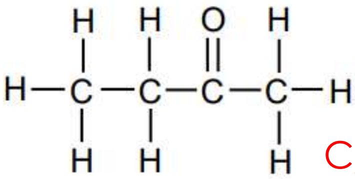
ALDEHYDES
KETONES

PREFIXES	
x1 C	Meth-
x2 C	Eth-
x3 C	Prop-
x4 C	But-
x5 C	Pent-
x6 C	Hex-
x7 C	Hept-
x8 C	Oct-

QUESTION 2

NSC 2023

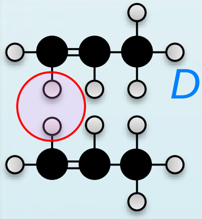
The letters A to H in the table below represent eight organic compounds.

A	Heptanoic acid $C_7H_{14}0_2$	**B**	$CH_3(CH_2)_3COOCH_3$ $C_6H_{12}0_2$ Ester
C	4-ethyl-3,3-difluorohexane $C_8H_{16}F_2$	**D**	Hexanoic acid $C_6H_{12}0_2$ Carboxylic acid
E	 C_6H_{12}	**F**	 $C_6H_{12}0$
G	 $C_6H_{12}0_2$ Carboxylic acid	**H**	 C_4H_80

2.4 Write down the letter(s) of the compound(s) that:
2.4.1 Is a FUNCTIONAL isomer of compound G
2.4.2 Are CHAIN isomers of each other

2.4.1 B

2.4.2 D & G



INTERMOLECULAR FORCES

Make sure you know the correct wording of all definitions!

MELTING POINT: The temperature at which the solid and liquid phases of a substance are in equilibrium.

BOILING POINT: The temperature at which vapor pressure of the substance equals atmospheric pressure.

VAPOR PRESSURE: This is the pressure that an enclosed vapor in equilibrium with its liquid exerts on the surface of the liquid.

TYPES of IMF
London (Dispersion) forces
Dipole-Dipole forces
Hydrogen bonds

COMPARE COMPOUNDS
1. ID 2 IMK
2. Strongest IMK
3. Most ENERGY
4. Declare PROPERTIES

Melting Point & Boiling Point

DIRECTLY PROPORTIONAL TO THE STRENGTH OF THE IMF

Vapor pressure

INVERSE PROPORTIONAL TO THE STRENGTH OF THE IMF

QUESTION 3

NSC 2023

The relationship between boiling point and the molecular mass of aldehydes, carboxylic acids and primary alcohols is investigated. Curves P, R and S are obtained. All compounds used are straight chain molecules.

3.1 Define the term boiling point.

3.2 Write down the conclusion that can be made for curve P.

3.3 Explain the answer to QUESTION 3.2 in terms of the structures of the compounds.

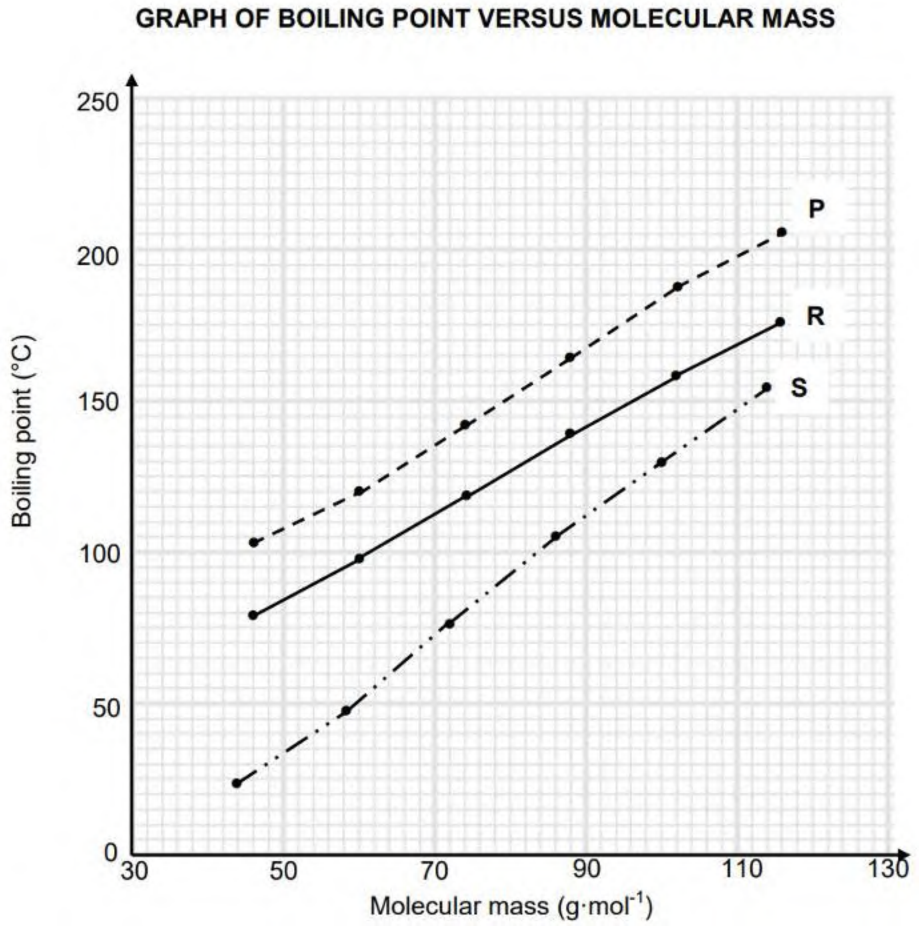
3.4 Curve R represents the alcohols.

3.4.1 Which homologous series is represented by curve S?

3.4.2 Explain the answer to QUESTION 3.4.1 by referring to the strength of intermolecular forces.

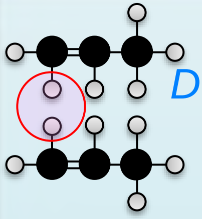
3.5 For curve R, write down the:

3.5.1 Molecular mass of the compound with a boiling point of 97 °C



3.5.2 IUPAC name of the compound in QUESTION 3.5.1

3.6 Two compounds, A and B, used in this investigation have a molecular mass of 74 g.mol^{-1} . A has a boiling point of 118 °C and B a boiling point of 142 °C. Explain the difference in these boiling points by referring to the structures of these compounds.



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VAPOR PRESSURE: This is the pressure that an enclosed vapor in equilibrium with its liquid exerts on the surface of the liquid.

TYPES of IMF

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Dipole-Dipole forces
Hydrogen bonds

COMPARE COMPOUNDS

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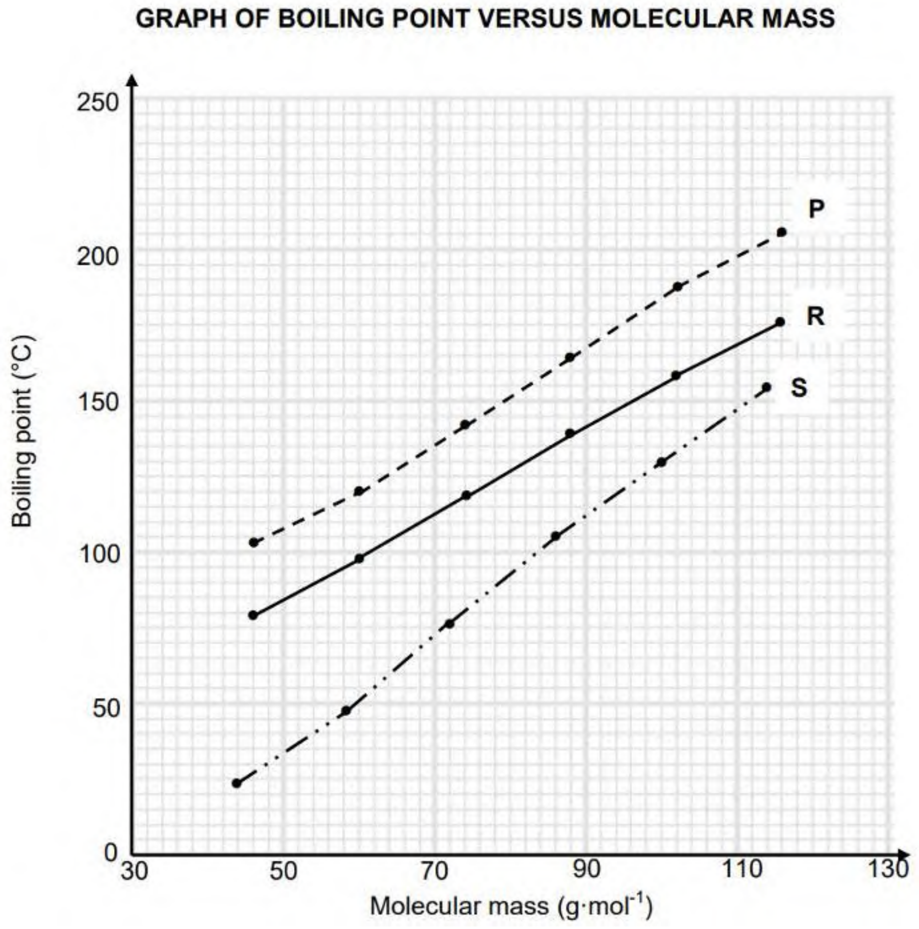
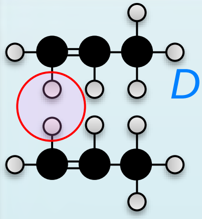
The relationship between boiling point and the molecular mass of aldehydes, carboxylic acids and primary alcohols is investigated. Curves P, R and S are obtained. All compounds used are straight chain molecules.

3.1 Define the term boiling point.

BOILING POINT: The temperature at which the vapour pressure of a LIQUID equals the atmospheric pressure.



GRAPH OF BOILING POINT VERSUS MOLECULAR MASS



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The relationship between boiling point and the molecular mass of aldehydes, carboxylic acids and primary alcohols is investigated. Curves P, R and S are obtained. All compounds used are straight chain molecules.

3.2 Write down the conclusion that can be made for curve P.

The higher the molecular mass, the higher the boiling point.

OR

As the molecular mass increases, so does the boiling point.

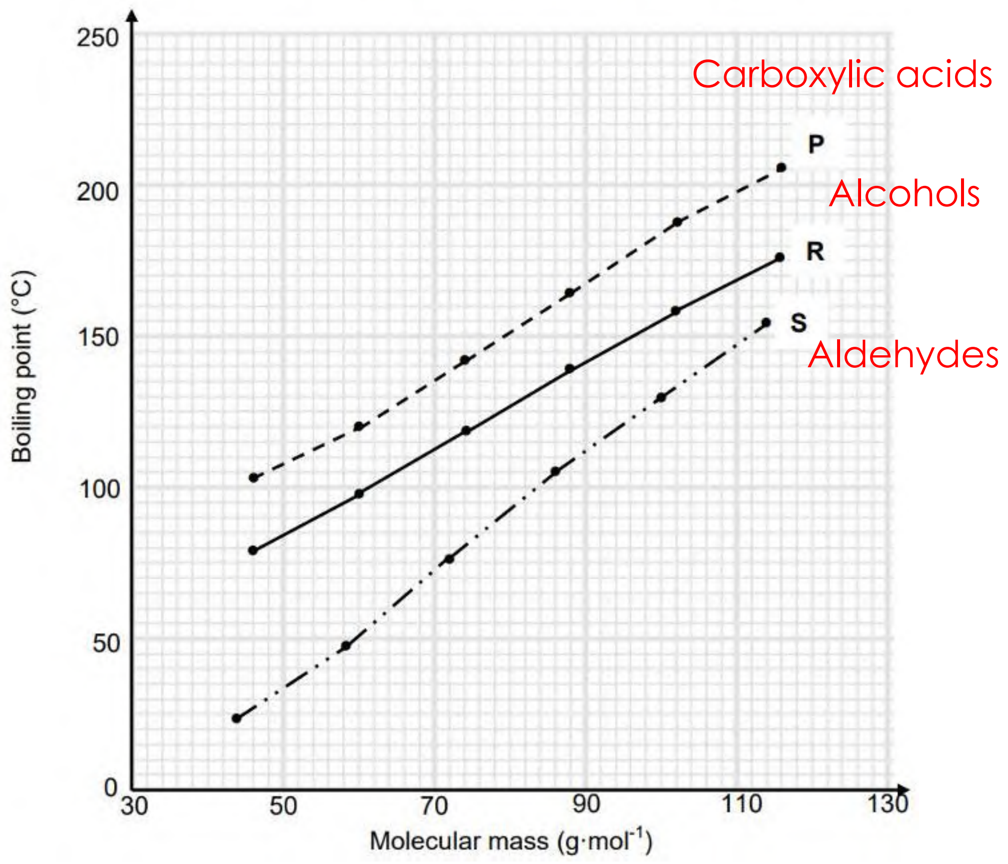
OR

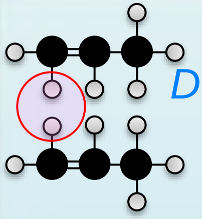
The longer the C-chain, the higher the boiling point The longer the C-chain, the higher the boiling point.

OR

The boiling point and the molecular mass are proportional.

GRAPH OF BOILING POINT VERSUS MOLECULAR MASS





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The relationship between boiling point and the molecular mass of aldehydes, carboxylic acids and primary alcohols is investigated. Curves P, R and S are obtained. All compounds used are straight chain molecules.

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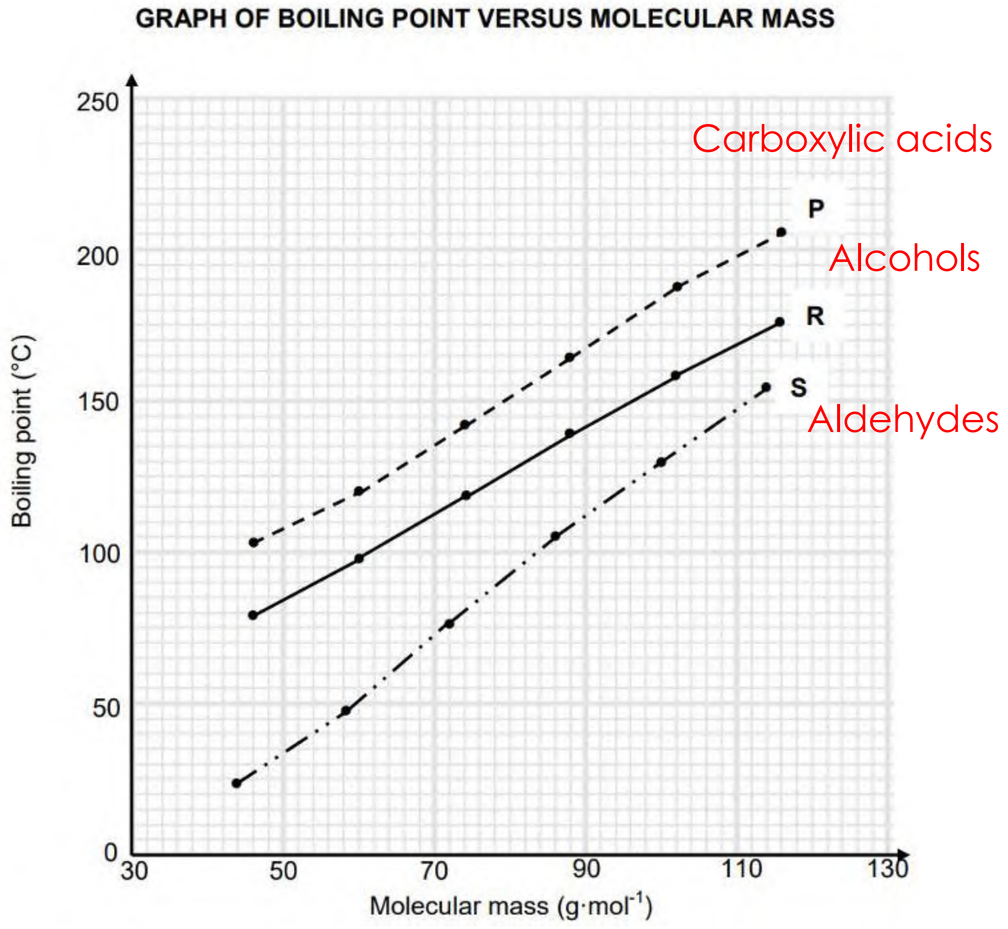
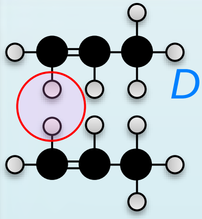


Strength of the intermolecular forces increases with increase In:

- molar mass
- Chain length
- contact surface.

More sites for London forces.

More energy required to overcome intermolecular forces.



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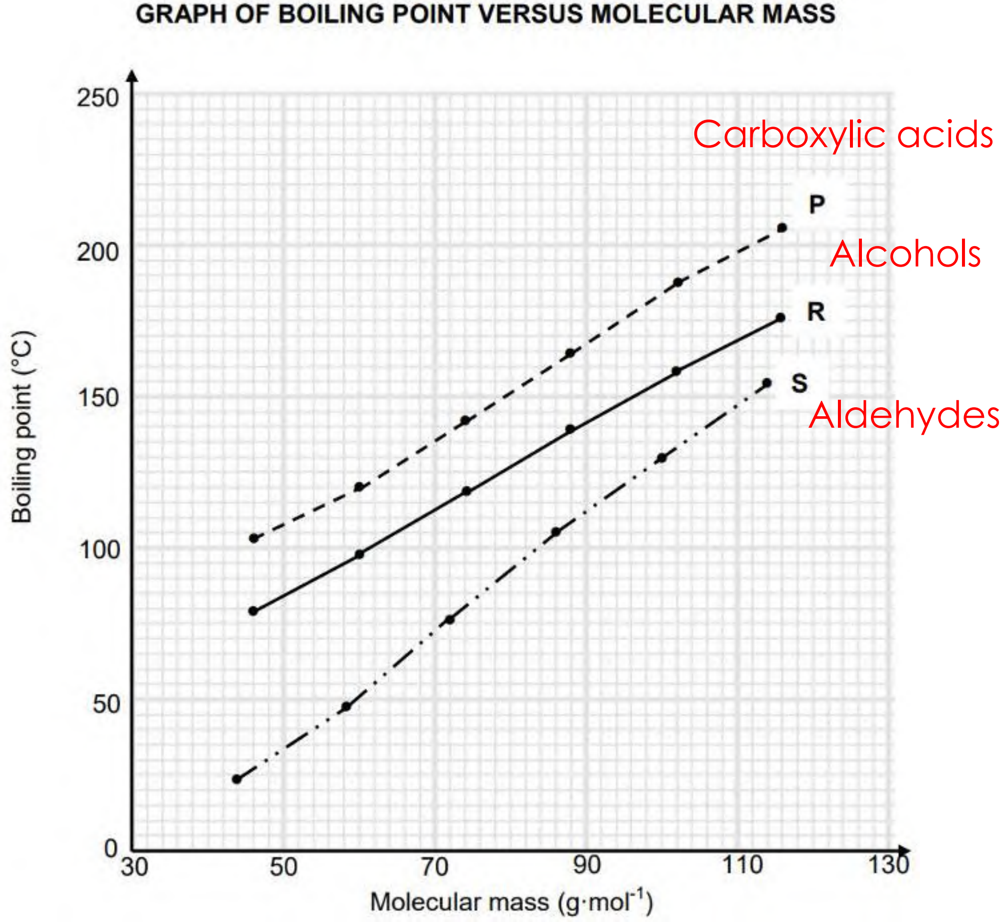
3.4.1 Which homologous series is represented by curve S?

3.4.2 Explain the answer to QUESTION 3.4.1 by referring to the strength of intermolecular forces.

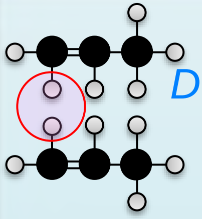


3.4.1 Aldehydes

3.4.2 Aldehydes have the weakest intermolecular forces.

Thus the aldehydes have the lowest boiling points.

The least energy needed to overcome the intermolecular forces.



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VAPOR PRESSURE: This is the pressure that an enclosed vapor in equilibrium with its liquid exerts on the surface of the liquid.

TYPES of IMF
London (Dispersion) forces
Dipole-Dipole forces
Hydrogen bonds

COMPARE COMPOUNDS
1. ID 2 IMK
2. Strongest IMK
3. Most ENERGY
4. Declare PROPERTIES

Melting Point & Boiling Point

DIRECTLY PROPORTIONAL TO THE STRENGTH OF THE IMF

Vapor pressure

INVERSE PROPORTIONAL TO THE STRENGTH OF THE IMF

QUESTION 3

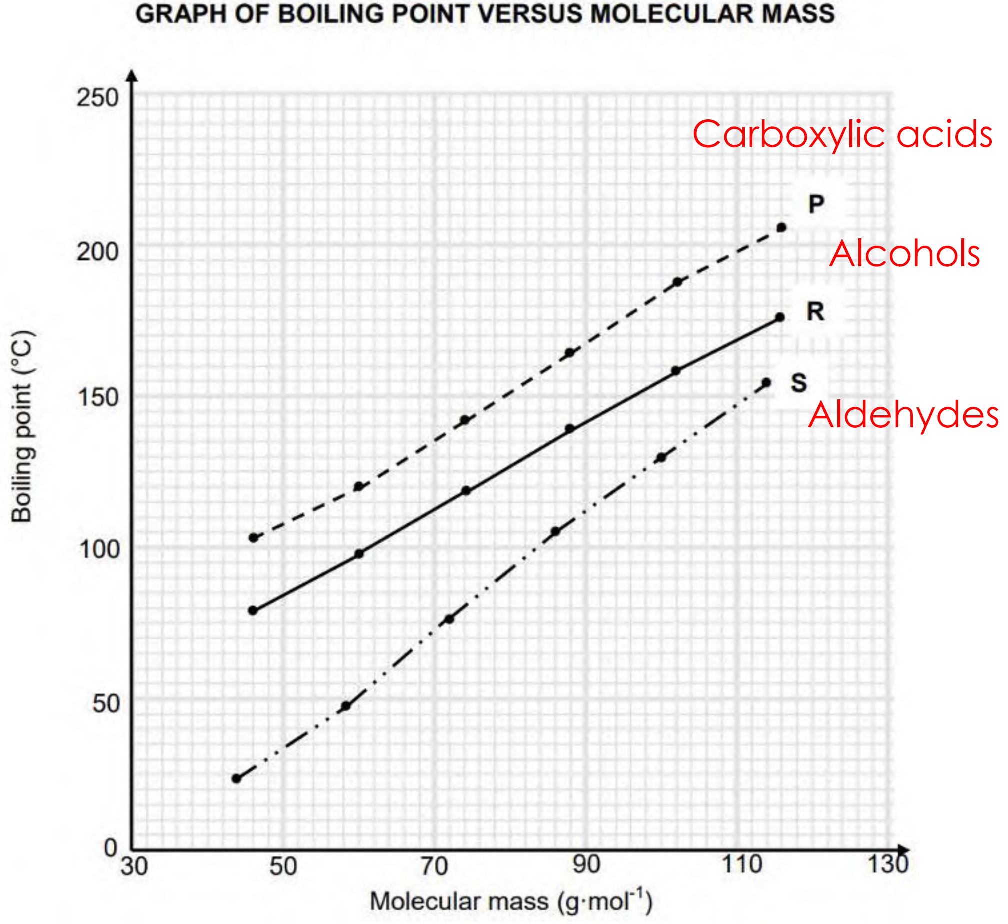
NSC 2023

The relationship between boiling point and the molecular mass of aldehydes, carboxylic acids and primary alcohols is investigated. Curves P, R and S are obtained. All compounds used are straight chain molecules.

3.5 For curve R, write down the:

3.5.1 Molecular mass of the compound with a boiling point of 97 °C

3.5.2 IUPAC name of the compound in QUE



3.5.1 Alcohol with a molar mass of 60 $g.mol^{-1}$

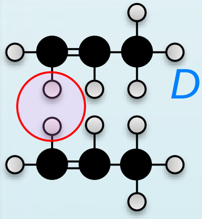
3.5.2 Propan-1-ol

$C_nH_{2n+2}O$

$C_1H_4O = 1(12) + 4(1) + 1(16) = 32\ g.mol^{-1}$

$C_2H_6O = 2(12) + 6(1) + 1(16) = 46\ g.mol^{-1}$

$C_3H_8O = 3(12) + 8(1) + 1(16) = 60\ g.mol^{-1}$



INTERMOLECULAR FORCES

Make sure you know the correct wording of all definitions!

MELTING POINT: The temperature at which the solid and liquid phases of a substance are in equilibrium.

BOILING POINT: The temperature at which vapor pressure of the substance equals atmospheric pressure.

VAPOR PRESSURE: This is the pressure that an enclosed vapor in equilibrium with its liquid exerts on the surface of the liquid.

TYPES of IMF
London (Dispersion) forces
Dipole-Dipole forces
Hydrogen bonds

COMPARE COMPOUNDS
1. ID 2 IMK
2. Strongest IMK
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Melting Point & Boiling Point

DIRECTLY PROPORTIONAL TO THE STRENGTH OF THE IMF

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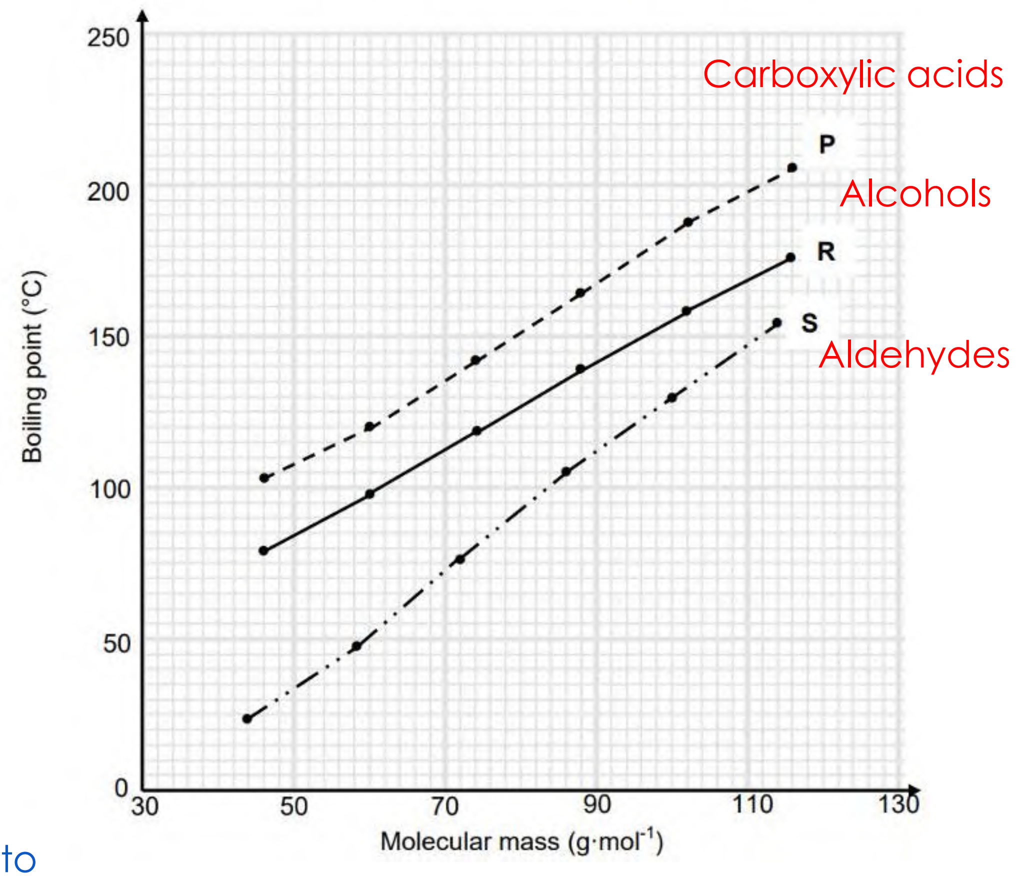
QUESTION 3

NSC 2023

The relationship between boiling point and the molecular mass of aldehydes, carboxylic acids and primary alcohols is investigated. Curves P, R and S are obtained. All compounds used are straight chain molecules.

3.6 Two compounds, A and B, used in this investigation have a molecular mass of 74 g.mol^{-1} . A has a boiling point of 118 °C and B a boiling point of 142 °C. Explain the difference in these boiling points by referring to the structures of these compounds.

GRAPH OF BOILING POINT VERSUS MOLECULAR MASS



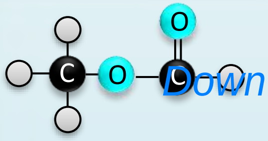
Both compounds has strong hydrogen bonds.

Carboxylic acids have two sites for hydrogen bonds while Alcohols have only one site for a hydrogen bond.

Thus, the intermolecular forces of Carboxylic acids are stronger than the intermolecular forces of Alcohols.

Carboxylic acids require more energy to overcome the intermolecular forces.

Carboxylic acids therefore have higher boiling points.



ORGANIC REACTIONS

QUESTION 4

NSC 2023

Combustion, Esterification, Cracking

ADDITION REACTIONS

HIDROGENATIONS	ALKENE + **H_2** → ALKANE (CATALYST: Pt/Ni/Pd & Non-polar solvent, Heat)
HALOGENATION	ALKENE + **X_2** → HALOALKANE (NO H_2O)
HIDROHALOGNATION	ALKENE + **HX** → HALOALKAEN (NO H_2O)
HIDRATION	ALKENE + **H_2O** → ALCOHOL (H_2SO_4 (dil) / H_3PO_4 (dil) & Heat in the form of steam)

ELIMINATION REACTIONS

DEHIDROGENATION	ALKANE - **H_2** → ALKENE (CATALYST: Pt / Ni / Pd)
DEHALOGENATION	HALOALKANE - **X_2** → ALKENE (Unreactive solvent)
DEHIDROHALOGENATION	HALOALKANE - **HX** → ALKENE (NaOH(c)/KOH(c), Ethanol, Heat … Reflux)
DEHIDRATION	ALCOHOL - **H_2O** → ALKENE (CATALYST: H_2SO_4(c) / H_3PO_4(c) & Heat)

SUBSTITUTION REACTIONS

HALOGENATION	ALKANE + **X_2** → HALOALKANE (IN THE PRESENCE OF SUNLIGHT)
HYDROLYSIS	HALOALKANE + **OH^-** → ALCOHOL (NaOH(aq) / KOH(aq) & Ethanol & Low Heat)
HIDROHALOGENATION	ALCOHOL + **HX** → HALOALKANE (CATALYST: H_2SO_4(c) / H_3PO_4(c) & Heat)

MARKOVNIKOV
ADDITION REACTIONS

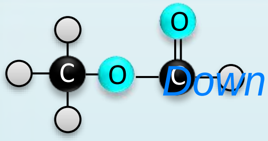
ZAITEV
ELIMINATION REACTIONS

REACTION CONDITIONS

Hydrogenation	Halogenation	Hydrohalogenation	Hydration
Pt / Ni / Pd 🔥 ⚗ Non-polar	🚫💧	🚫💧	**STRONG** H_2SO_4 **DILUTE** H_3PO_4 💧 STEAM

Dehydrogenation	Dehalogenation	Dehydrohalogenation	Dehydration
Pt / Ni / Pd	⚗ Unreactive	**STRONG** NaOH **(c)** KOH ⚗ Etanol	**STRONG** H_2SO_4 **(c)** H_3PO_4 🔥

Halogenation	Hydrolysis	Hydrohalogenation
☀	**STRONG** NaOH **DILUTE** KOH ⚗ Etanol 🔥	**STRONG** H_2SO_4 **(c)** H_3PO_4 🔥



ORGANIC REACTIONS

Combustion, Esterification, Cracking

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DEHIDRATION	ALCOHOL - H_2O → ALKENE (CATALYST: H_2SO_4(c) / H_3PO_4(c) & Heat)

SUBSTITUTION REACTIONS

HALOGENATION	ALKANE + X_2 → HALOALKANE (IN THE PRESENCE OF SUNLIGHT)
HYDROLYSIS	HALOALKANE + OH^- → ALCOHOL (NaOH(aq) / KOH(aq) & Ethanol & Low Heat)
HIDROHALOGENATION	ALCOHOL + HX → HALOALKANE (CATALYST: H_2SO_4(c) / H_3PO_4(c) & Heat)

MARKOVNIKOV ADDITION REACTIONS	**ZAITEV** ELIMINATION REACTIONS

QUESTION 4

NSC 2023

4.1 Consider the cracking reaction below. $C_{16}H_{34} \rightarrow C_6H_{14} + C_6H_x + 2C_yH_z$

4.1.1 Define cracking.

4.1.2 Write down the values represented by x, y and z in the equation above.

Compound C_6H_{14} undergoes complete combustion.

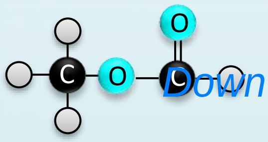
4.1.3 Using MOLECULAR FORMULAE, write down the balanced equation for this reaction.

4.2 Consider the equations for reactions I to III below. A and B represent organic compounds that are POSITIONAL ISOMERS. X is an inorganic product.

I	$CH_3CH_2CHCHCH_3 + HC\ell \rightarrow \mathbf{A} + \mathbf{B}$
II	$\mathbf{A} \xrightarrow[\Delta]{H_2O} CH_3CH_2CH_2CH(OH)CH_3 + \mathbf{X}$
III	$CH_3CH_2CH_2CH(OH)CH_3 \longrightarrow CH_3CH_2CHCHCH_3 + H_2O$

Write down the:
4.2.1 Definition of positional isomers
4.2.2 Type of reaction represented by reaction I
4.2.3 STRUCTURAL formula of compound B
4.2.4 Formula of X
4.2.5 Inorganic reagent for reaction III

Compound A can be converted directly to the organic product of reaction III.
4.2.6 Besides heat, write down the reaction condition needed for this conversion.
4.2.7 Write down TWO terms that describe this type of reaction.



ORGANIC REACTIONS

Combustion, Esterification, Cracking

ADDITION REACTIONS

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HIDRATION	ALKENE + H_2O → ALCOHOL (H_2SO_4 (dil) / H_3PO_4 (dil) & Heat in the form of steam)

ELIMINATION REACTIONS

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SUBSTITUTION REACTIONS

HALOGENATION	ALKANE + X_2 → HALOALKANE (IN THE PRESENCE OF SUNLIGHT)
HYDROLYSIS	HALOALKANE + OH^- → ALCOHOL (NaOH(aq) / KOH(aq) & Ethanol & Low Heat)
HIDROHALOGENATION	ALCOHOL + HX → HALOALKANE (CATALYST: H_2SO_4(c) / H_3PO_4(c) & Heat)

MARKOVNIKOV
ADDITION REACTIONS

ZAITEV
ELIMINATION REACTIONS

QUESTION 4

NSC 2023

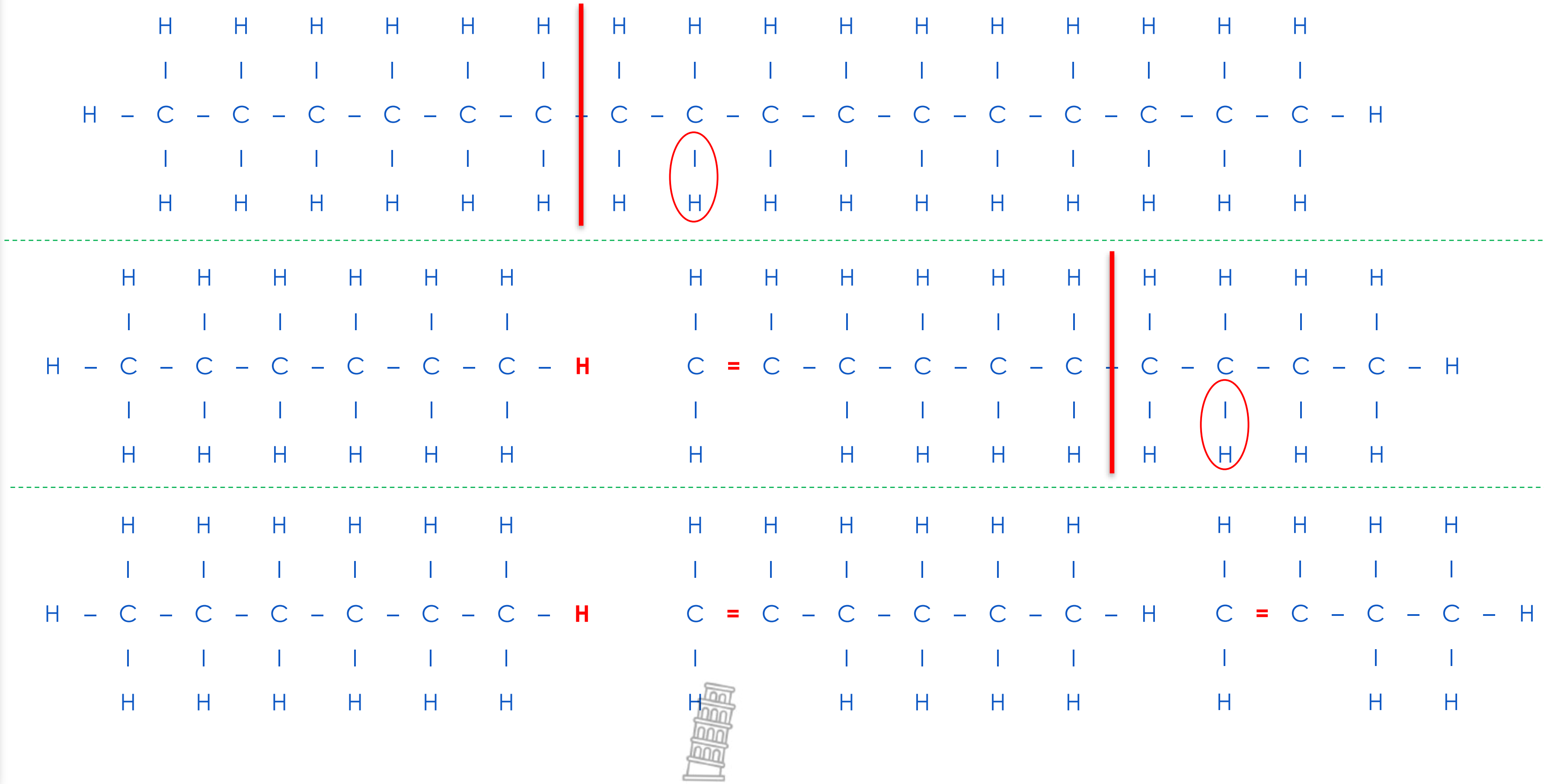
4.1 Consider the cracking reaction below. $C_{16}H_{34} \rightarrow C_6H_{14} + C_6H_x + 2C_yH_z$

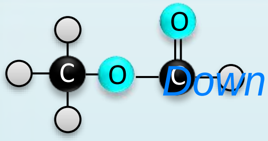
(Alkane) (Alkane) (Alkene) (Alkene)

4.1.1 Define cracking.

4.1.2 Write down the values represented by x, y and z in the equation above.

The chemical process/reaction in which longer chain hydrocarbon/alkane molecule is broken down into shorter (more useful) molecules.





ORGANIC REACTIONS

Combustion, Esterification, Cracking

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HIDROHALOGENATION	ALCOHOL + **HX** → HALOALKANE (CATALYST: H_2SO_4(c) / H_3PO_4(c) & Heat)

MARKOVNIKOV ADDITION REACTIONS	**ZAITEV** ELIMINATION REACTIONS

QUESTION 4

NSC 2023

Compound C_6H_{14} undergoes complete combustion.

4.1.3 Using MOLECULAR FORMULAE, write down the balanced equation for this reaction.

EXCESS OXYGEN : Compound + O_2 → CO_2 + H_2O

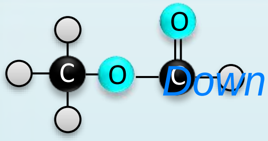
Reactants & Products: $C_6H_{14} + O_2 \rightarrow CO_2 + H_2O$

Balance C: $C_6H_{14} + O_2 \rightarrow 6CO_2 + H_2O$

Balance H: $C_6H_{14} + O_2 \rightarrow 6CO_2 + 7H_2O$

Balance O: $C_6H_{14} + \frac{19}{2}O_2 \rightarrow 6CO_2 + 7H_2O$

Empirical : $2C_6H_{14} + 19O_2 \rightarrow 12CO_2 + 14H_2O$



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Combustion, Esterification, Cracking

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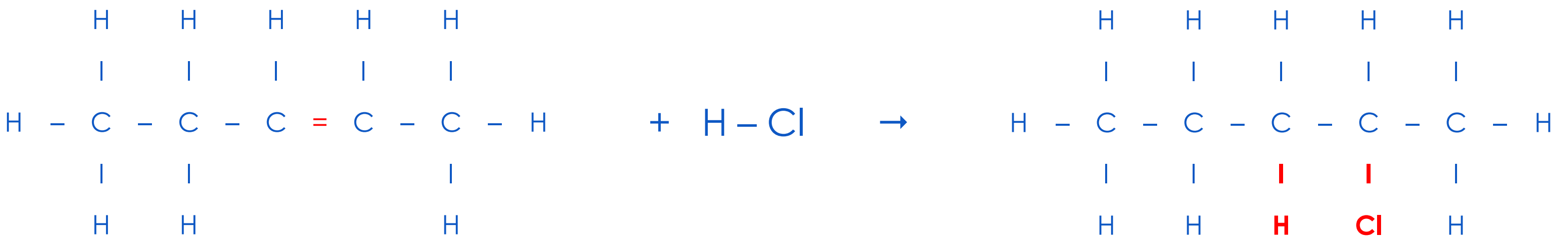
MARKOVNIKOV ADDITION REACTIONS	**ZAITEV** ELIMINATION REACTIONS

QUESTION 4

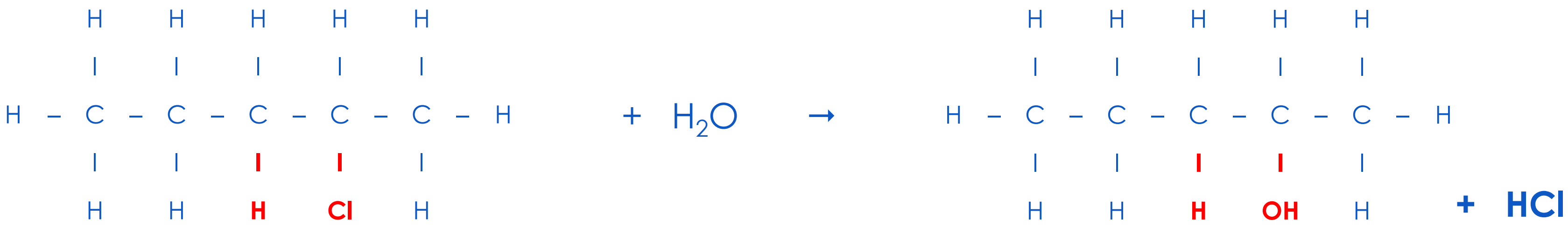
NSC 2023

4.2 Consider the equations for reactions I to III below. A and B represent organic compounds that are POSITIONAL ISOMERS. X is an inorganic product.



$$CH_3CH_2CH{=}CHCH_3 + H{-}Cl \rightarrow CH_3CH_2CH_2CHClCH_3$$

I	$CH_3CH_2CHCHCH_3$ + $HC\ell$ → **A** + **B**
II	**A** $\xrightarrow[\Delta]{H_2O}$ $CH_3CH_2CH_2CH(OH)CH_3$ + **X**
III	$CH_3CH_2CH_2CH(OH)CH_3 \longrightarrow CH_3CH_2CHCHCH_3 + H_2O$



$$CH_3CH_2CH_2CHClCH_3 + H_2O \rightarrow CH_3CH_2CH_2CH(OH)CH_3 + HCl$$

Write down the:

4.2.1 Definition of positional isomers

POSITIONAL ISOMERS: Organic molecules with the same molecular formula but whose position of the functional groups/sibstituents/branches differs from each other.

ORGANIC REACTIONS

Combustion, Esterification, Cracking

ADDITION REACTIONS

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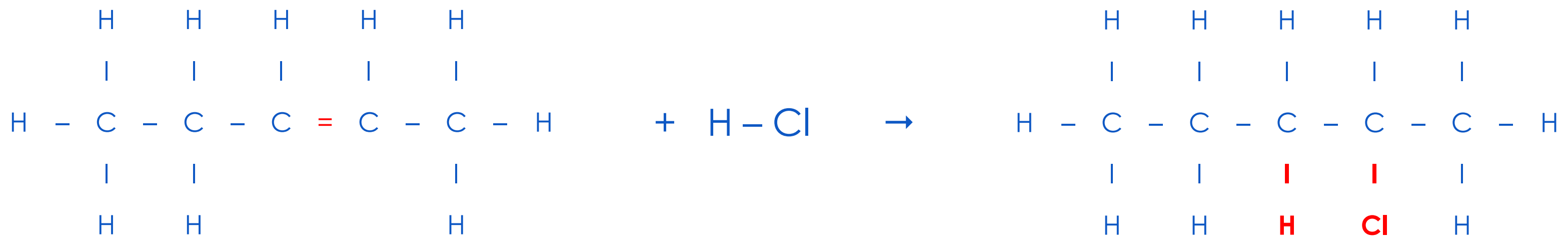
MARKOVNIKOV	ZAITEV
ADDITION REACTIONS	ELIMINATION REACTIONS

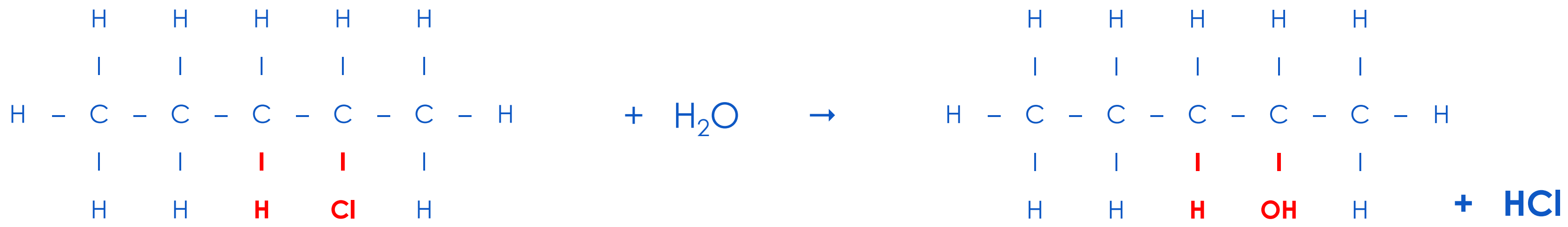
QUESTION 4

NSC 2023

4.2 Consider the equations for reactions I to III below. A and B represent organic compounds that are POSITIONAL ISOMERS. X is an inorganic product.



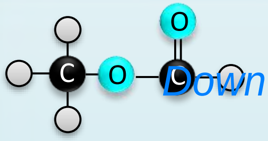
I	$CH_3CH_2CHCHCH_3$ + HCℓ → **A** + **B**
II	**A** $\xrightarrow[\Delta]{H_2O}$ $CH_3CH_2CH_2CH(OH)CH_3$ + **X**
III	$CH_3CH_2CH_2CH(OH)CH_3 \longrightarrow CH_3CH_2CHCHCH_3 + H_2O$



Write down the:

4.2.2 Type of reaction represented by reaction I

ADDITION / HYDROHALOGENATION



ORGANIC REACTIONS

Combustion, Esterification, Cracking

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MARKOVNIKOV
ADDITION REACTIONS

ZAITEV
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NSC 2023

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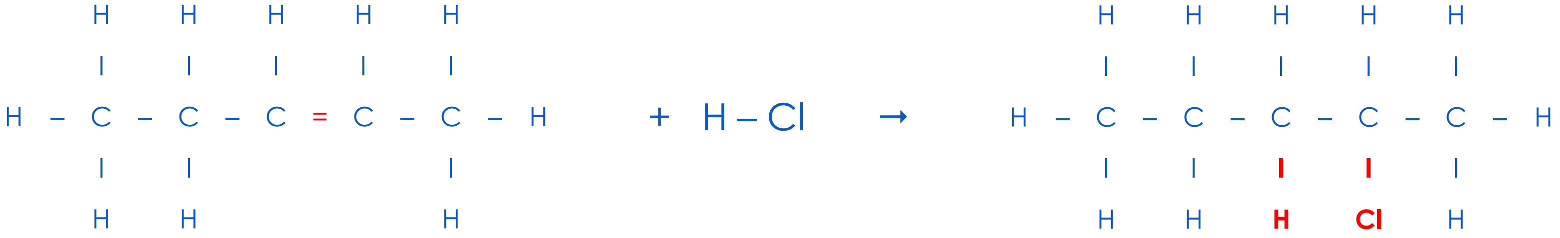
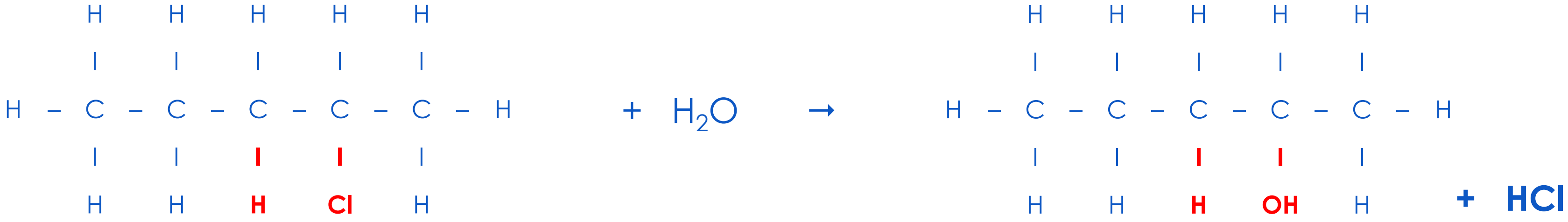


$$\begin{array}{ccccccccccccc} & & H & & H & & H & & H & & H & & \\ & & | & & | & & | & & | & & | & & \\ H & - & C & - & C & - & C & = & C & - & C & - & H \\ & & | & & | & & & & & & | & & \\ & & H & & H & & & & & & H & & \end{array} + H-Cl \rightarrow \begin{array}{ccccccccccccc} & & H & & H & & H & & H & & H & & \\ & & | & & | & & | & & | & & | & & \\ H & - & C & - & C & - & C & - & C & - & C & - & H \\ & & | & & | & & | & & | & & | & & \\ & & H & & H & & H & & Cl & & H & & \end{array}$$

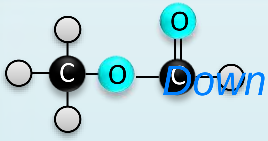
I	$CH_3CH_2CHCHCH_3 + HC\ell \rightarrow$ **A** + **B**
II	**A** $\xrightarrow[\Delta]{H_2O}$ $CH_3CH_2CH_2CH(OH)CH_3$ + **X**
III	$CH_3CH_2CH_2CH(OH)CH_3 \longrightarrow CH_3CH_2CHCHCH_3 + H_2O$



$$\begin{array}{ccccccccccccc} & & H & & H & & H & & H & & H & & \\ & & | & & | & & | & & | & & | & & \\ H & - & C & - & C & - & C & - & C & - & C & - & H \\ & & | & & | & & | & & | & & | & & \\ & & H & & H & & H & & Cl & & H & & \end{array} + H_2O \rightarrow \begin{array}{ccccccccccccc} & & H & & H & & H & & H & & H & & \\ & & | & & | & & | & & | & & | & & \\ H & - & C & - & C & - & C & - & C & - & C & - & H \\ & & | & & | & & | & & | & & | & & \\ & & H & & H & & H & & OH & & H & & \end{array} + HCl$$

Write down the:
4.2.3 STRUCTURAL formula of compound B

SEE STRUCTURE DRAWN ABOVE.



ORGANIC REACTIONS

Combustion, Esterification, Cracking

ADDITION REACTIONS

HIDROGENATIONS	ALKENE + **H_2** → ALKANE (CATALYST: Pt/Ni/Pd & Non-polar solvent, Heat)
HALOGENATION	ALKENE + **X_2** → HALOALKANE (NO H_2O)
HIDROHALOGNATION	ALKENE + **HX** → HALOALKAEN (NO H_2O)
HIDRATION	ALKENE + **H_2O** → ALCOHOL (H_2SO_4 (dil) / H_3PO_4 (dil) & Heat in the form of steam)

ELIMINATION REACTIONS

DEHIDROGENATION	ALKANE - **H_2** → ALKENE (CATALYST: Pt / Ni / Pd)
DEHALOGENATION	HALOALKANE - **X_2** → ALKENE (Unreactive solvent)
DEHIDROHALOGENATION	HALOALKANE - **HX** → ALKENE (NaOH(c)/KOH(c), Ethanol, Heat … Reflux)
DEHIDRATION	ALCOHOL - **H_2O** → ALKENE (CATALYST: H_2SO_4(c) / H_3PO_4(c) & Heat)

SUBSTITUTION REACTIONS

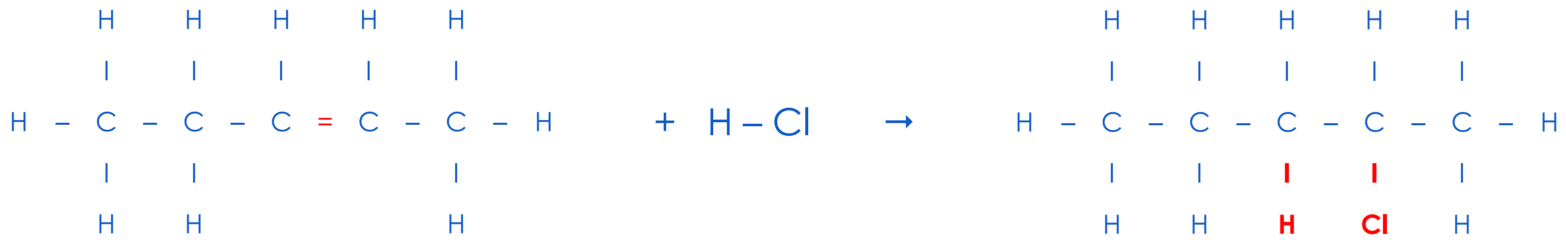
HALOGENATION	ALKANE + **X_2** → HALOALKANE (IN THE PRESENCE OF SUNLIGHT)
HYDROLYSIS	HALOALKANE + **OH^-** → ALCOHOL (NaOH(aq) / KOH(aq) & Ethanol & Low Heat)
HIDROHALOGENATION	ALCOHOL + **HX** → HALOALKANE (CATALYST: H_2SO_4(c) / H_3PO_4(c) & Heat)

MARKOVNIKOV ADDITION REACTIONS	**ZAITEV** ELIMINATION REACTIONS

QUESTION 4

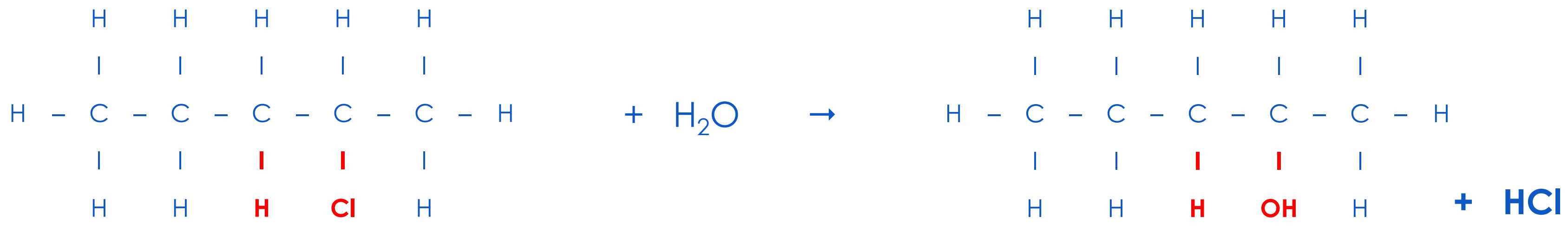
NSC 2023

4.2 Consider the equations for reactions I to III below. A and B represent organic compounds that are POSITIONAL ISOMERS. X is an inorganic product.



$$\begin{array}{ccccccccccccc} & & H & & H & & H & & H & & H & & \\ & & | & & | & & | & & | & & | & & \\ H & - & C & - & C & - & C & = & C & - & C & - & H \\ & & | & & | & & & & & & | & & \\ & & H & & H & & & & & & H & & \end{array} + H-Cl \rightarrow \begin{array}{ccccccccccccc} & & H & & H & & H & & H & & H & & \\ & & | & & | & & | & & | & & | & & \\ H & - & C & - & C & - & C & - & C & - & C & - & H \\ & & | & & | & & | & & | & & | & & \\ & & H & & H & & H & & Cl & & H & & \end{array}$$

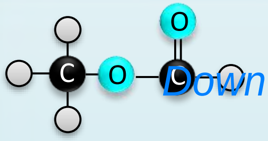
I	$CH_3CH_2CHCHCH_3$ + $HC\ell$ → **A** + **B**
II	**A** $\xrightarrow[\Delta]{H_2O}$ $CH_3CH_2CH_2CH(OH)CH_3$ + **X**
III	$CH_3CH_2CH_2CH(OH)CH_3$ ⟶ $CH_3CH_2CHCHCH_3$ + H_2O



$$\begin{array}{ccccccccccccc} & & H & & H & & H & & H & & H & & \\ & & | & & | & & | & & | & & | & & \\ H & - & C & - & C & - & C & - & C & - & C & - & H \\ & & | & & | & & | & & | & & | & & \\ & & H & & H & & H & & Cl & & H & & \end{array} + H_2O \rightarrow \begin{array}{ccccccccccccc} & & H & & H & & H & & H & & H & & \\ & & | & & | & & | & & | & & | & & \\ H & - & C & - & C & - & C & - & C & - & C & - & H \\ & & | & & | & & | & & | & & | & & \\ & & H & & H & & H & & OH & & H & & \end{array} + HCl$$

Write down the:
4.2.4 Formula of X

HCl



ORGANIC REACTIONS

Combustion, Esterification, Cracking

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ELIMINATION REACTIONS	
DEHIDROGENATION	ALKANE - H_2 → ALKENE (CATALYST: Pt / Ni / Pd)
DEHALOGENATION	HALOALKANE - X_2 → ALKENE (Unreactive solvent)
DEHIDROHALOGENATION	HALOALKANE - HX → ALKENE (NaOH(c)/KOH(c), Ethanol, Heat … Reflux)
DEHIDRATION	ALCOHOL - H_2O → ALKENE (CATALYST: H_2SO_4(c) / H_3PO_4(c) & Heat)

SUBSTITUTION REACTIONS	
HALOGENATION	ALKANE + X_2 → HALOALKANE (IN THE PRESENCE OF SUNLIGHT)
HYDROLYSIS	HALOALKANE + OH^- → ALCOHOL (NaOH(aq) / KOH(aq) & Ethanol & Low Heat)
HIDROHALOGENATION	ALCOHOL + HX → HALOALKANE (CATALYST: H_2SO_4(c) / H_3PO_4(c) & Heat)

MARKOVNIKOV ADDITION REACTIONS	**ZAITEV** ELIMINATION REACTIONS

QUESTION 4

NSC 2023

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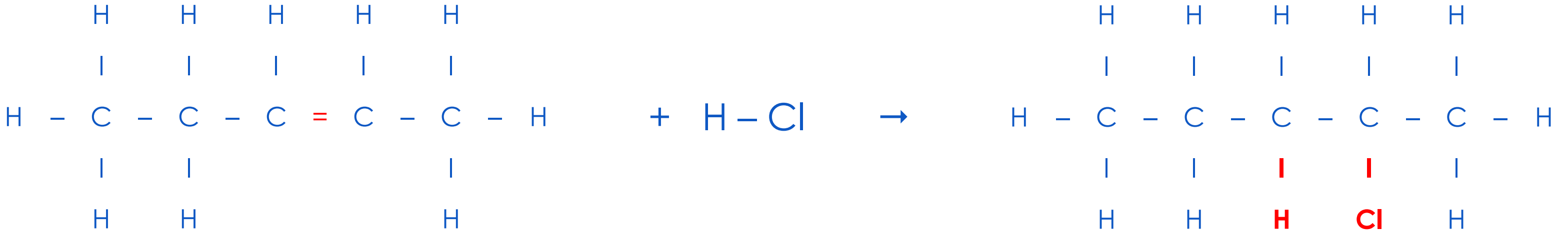
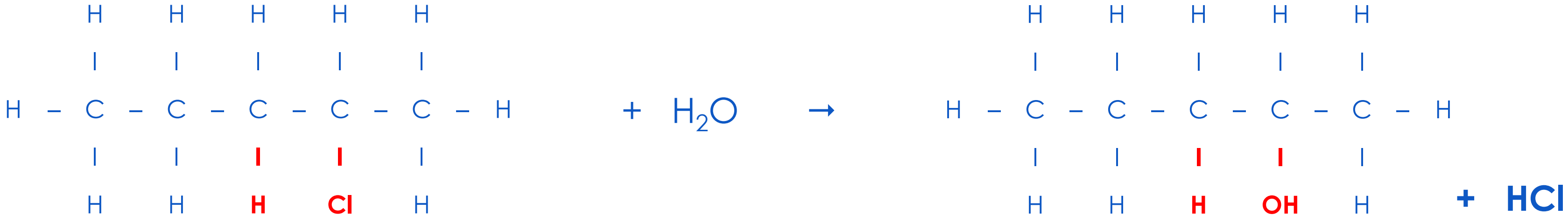
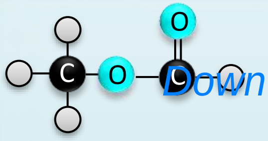


I	$CH_3CH_2CHCHCH_3$ + $HC\ell$ → **A** + **B**
II	**A** $\xrightarrow[\Delta]{H_2O}$ $CH_3CH_2CH_2CH(OH)CH_3$ + **X**
III	$CH_3CH_2CH_2CH(OH)CH_3 \longrightarrow CH_3CH_2CHCHCH_3 + H_2O$



Write down the:
4.2.5 Inorganic reagent for reaction III

Concentrated sulfuric acid / H_2SO_4 (c) / Concentrated phosphoric acid / H_3PO_4 (c)



ORGANIC REACTIONS

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ELIMINATION REACTIONS

DEHIDROGENATION	ALKANE - H_2 → ALKENE (CATALYST: Pt / Ni / Pd)
DEHALOGENATION	HALOALKANE - X_2 → ALKENE (Unreactive solvent)
DEHIDROHALOGENATION	HALOALKANE - HX → ALKENE (NaOH(c)/KOH(c), Ethanol, Heat … Reflux)
DEHIDRATION	ALCOHOL - H_2O → ALKENE (CATALYST: H_2SO_4(c) / H_3PO_4(c) & Heat)

SUBSTITUTION REACTIONS

HALOGENATION	ALKANE + X_2 → HALOALKANE (IN THE PRESENCE OF SUNLIGHT)
HYDROLYSIS	HALOALKANE + OH^- → ALCOHOL (NaOH(aq) / KOH(aq) & Ethanol & Low Heat)
HIDROHALOGENATION	ALCOHOL + HX → HALOALKANE (CATALYST: H_2SO_4(c) / H_3PO_4(c) & Heat)

MARKOVNIKOV ADDITION REACTIONS	**ZAITEV** ELIMINATION REACTIONS

QUESTION 4

NSC 2023

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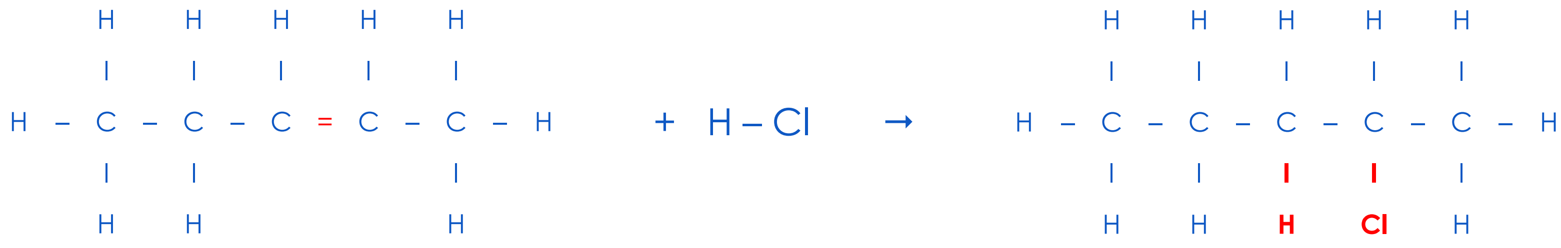

I	$CH_3CH_2CHCHCH_3$ + $HC\ell$ → **A** + **B**
II	**A** $\xrightarrow[\Delta]{H_2O}$ $CH_3CH_2CH_2CH(OH)CH_3$ + **X**
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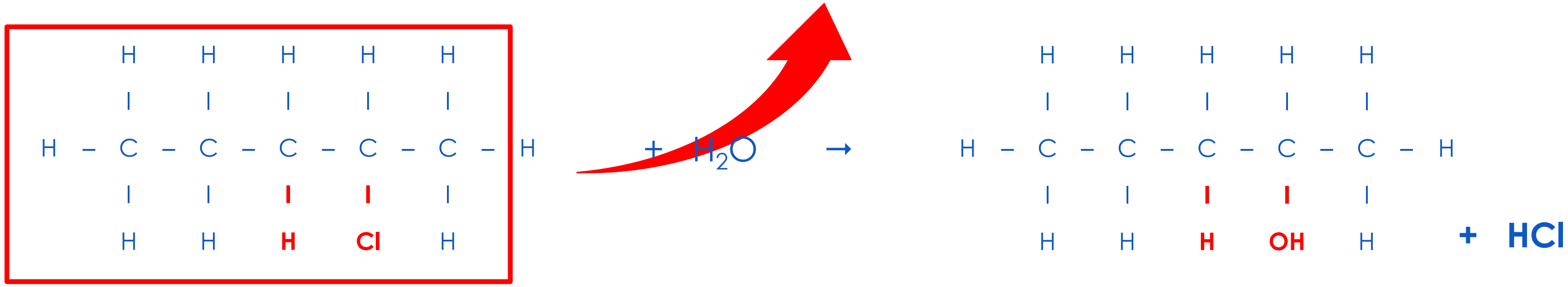
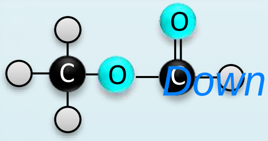


Compound A can be converted directly to the organic product of reaction III.

4.2.6 Besides heat, write down the reaction condition needed for this conversion

Strong base/NaOH /KOH/ LiOH/sodium hydroxide/potassium hydroxide/dissolved in ethanol



ORGANIC REACTIONS

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DEHIDROGENATION	ALKANE - H_2 → ALKENE (CATALYST: Pt / Ni / Pd)
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SUBSTITUTION REACTIONS	
HALOGENATION	ALKANE + X_2 → HALOALKANE (IN THE PRESENCE OF SUNLIGHT)
HYDROLYSIS	HALOALKANE + OH^- → ALCOHOL (NaOH(aq) / KOH(aq) & Ethanol & Low Heat)
HIDROHALOGENATION	ALCOHOL + HX → HALOALKANE (CATALYST: H_2SO_4(c) / H_3PO_4(c) & Heat)

MARKOVNIKOV ADDITION REACTIONS	ZAITEV ELIMINATION REACTIONS

QUESTION 4

NSC 2023

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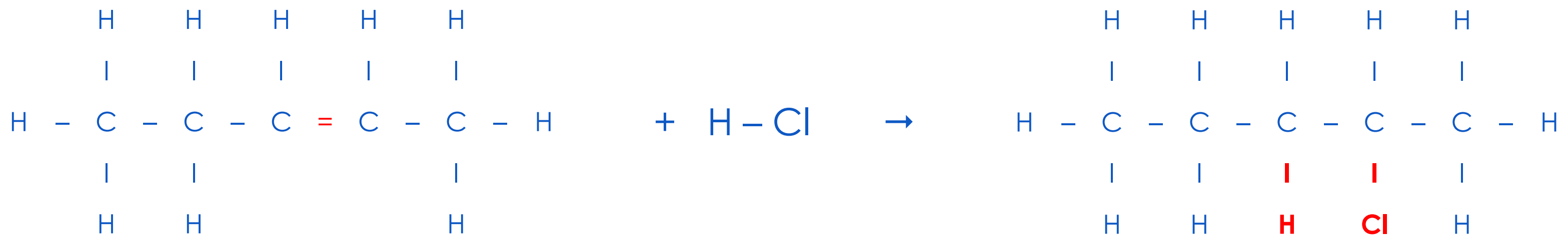
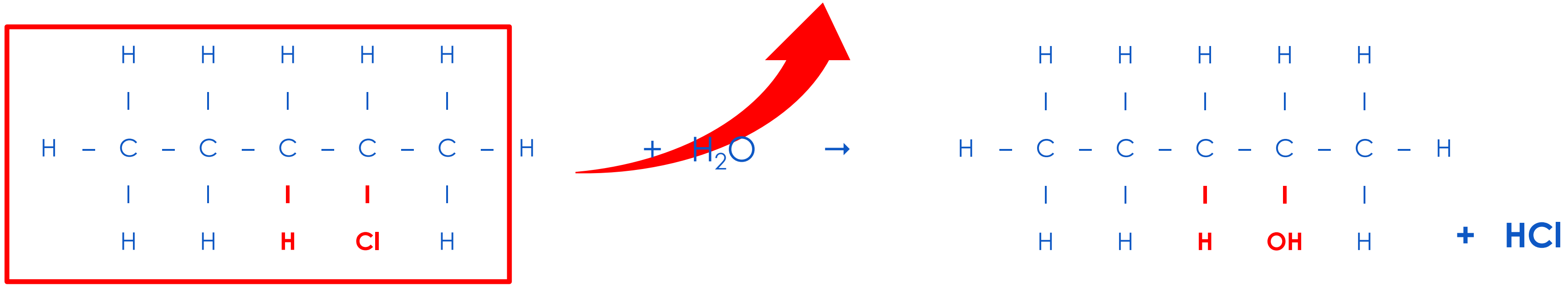


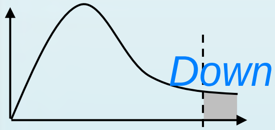
I	$CH_3CH_2CHCHCH_3$ + HCℓ → **A** + **B**
II	**A** $\xrightarrow[\Delta]{H_2O}$ $CH_3CH_2CH_2CH(OH)CH_3$ + **X**
III	$CH_3CH_2CH_2CH(OH)CH_3 \longrightarrow CH_3CH_2CHCHCH_3 + H_2O$



Compound A can be converted directly to the organic product of reaction III.

4.2.7 Write down TWO terms that describe this type of reaction.

ELIMINATION/DEHYDROHALOGENATION



REACTION RATE

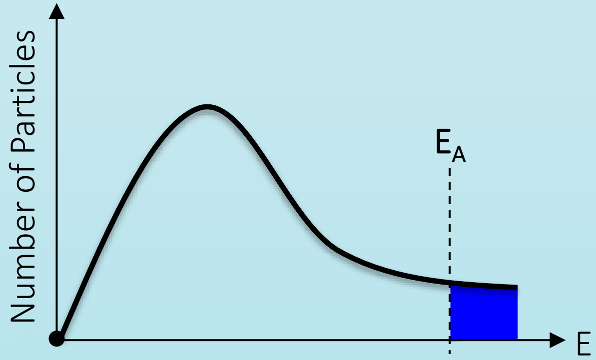
Make sure you know the correct wording of all definitions!

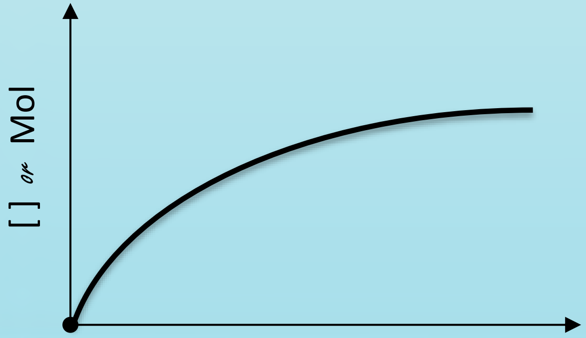
FACTORS:
Temperature / Concentration
Catalyst / Pressure
Nature of the reactants
State of division

$RT = \pm \frac{\Delta[\quad]}{\Delta \text{Time}}$

COLLISION THEORY

1. Identify the factor that differs.
2. Difference between particles.
3. Number of effective collisions per unit time.
4. Effect on reaction rate.





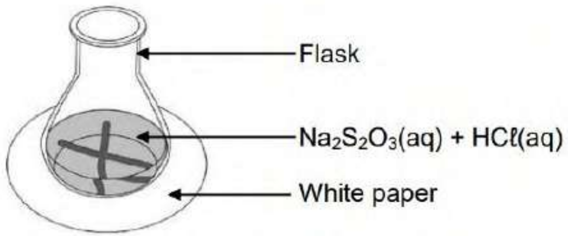
QUESTION 5

The reaction between EXCESS dilute hydrochloric acid and sodium thiosulphate is used to investigate factors that influence reaction rate. $Na_2S_2O_3(aq) + 2HC\ell(aq) \rightarrow 2NaC\ell(aq) + S(s) + H_2O(\ell) + SO_2(g)$

The concentration of $HC\ell(aq)$ used is 1 $mol.dm^{-3}$. The same volume of $HC\ell(aq)$ is used in each run. The time taken for the cross on the paper under the flask to become invisible is measured.

The table below summarises the reaction conditions and results of the experiment.

RUN	VOLUME $Na_2S_2O_3(aq)$ (cm^3)	VOLUME $H_2O(\ell)$ ADDED (cm^3)	CONCENTRATION $Na_2S_2O_3(aq)$ ($mol \cdot dm^{-3}$)	TIME (s)
1	50	0	0,13	20,4
2	40	10	0,10	26,7
3	30	20	**P**	33,3



5.1 Define reaction rate.

5.2 Write down the independent variable for this investigation.

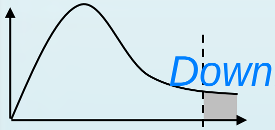
5.3 Calculate the value of P in the table.

5.4 When 0,21 g of sulphur has formed in Run 1, the cross becomes invisible. Calculate the average reaction rate with respect to sodium thiosulphate, $Na_2S_2O_3(aq)$, in $g.s^{-1}$.

Another investigation is performed at different temperatures.

5.5 Sketch the Maxwell-Boltzmann distribution curve for the reaction at 20 °C. Label this curve as A. On the same set of axis, draw the curve that will be obtained at 35 °C and label it as B.

5.6 Explain the effect of temperature on reaction rate in terms of the collision theory.



REACTION RATE

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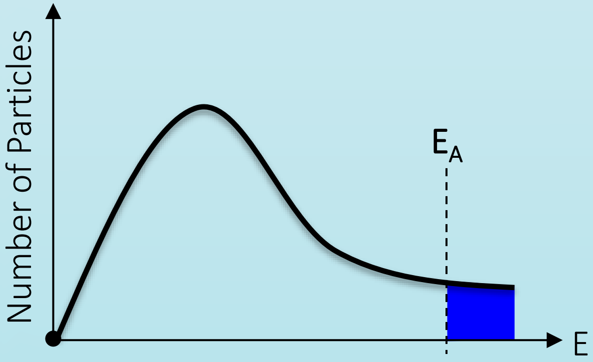

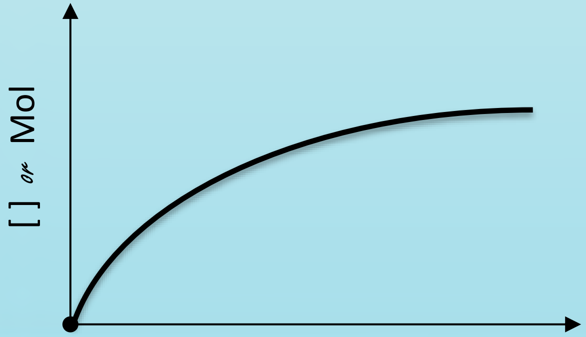

QUESTION 5

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The table below summarises the reaction conditions and results of the experiment.

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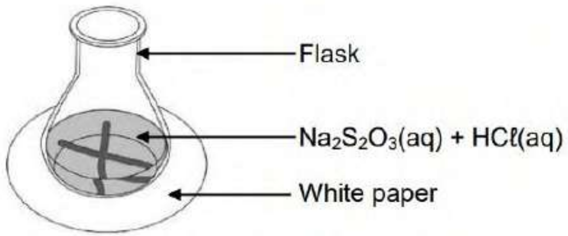
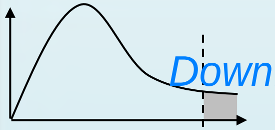


5.1 Define reaction rate.

REACTION RATE: The change in concentration of reactants or products per unit time.



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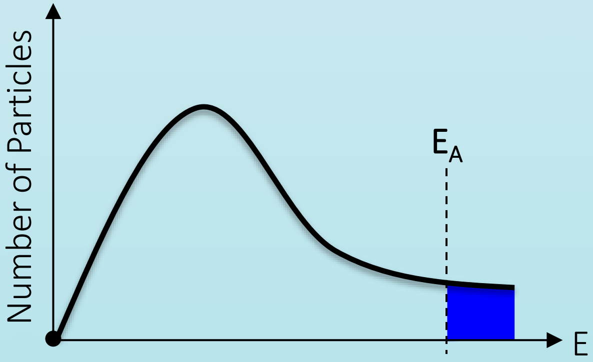

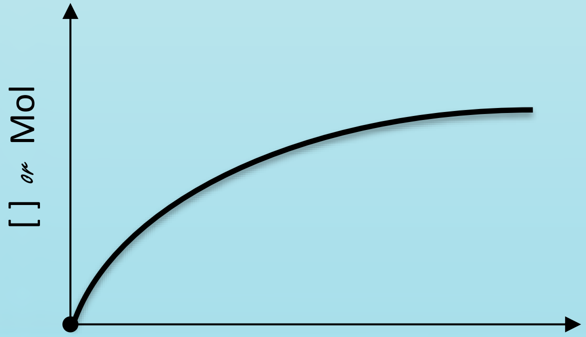

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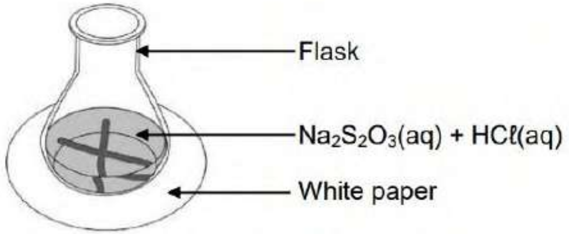
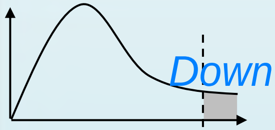
50 cm^3



5.2 Write down the independent variable for this investigation.

Concentration of the sodium thiosulphate ($Na_2S_2O_3$)



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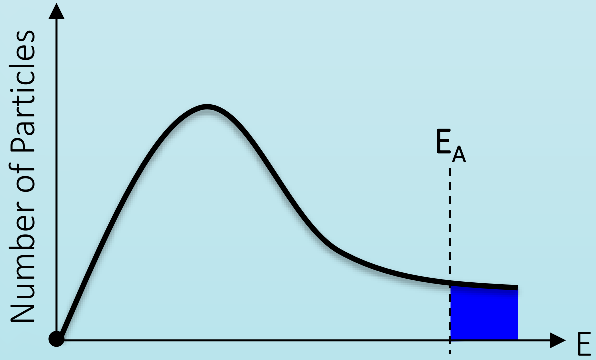

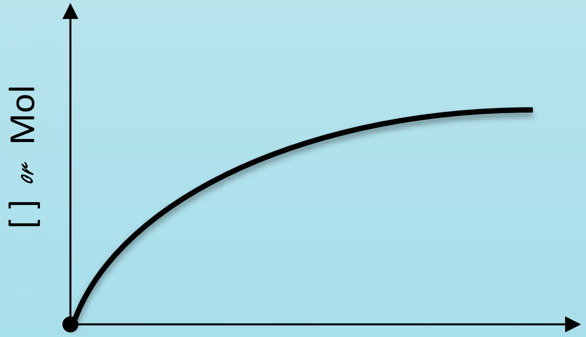

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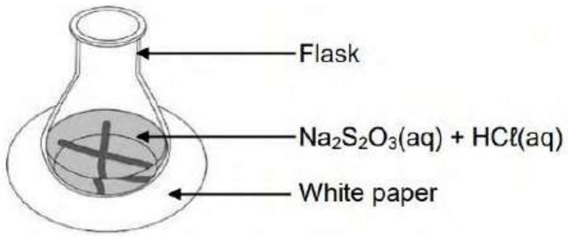
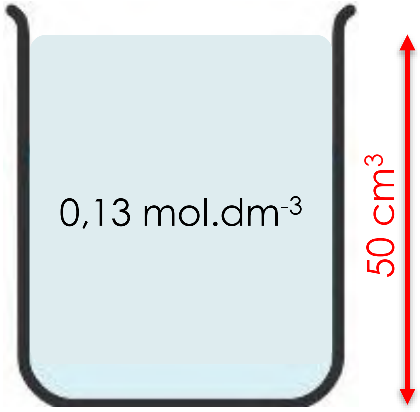
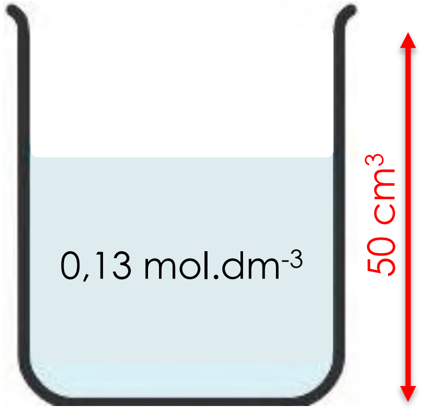
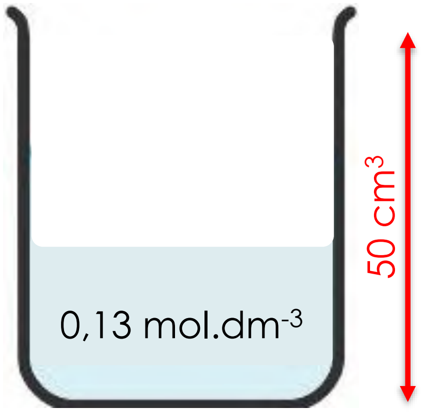


5.3 Calculate the value of P in the table.



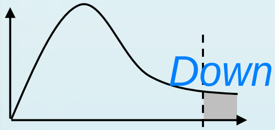




n = cV = (0,13)(0,05)
n = 0,0065 mol

n = cV = (0,13)(0,04)
n = 0,0052 mol

n = cV = (0,13)(0,03)
n = 0,0039 mol



REACTION RATE

Make sure you know the correct wording of all definitions!

FACTORS:
Temperature / Concentration
Catalyst / Pressure
Nature of the reactants
State of division

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COLLISION THEORY

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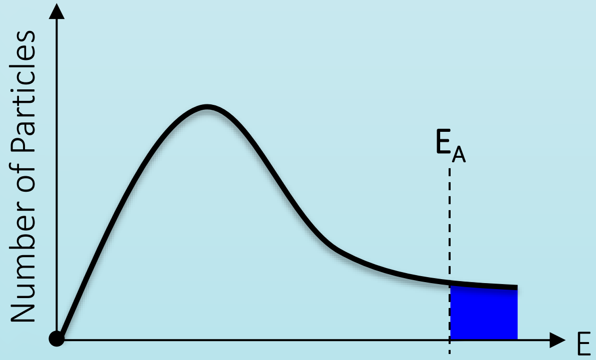

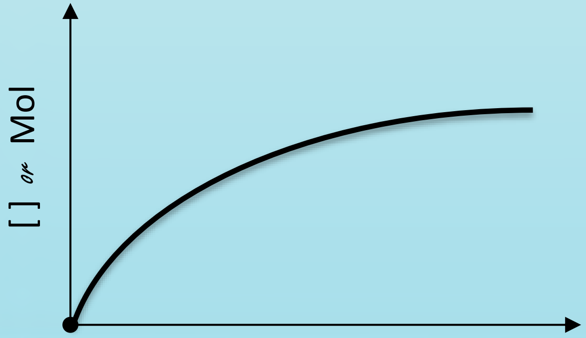

QUESTION 5

NSC 2023

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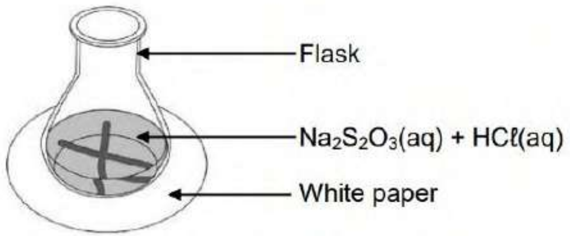

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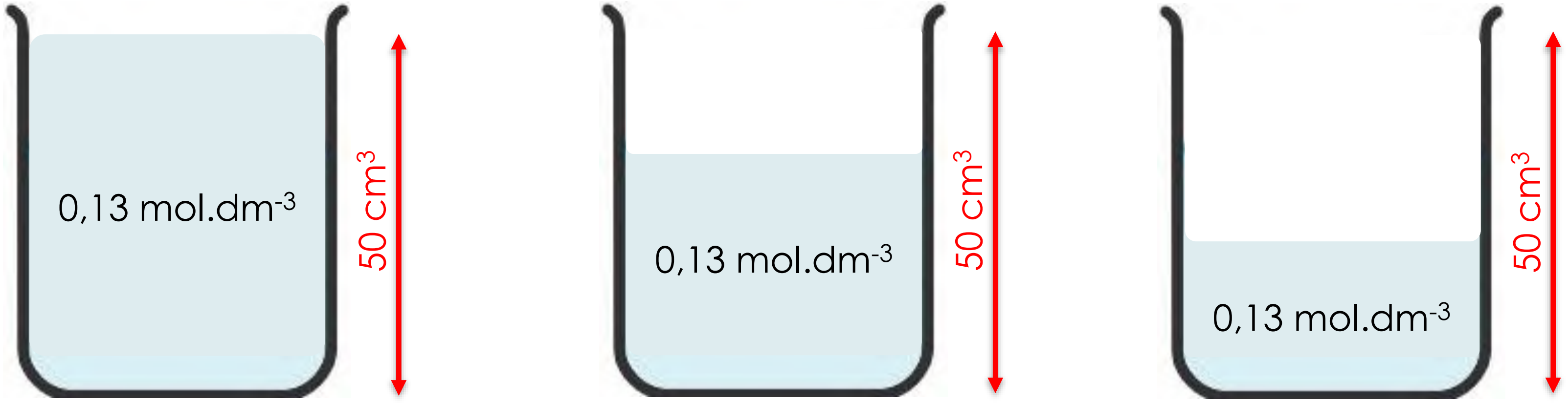
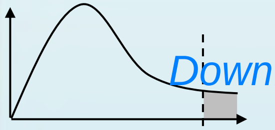


n = cV = (0,13)(0,05)
n = 0,0065 mol

$c = \frac{0,0052}{0,05} = 0,104$ mol.dm^{-3}

$c = \frac{0,0039}{0,05} = 0,078$ mol.dm^{-3}



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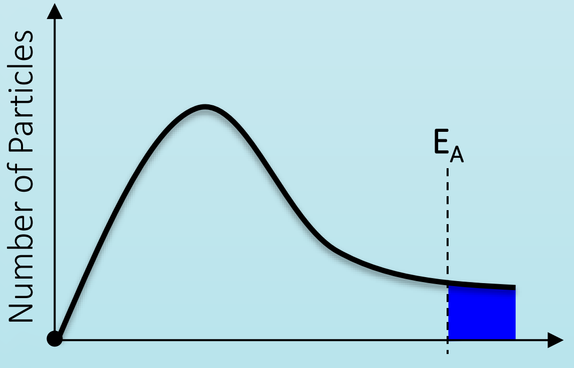

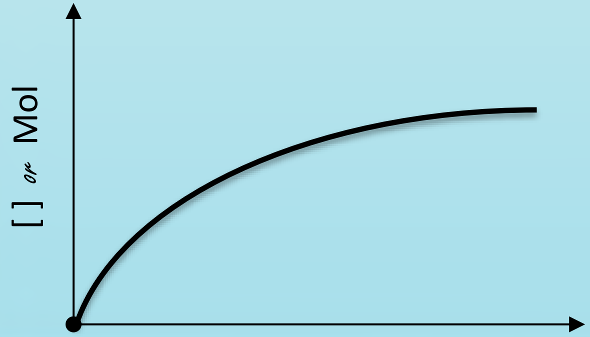

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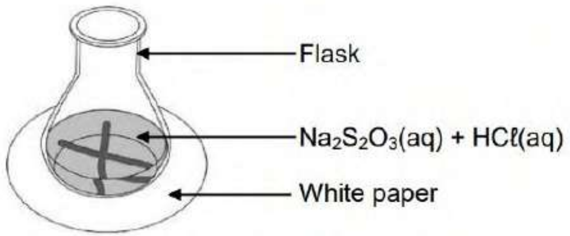


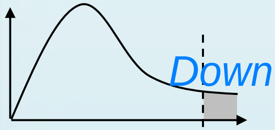
5.4 When 0,21 g of sulphur has formed in Run 1, the cross becomes invisible. Calculate the average reaction rate with respect to sodium thiosulphate, $Na_2S_2O_3(aq)$, in g.s^{-1} .

	$Na_2S_2O_3$	2HCl	2NaCl	S	H_2O	SO_2
n_i						
Δn	0,0065625			0,0065625		
n_f						
	$0{,}0065625 = \frac{\Delta m}{158}$ $\Delta m = 1{,}036875$			$\Delta n = \frac{\Delta m}{M}$ $\Delta n = \frac{0{,}21}{32}$ $\Delta n = 0{,}0065625$		

$$\text{Rate} = \frac{\Delta m}{\Delta t}$$

$$\text{Rate} = \frac{1{,}036875}{20{,}4}$$

$$\text{Rate} = 0{,}051 \text{ g.s}^{-1}$$



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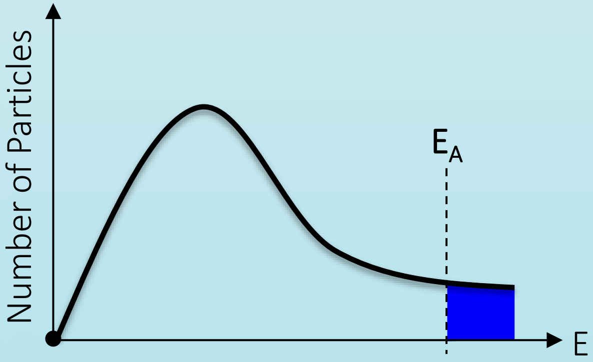

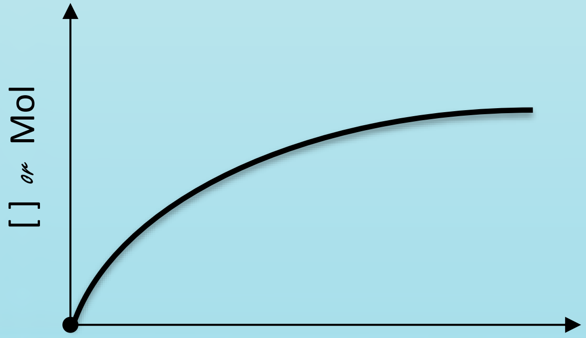

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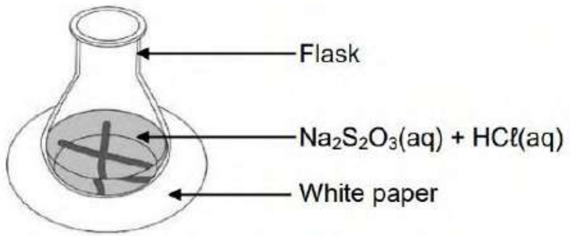
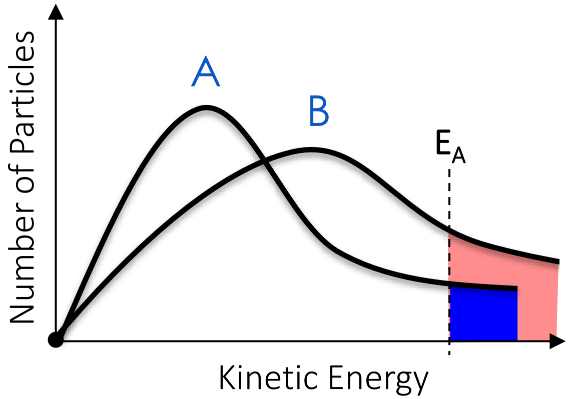
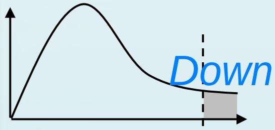


Another investigation is performed at different temperatures.

5.5 Sketch the Maxwell-Boltzmann distribution curve for the reaction at 20 °C. Label this curve as A. On the same set of axis, draw the curve that will be obtained at 35 °C and label it as B.





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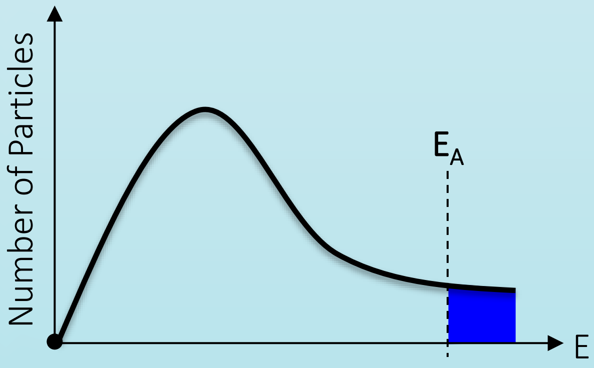

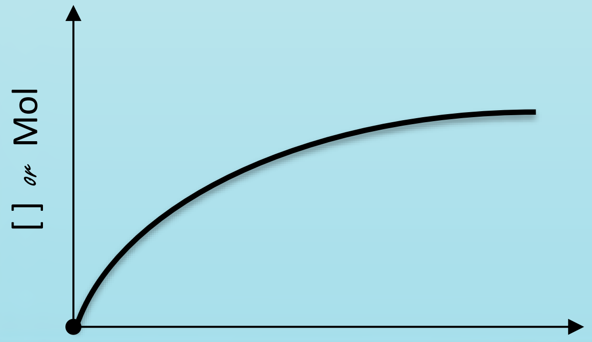

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NSC 2023

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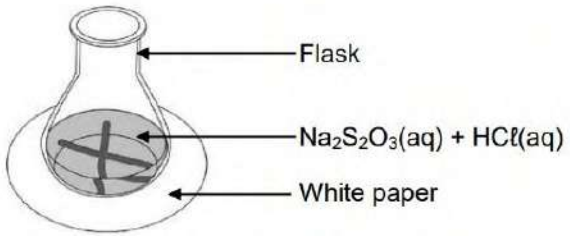


5.6 Explain the effect of temperature on reaction rate in terms of the collision theory.

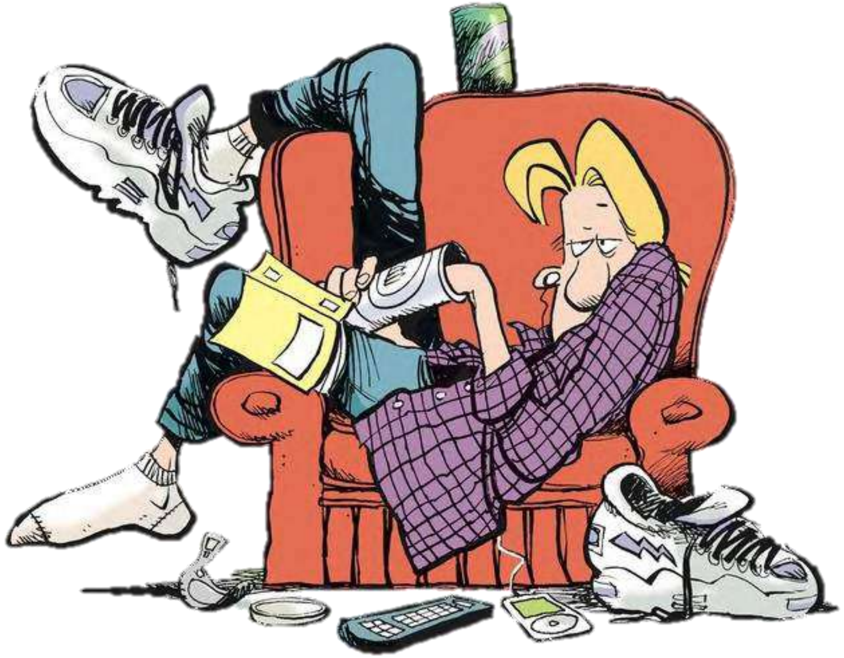
- At a higher temperature, the particles have more kinetic energy.
- More molecules have kinetic energy equal to or greater than the activation energy.
- More effective collisions per unit time.
- Reaction rate increases.

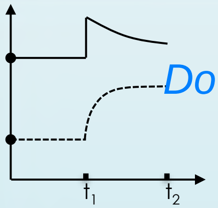
Complete the following Google form if you would like the video link and other resources to be sent to you:

https://bit.ly/4dIYf3i

5 minutes

OXYGEN BREAK



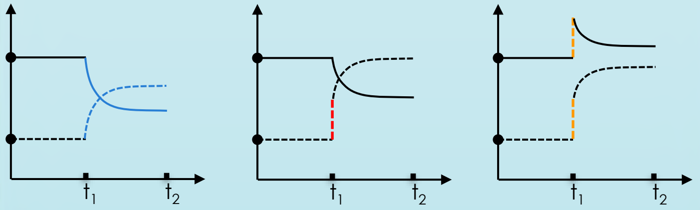


CHEMICAL EQUILIBRIUM

Make sure you know the correct wording of all definitions!

FACTORS

ENDOTHERMIC	↑ T ↓	EXOTHERMIC
AWAY	↑ [ ] ↓	TOWARDS
LEAST MOL	↑ P ↓	MOST MOL



- ID Disturbance.
- Le Chatelier
- Reaction favoured.
- Result.

Is the reaction **Exo**- or **Endo**thermic?

Temperature ↑ or ↓
Le Chatelier
Reaction favoured
K_c value ↑ or ↓

$$K_c = \frac{[A]^a[B]^b}{[C]^c[D]^d}$$

	H_2SO_4	2NaOH	Na_2SO_4	$2H_2O$
n_i			0	0
▲n				
n_f				
$c = \frac{n}{V}$				

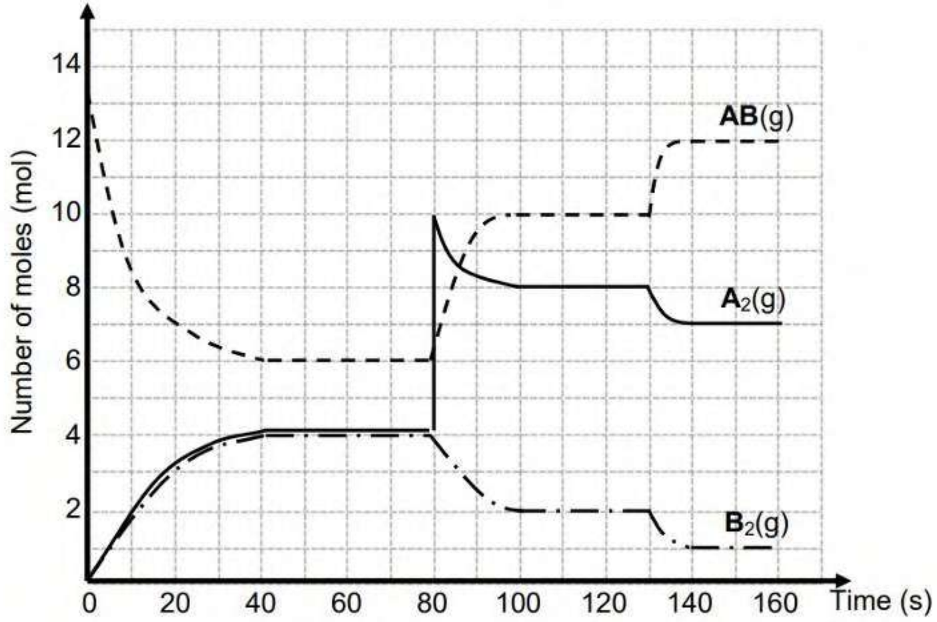
QUESTION 6

NSC 2023

Consider the following hypothetical reaction reaching equilibrium in a 4 dm³ closed container at 150 °C.

$$2AB(g) \rightleftharpoons A_2(g) + B_2(g)$$

The graph below shows the changes in the amounts of reactants and products over time.



6.1 Write down the meaning of the term reversible reaction.

6.2 State Le Chatelier's principle.

6.3 A change was made to the equilibrium mixture at t = 80 s.

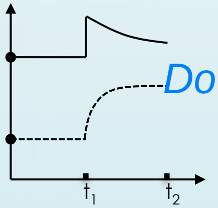
6.3.1 Write down the change made at t = 80 s.

6.3.2 Use Le Chatelier's principle to explain how the system reacts to this change.

6.4 Calculate the equilibrium constant, Kc, at t = 120 s.

6.5 At t = 130 s the temperature of the system is decreased to 100 °C.
6.5.1 Draw a potential energy diagram for this reaction.
6.5.2 Will the equilibrium constant, Kc, at 100 °C be GREATER THAN, LESS THAN or EQUAL TO the Kc at 150 °C? Explain the answer.

6.6 The initial reaction now takes place in the presence of a catalyst at 150 °C. Describe the changes that will be observed on the graph between t = 0 s and t = 60 s.



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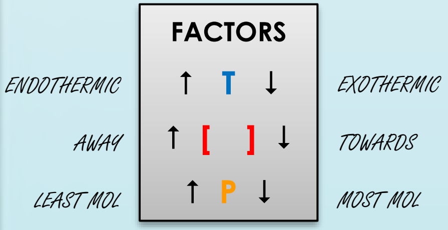

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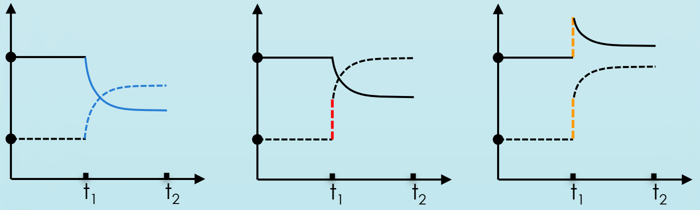

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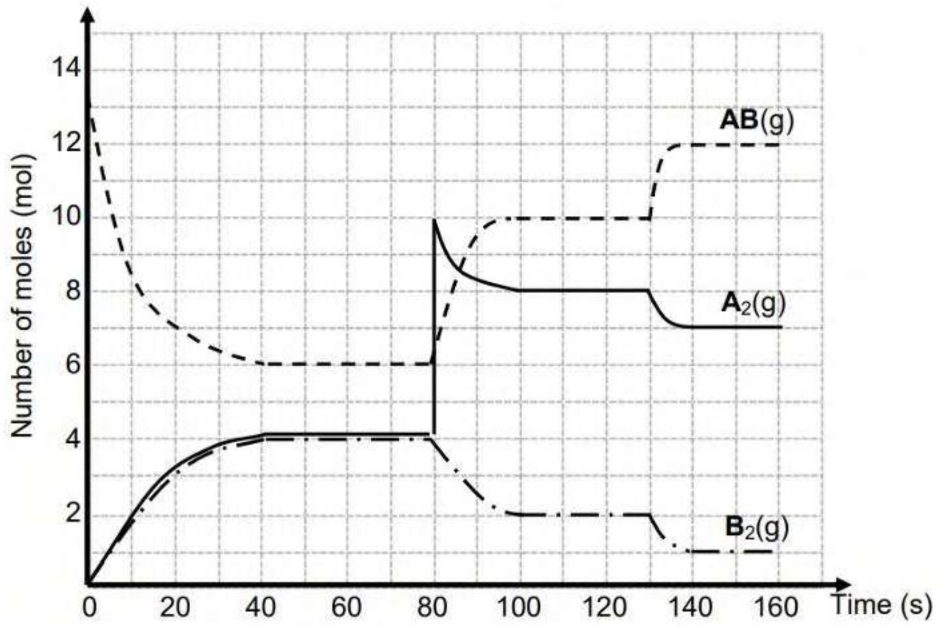
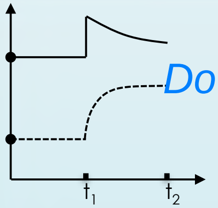


6.1 Write down the meaning of the term reversible reaction.

A reaction in which products can be converted back to reactants, and (vice versa).



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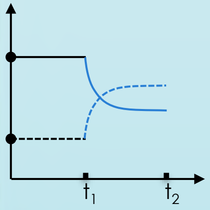

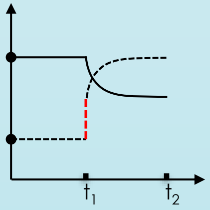

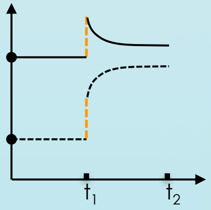

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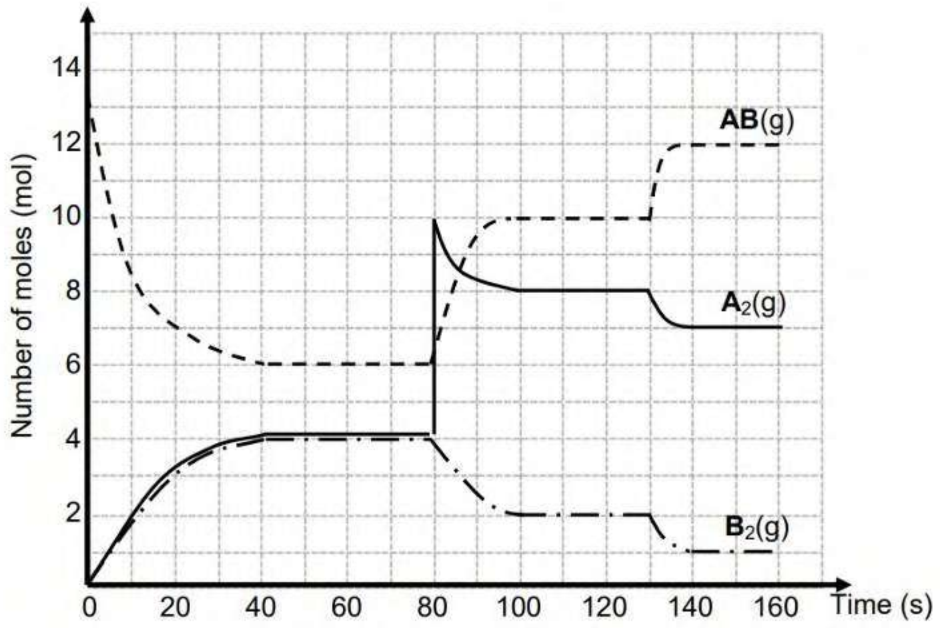
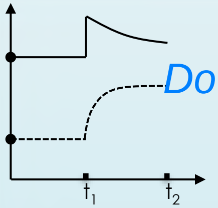


LE CHATELIER'S PRINCIPLE:

When the equilibrium in a closed system is disturbed, the system will re-instate a new equilibrium by favouring the reaction that will oppose the disturbance.



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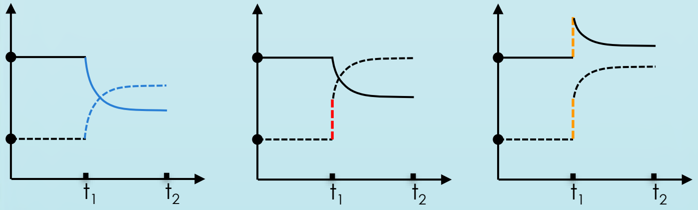

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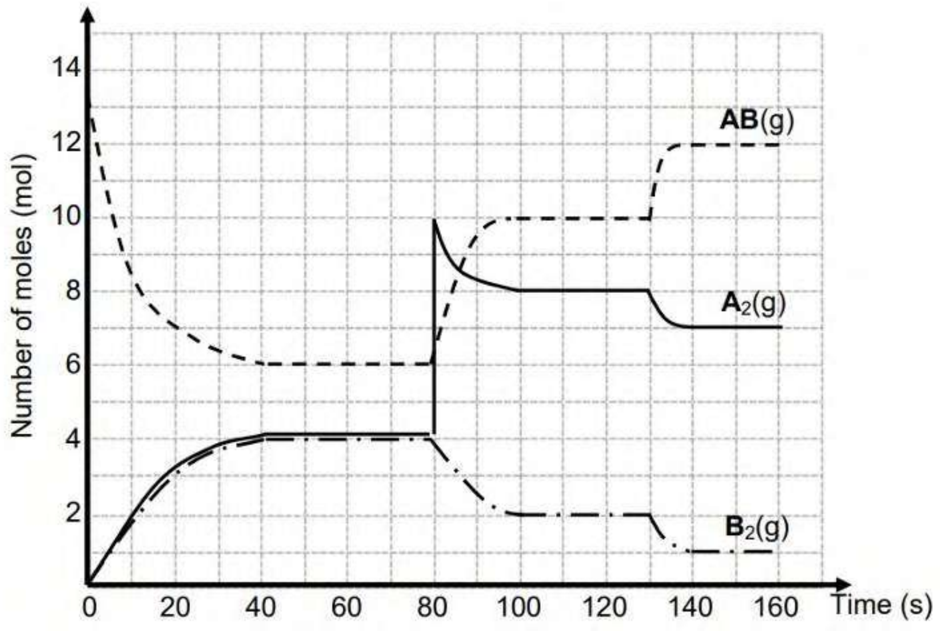


6.3 A change was made to the equilibrium mixture at t = 80 s.

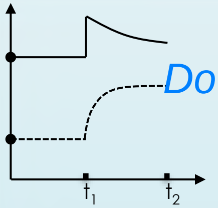
6.3.1 Write down the change made at t = 80 s.

6.3.2 Use Le Chatelier's principle to explain how the system reacts to this change.

6.3.1 The concentration $A_2(g)$ was increased

6.3.2 An increase in concentration of A_2 favors the reaction that decreases the concentration (away from the increase).

The reverse reaction is favored.
The amount of moles of the reactants increases.



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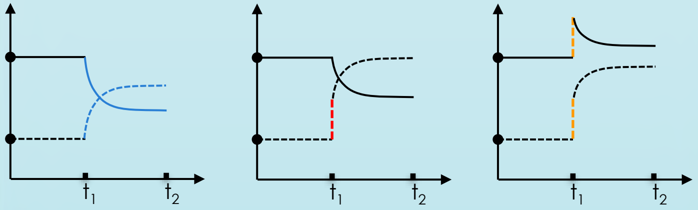
AWAY	↑	[ ]	↓	TOWARDS
LEAST MOL	↑	P	↓	MOST MOL



- ID Disturbance.
- Le Chatelier
- Reaction favoured.
- Result.

Is the reaction **Exo**- or **Endo**thermic?

Temperature ↑ or ↓
Le Chatelier
Reaction favoured
K_c value ↑ or ↓

$$K_c = \frac{[A]^a[B]^b}{[C]^c[D]^d}$$

	H_2SO_4	2NaOH	Na_2SO_4	$2H_2O$
n_i			0	0
▲n				
n_f				
$c = \frac{n}{V}$				

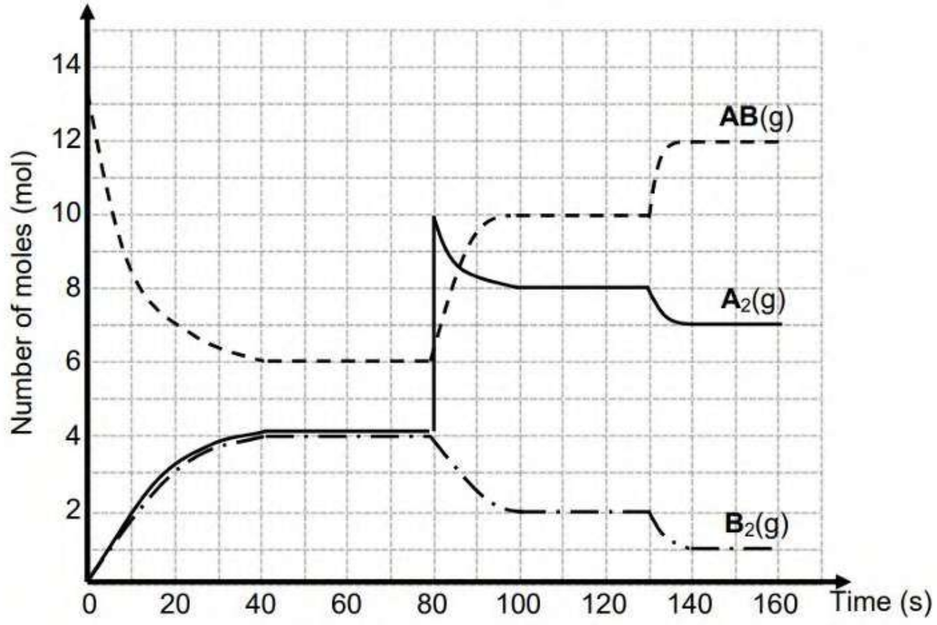
QUESTION 6

NSC 2023

Consider the following hypothetical reaction reaching equilibrium in a 4 dm³ closed container at 150 °C.

$$2AB(g) \rightleftharpoons A_2(g) + B_2(g)$$

The graph below shows the changes in the amounts of reactants and products over time.



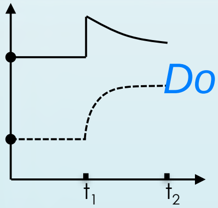
6.4 Calculate the equilibrium constant, Kc, at t = 120 s.

	2AB	A_2	B_2
ni	14	0	0
△n	– 8	+ 4	+ 4
nf	6	4	4
$c = \frac{n}{V}$	$c = \frac{6}{4}$	$c = \frac{4}{4}$	$c = \frac{4}{4}$

$$K_c = \frac{[A_2][B_2]}{[AB]^2}$$

$$K_c = \frac{(1)(1)}{(1,5)^2}$$

$$K_c = 0,44$$

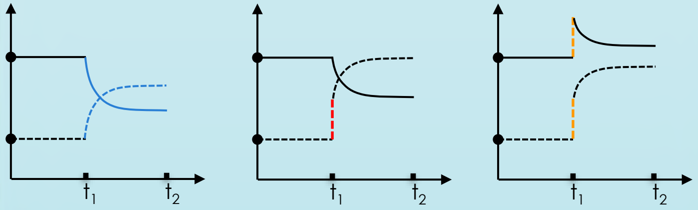


CHEMICAL EQUILIBRIUM

Make sure you know the correct wording of all definitions!

FACTORS

ENDOTHERMIC	↑ T ↓	EXOTHERMIC
AWAY	↑ [ ] ↓	TOWARDS
LEAST MOL	↑ P ↓	MOST MOL



- ID Disturbance.
- Le Chatelier
- Reaction favoured.
- Result.

Is the reaction **Exo**- or **Endo**thermic?

Temperature ↑ or ↓
Le Chatelier
Reaction favoured
K_c value ↑ or ↓

$$K_c = \frac{[A]^a[B]^b}{[C]^c[D]^d}$$

	H_2SO_4	$2NaOH$	Na_2SO_4	$2H_2O$
n_i			0	0
▲n				
n_f				
$c = \frac{n}{V}$				

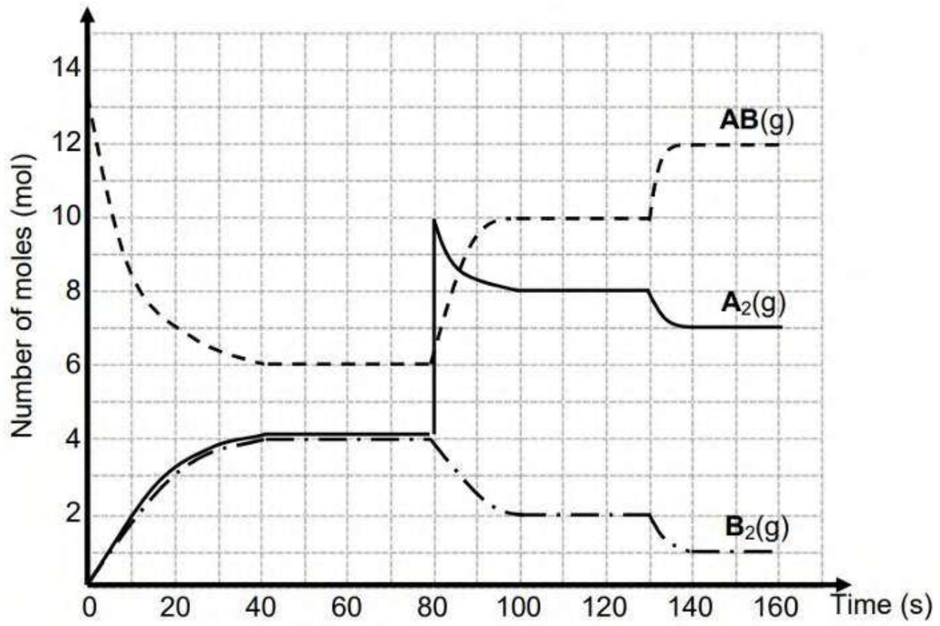
QUESTION 6

NSC 2023

Consider the following hypothetical reaction reaching equilibrium in a 4 dm^3 closed container at 150 °C.

$$2AB(g) \rightleftharpoons A_2(g) + B_2(g)$$

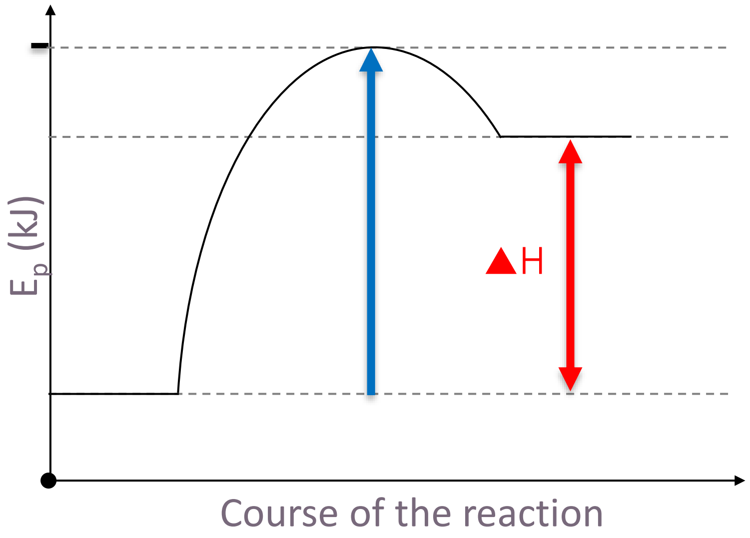
The graph below shows the changes in the amounts of reactants and products over time.



6.5 At t = 130 s the temperature of the system is decreased to 100 °C.

6.5.1 Draw a potential energy diagram for this reaction.

6.5.2 Will the equilibrium constant, Kc, at 100 °C be GREATER THAN, LESS THAN or EQUAL TO the Kc at 150 °C? Explain the answer.



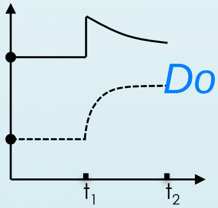
Temperature decreases. ↑

[AB] increases. ↓

∴ Reverse reaction is exothermic.

∴ Forward reaction in endothermic.

K_c decreases with a decrease in temperature.



CHEMICAL EQUILIBRIUM

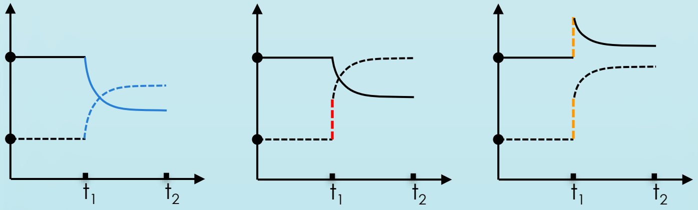
Make sure you know the correct wording of all definitions!

FACTORS

ENDOTHERMIC ↑ T ↓ EXOTHERMIC

AWAY ↑ [ ] ↓ TOWARDS

LEAST MOL ↑ P ↓ MOST MOL



- ID Disturbance.
- Le Chatelier
- Reaction favoured.
- Result.

Is the reaction **Exo**- or **Endo**thermic?

Temperature ↑ or ↓
Le Chetalier
Reaction favoured
K_c value ↑ or ↓

$$K_c = \frac{[A]^a[B]^b}{[C]^c[D]^d}$$

	H_2SO_4	2NaOH	Na_2SO_4	$2H_2O$
n_i			0	0
▲n				
n_f				
$c = \frac{n}{V}$				

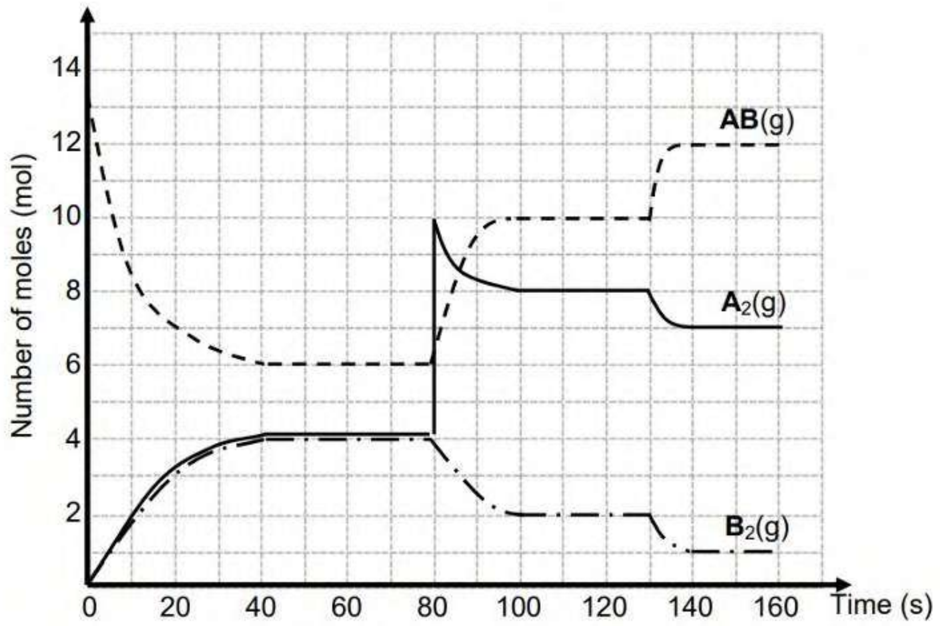
QUESTION 6

NSC 2023

Consider the following hypothetical reaction reaching equilibrium in a 4 dm^3 closed container at 150 °C.

$$2AB(g) \rightleftharpoons A_2(g) + B_2(g)$$

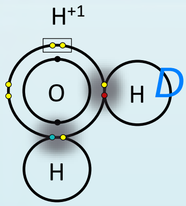
The graph below shows the changes in the amounts of reactants and products over time.



6.6 The initial reaction now takes place in the presence of a catalyst at 150 °C. Describe the changes that will be observed on the graph between t = 0 s and t = 60 s.

CATALYST increases the forward AND the reverse reaction rates.

All three curves will start and end at the same place, but the gradients of all three curves are steeper and reach equilibrium faster.



ACID-BASE REACTIONS

Make sure you know the correct wording of all definitions!

Acid + Metal → Salt + H_2

Acid + Metal hydroxide → Salt + H_2O

Acid + Metal oxide → Salt + H_2O

Acid + Metal carbonate → Salt + CO_2 + H_2O

INDICATORS

Methyl Orange (Red/Yellow)

Bromothymol Blue (Yellow/Blue)

Phenolphthalein (Colorless/Pink)

TITRATIONS

$$\frac{c_a V_a}{c_b V_b} = \frac{n_a}{n_b}$$

pH-CALCULATIONS

$2H_2O \leftrightarrows H_3O^+ + OH^-$

$K_w = [H_3O^+][OH^-] = 1 \times 10^{-14}$

$pH = -\log[H_3O^+]$

Hydrolysis of *Salts*

QUANTITATIVE CHEMISTRY

	H_2SO_4	2NaOH	Na_2SO_4	$2H_2O$
n : n	1	2	1	2
n_i				
▲n				
n_f				

QUESTION 7

NSC 2023

To identify metal **M** in an unknown metal carbonate, **M**CO_3, the following procedure is carried out:

Step 1: 0,198 g of IMPURE **M**CO_3 is reacted with 25 cm^3 of 0,4 $mol.dm^{-3}$ nitric acid, HNO_3(aq).

Step 2: The EXCESS HNO_3(aq) is then neutralised with 20 cm^3 of 0,15 $mol.dm^{-3}$ barium hydroxide, $Ba(OH)_2$(aq).

Assume that the volumes are additive.

The following reactions take place:

$$2HNO_3(aq) + \mathbf{M}CO_3(s) \rightarrow \mathbf{M}(NO_3)_2(aq) + CO_2(g) + H_2O(\ell)$$

$$2HNO_3(aq) + Ba(OH)_2(aq) \rightarrow Ba(NO_3)_2(aq) + 2H_2O(\ell)$$

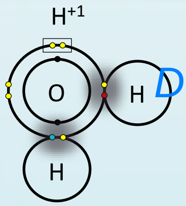
7.1 Define the term strong base.

7.2 Calculate the:

7.2.1 Number of moles of $Ba(OH)_2$(aq) that reacted with the excess HNO_3(aq)

7.2.2 pH of the solution after Step 1

7.3 The percentage purity of the **M**CO_3(s) in the sample is 85%. Identify metal **M**.



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Acid + Metal carbonate → Salt + CO_2 + H_2O

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Methyl Orange (Red/Yellow)
Bromothymol Blue (Yellow/Blue)
Phenolphthalein (Colorless/Pink)

TITRATIONS

$$\frac{c_a V_a}{c_b V_b} = \frac{n_a}{n_b}$$

pH-CALCULATIONS

$2H_2O \leftrightharpoons H_3O^+ + OH^-$

$K_w = [H_3O^+][OH^-] = 1 \times 10^{-14}$

$pH = -\log[H_3O^+]$

Hydrolysis of *Salts*

QUANTITATIVE CHEMISTRY

	H_2SO_4	2NaOH	Na_2SO_4	$2H_2O$
n : n	1	2	1	2
n_i				
▲n				
n_f				

QUESTION 7

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The following reactions take place:

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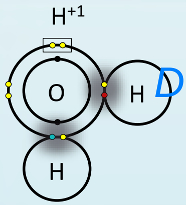
$$2HNO_3(aq) + Ba(OH)_2(aq) \rightarrow Ba(NO_3)_2(aq) + 2H_2O(\ell)$$

7.1 Define the term strong base.

STRONG BASE: Base that completely dissociates in water to form a high concentration of hydroxyde ions.



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Phenolphthalein (Colorless/Pink)

TITRATIONS

$$\frac{c_a V_a}{c_b V_b} = \frac{n_a}{n_b}$$

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$K_w = [H_3O^+][OH^-] = 1 \times 10^{-14}$

$pH = -\log[H_3O^+]$

Hydrolysis of *Salts*

QUANTITATIVE CHEMISTRY

	H_2SO_4	2NaOH	Na_2SO_4	$2H_2O$
n : n	1	2	1	2
n_i				
▲n				
n_f				

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Assume that the volumes are additive.

The following reactions take place:

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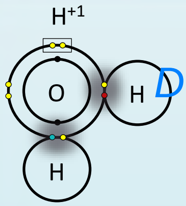
$$2HNO_3(aq) + Ba(OH)_2(aq) \rightarrow Ba(NO_3)_2(aq) + 2H_2O(\ell)$$

7.2 Calculate the:

7.2.1 Number of moles of $Ba(OH)_2(aq)$ that reacted with the excess $HNO_3(aq)$

7.2.2 pH of the solution after Step 1



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Phenolphthalein (Colorless/Pink)

TITRATIONS

$$\frac{c_a v_a}{c_b v_b} = \frac{n_a}{n_b}$$

pH-CALCULATIONS

$2H_2O \leftrightharpoons H_3O^+ + OH^-$
$K_w = [H_3O^+][OH^-] = 1 \times 10^{-14}$
$pH = -\log[H_3O^+]$

Hydrolysis of
Salts

QUANTITATIVE CHEMISTRY

	H_2SO_4	2NaOH	Na_2SO_4	$2H_2O$
n : n	1	2	1	2
n_i				
▲n				
n_f				

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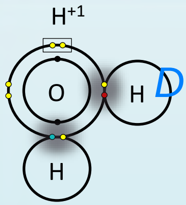
Assume that the volumes are additive.

The following reactions take place:

$$2HNO_3(aq) + \mathbf{M}CO_3(s) \rightarrow \mathbf{M}(NO_3)_2(aq) + CO_2(g) + H_2O(\ell)$$

	$2HNO_3$	MCO_3	$M(NO_3)_2$	CO_2	H_2O
ni			0	0	0
△n					
nf	0,006 ❹				
	c = 0,4 $mol.dm^{-3}$ V = 0,025 dm^3	m = 0,198 g			

	$2HNO_3$	$Ba(OH)_2$	$Ba(NO_3)_2$	H_2O
ni	0,006 ❹	0,003 ❶	0	0
△n	0,006 ❸	0,003 ❷		
nf	0	0		
		c = 0,15 $mol.dm^{-3}$ V = 0,02 dm^3 n = cV =(0,15)(0,02)		



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Hydrolysis of **Salts**

QUANTITATIVE CHEMISTRY

	H_2SO_4	2NaOH	Na_2SO_4	$2H_2O$
n : n	1	2	1	2
n_i				
▲n				
n_f				

	$2HNO_3$	MCO_3	$M(NO_3)_2$	CO_2	H_2O
ni			0	0	0
△n					
nf	0,006 ❹				
	c = 0,4 mol.dm^{-3} V = 0,025 dm^3	m = 0,198 g			

Assume that the volumes are additive

	$2HNO_3$	$Ba(OH)_2$	$Ba(NO_3)_2$	H_2O
ni	0,006 ❹	0,003 ❶	0	0
△n	0,006 ❸	0,003 ❷		
nf	0	0		
		c = 0,15 mol.dm^{-3} V = 0,02 dm^3 n = cV =(0,15)(0,02)		

7.2.1 Number of moles of $Ba(OH)_2$(aq) that reacted with the excess HNO_3(aq)

7.2.2 pH of the solution after Step 1

7.2.1 ❶ n = cV = (0,15)(0,02) = 0,003 mol

❷ $\triangle n_{(Ba(OH)_2)}$ = 0,003 mol

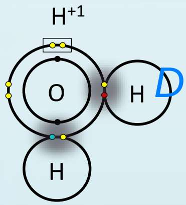
7.2.2 ❸ $\triangle n_{(HNO_3)} : \triangle n_{(Ba(OH)_2)} = 2 : 1$

$\therefore \triangle n_{(HNO_3)}$ = 0,006 mol

❹ $c_{f\,(HNO_3)} = \frac{n}{V} = \frac{0,006}{0,025} = 0,24 \text{ mol.dm}^{-3}$

$pH = -\log[H_30^+]$

pH = -log(0,24) = 0,62



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$$\frac{c_a V_a}{c_b V_b} = \frac{n_a}{n_b}$$

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$2H_2O \leftrightharpoons H_3O^+ + OH^-$
$K_w = [H_3O^+][OH^-] = 1 \times 10^{-14}$
$pH = -\log[H_3O^+]$

Hydrolysis of *Salts*

QUANTITATIVE CHEMISTRY

	H_2SO_4	2NaOH	Na_2SO_4	$2H_2O$
n : n	1	2	1	2
n_i				
▲n				
n_f				

	$2HNO_3$	MCO_3	$M(NO_3)_2$	CO_2	H_2O
ni	0,01 ⑤	0,00235294117 ⑧	0	0	0
△n	0,004 ⑥	0,002 ⑦			
nf	0,006 ④				
	c = 0,4 mol.dm^{-3} V = 0,025 dm^3 n = cV = (0,4)(0,025)	m = 0,198 g			

Assume that the volumes are additive

	$2HNO_3$	$Ba(OH)_2$	$Ba(NO_3)_2$	H_2O
ni	0,006 ④	0,003 ①	0	0
△n	0,006 ③	0,003 ②		
nf	0	0		
		c = 0,15 mol.dm^{-3} V = 0,02 dm^3 n = cV =(0,15)(0,02)		

7.3 The percentage purity of the **M**CO_3(s) in the sample is 85%. Identify metal **M**.

⑤ $n_{(HNO_3)} = cV = (0,4)(0,025) = 0,01$ mol

⑥ $\triangle n_{(HNO_3)} = 0,01 - 0,006 = 0,004$ mol

⑦ $\triangle n_{(HNO_3)} : \triangle n_{(MCO_3)} = 2 : 1$

$\therefore \triangle n_{(MCO_3)} = 0,002$ mol

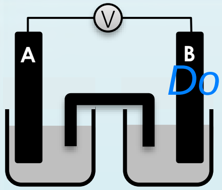
⑧ 85% van $n_{i\,(MCO_3)} = 0,002$ mol

$\therefore n_{i\,(MCO_3)} = 0,00235294117$ mol

$\therefore n_{i\,(MCO_3)} = \frac{m}{M}$

$0,00235294117 = \frac{0,198}{M+12+3(16)}$

$\therefore$ M = 24,15 g.mol^{-1} en M is Mg



GALVANIC CELLS

Make sure you know the correct wording of all definitions!

CELL NOTATION: Anode // Cathode

Element / Ion // Ion / Element

$Zn / Zn^{2+} // Cu^{2+} / Cu$

STANDARD CONDITIONS

Temp. 25 °C (298 K)

Concentration 1 $mol \cdot dm^{-3}$

Pressure 101,3 kPa.

ELECTRODES

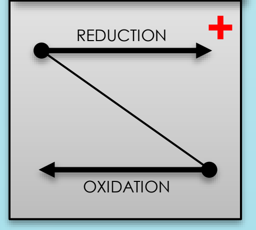
Metal

Gas

$$E^{\theta}_{cell} = E^{\theta}_{cathode} - E^{\theta}_{anode}$$

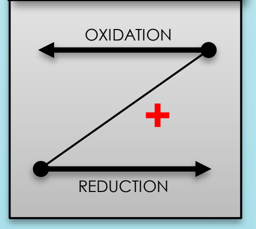
$$E^{\theta}_{cell} = E^{\theta}_{reduction} - E^{\theta}_{oxidation}$$

TABLE 4A



Spontaneous Reaction

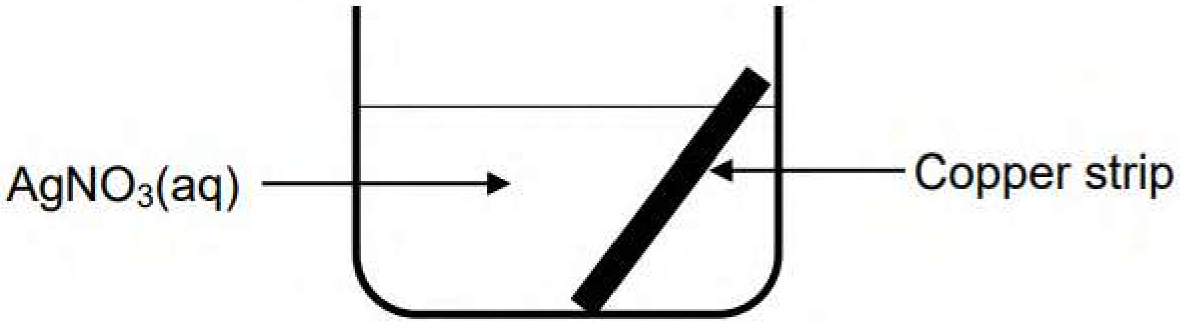
TABLE 4B



QUESTION 8

NSC 2023

A cleaned pure copper strip, Cu(s), is placed in a beaker containing a colourless silver nitrate solution, $AgNO_3(aq)$, at 25 °C, as shown below.



After a while, it is observed that the solution in the beaker becomes blue.

8.1 Write down:

8.1.1 ONE other OBSERVABLE change, besides the solution turning blue

8.1.2 The NAME or FORMULA of the oxidising agent

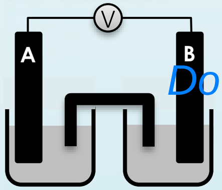
8.2 Explain the answer to QUESTION 8.1.1 by referring to the relative strengths of the oxidising agents or reducing agents.

TABLE 4A: REDOX HALF REACTIONS

			E^{θ} (V)
$F_2(g) + 2e^-$	⇌	$2F^-$	+ 2,87
$Co^{3+} + e^-$	⇌	Co^{2+}	+ 1,81
$H_2O_2 + 2H^+ + 2e^-$	⇌	$2H_2O$	+1,77
$MnO_4^- + 8H^+ + 5e^-$	⇌	$Mn^{2+} + 4H_2O$	+ 1,51
$Cl_2(g) + 2e^-$	⇌	$2Cl^-$	+ 1,36
$Cr_2O_7^{2-} + 14H^+ + 6e^-$	⇌	$2Cr^{3+} + 7H_2O$	+ 1,33
$O_2(g) + 4H^+ + 4e^-$	⇌	$2H_2O$	+ 1,23
$MnO_2 + 4H^+ + 2e^-$	⇌	$Mn^{2+} + 2H_2O$	+ 1,23
$Pt^{2+} + 2e^-$	⇌	Pt	+ 1,20
$Br_2(l) + 2e^-$	⇌	$2Br^-$	+ 1,07
$NO_3^- + 4H^+ + 3e^-$	⇌	$NO(g) + 2H_2O$	+ 0,96
$Hg^{2+} + 2e^-$	⇌	$Hg(l)$	+ 0,85
$Ag^+ + e^-$	⇌	Ag	+ 0,80
$NO_3^- + 2H^+ + e^-$	⇌	$NO_2(g) + H_2O$	+ 0,80
$Fe^{3+} + e^-$	⇌	Fe^{2+}	+ 0,77
$O_2(g) + 2H^+ + 2e^-$	⇌	H_2O_2	+ 0,68
$I_2 + 2e^-$	⇌	$2I^-$	+ 0,54
$Cu^+ + e^-$	⇌	Cu	+ 0,52
$SO_2 + 4H^+ + 4e^-$	⇌	$S + 2H_2O$	+ 0,45
$2H_2O + O_2 + 4e^-$	⇌	$4OH^-$	+ 0,40
$Cu^{2+} + 2e^-$	⇌	Cu	+ 0,34
$SO_4^{-2} + 4H^+ + e^-$	⇌	$SO_2(g) + 2H_2O$	+ 0,17

TABLE 4B: REDOX HALF REACTIONS

			E^{θ} (V)
$Li^+ + e^-$	⇌	Li	– 3,05
$K^+ + e^-$	⇌	K	– 2,93
$Cs^+ + e^-$	⇌	Cs	– 2,92
$Ba^{2+} + 2e^-$	⇌	Ba	– 2,90
$Sr^{2+} + 2e^-$	⇌	Sr	– 2,89
$Ca^{2+} + 2e^-$	⇌	Ca	– 2,87
$Na^+ + e^-$	⇌	Na	– 2,71
$Mg^{2+} + 2e^-$	⇌	Mg	– 2,36
$Al^{3+} + 3e^-$	⇌	Al	– 1,66
$Mn^{2+} + 2e^-$	⇌	Mn	– 1,18
$Cr^{2+} + 2e^-$	⇌	Cr	– 0,91
$2H_2O + 2e^-$	⇌	$H_2(g) + 2OH^-$	– 0,83
$Zn^{2+} + 2e^-$	⇌	Zn	– 0,76
$Cr^{3+} + 3e^-$	⇌	Cr	– 0,74
$Fe^{2+} + 2e^-$	⇌	Fe	– 0,44
$Cr^{3+} + e^-$	⇌	Cr^{2+}	– 0,41
$Cd^{2+} + 2e^-$	⇌	Cd	– 0,40
$Co^{2+} + 2e^-$	⇌	Co	– 0,28
$Ni^{2+} + 2e^-$	⇌	Ni	– 0,27
$Sn^{2+} + 2e^-$	⇌	Sn	– 0,14
$Pb^{2+} + 2e^-$	⇌	Pb	– 0,13
$Fe^{3+} + 3e^-$	⇌	Fe	– 0,06



GALVANIC CELLS

Make sure you know the correct wording of all definitions!

CELL NOTATION: Anode // Cathode

Element / Ion // Ion / Element

$Zn / Zn^{2+} // Cu^{2+} / Cu$

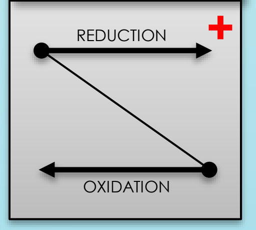
STANDARD CONDITIONS
Temp. 25 °C (298 K)
Concentration 1 $mol \cdot dm^{-3}$
Pressure 101,3 kPa.

ELECTRODES
Metal
Gas

$$E^{\theta}_{cell} = E^{\theta}_{cathode} - E^{\theta}_{anode}$$

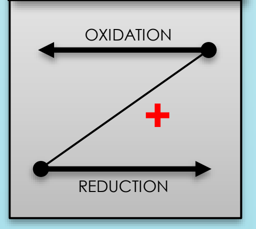
$$E^{\theta}_{cell} = E^{\theta}_{reduction} - E^{\theta}_{oxidation}$$

TABLE 4A



Spontaneous Reaction

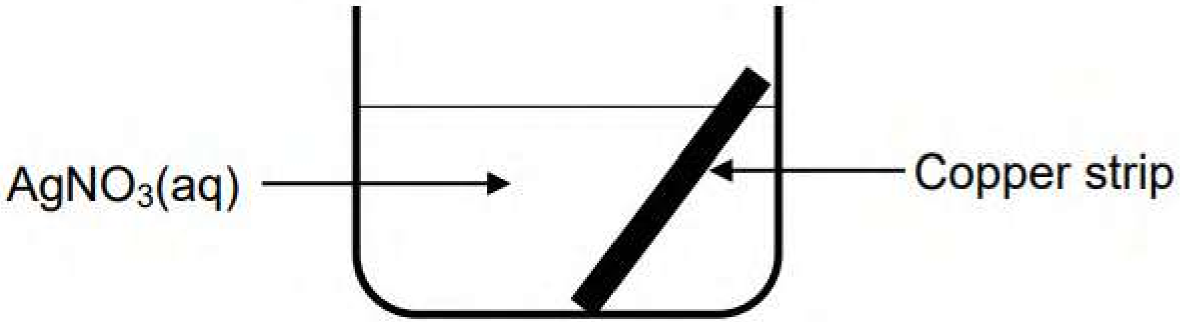
TABLE 4B



QUESTION 8

NSC 2023

A cleaned pure copper strip, Cu(s), is placed in a beaker containing a colourless silver nitrate solution, $AgNO_3(aq)$, at 25 °C, as shown below.



After a while, it is observed that the solution in the beaker becomes blue.

8.1 Write down:

8.1.1 ONE other OBSERVABLE change, besides the solution turning blue

Copper strip corrodes / gets eaten away / loses mass.
Silver settles down.

8.1.2 The NAME or FORMULA of the oxidising agent

Ag^+ -ioon / Silver ion / $AgNO_3$

TABLE *4A*

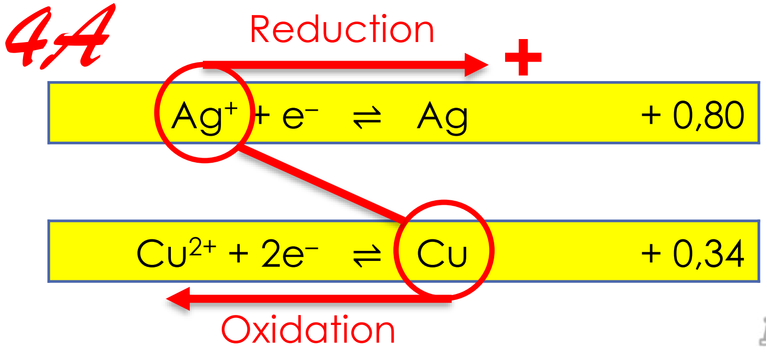
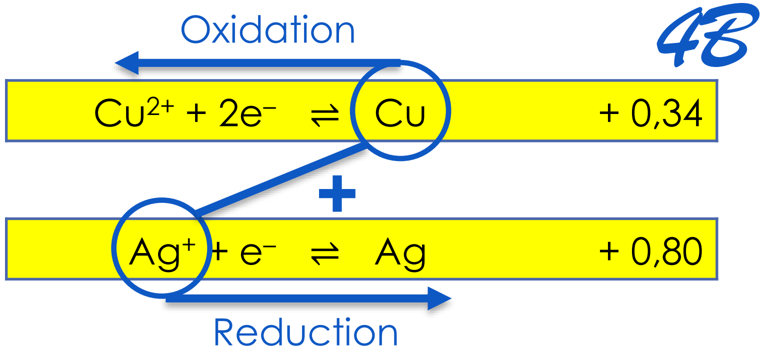
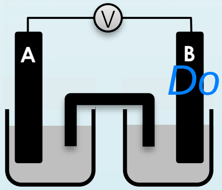


TABLE *4B*





GALVANIC CELLS

QUESTION 8

NSC 2023

Make sure you know the correct wording of all definitions!

CELL NOTATION:

Anode // Cathode

Element / Ion // Ion / Element

Zn / Zn^{2+} // Cu^{2+} / Cu

STANDARD CONDITIONS

Temp. 25 °C (298 K)

Concentration 1 $mol{\cdot}dm^{-3}$

Pressure 101,3 kPa.

ELECTRODES

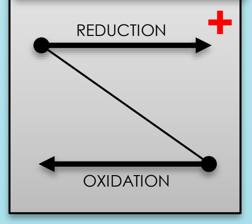
Metal

Gas

$$E^{\theta}_{cell} = E^{\theta}_{cathode} - E^{\theta}_{anode}$$

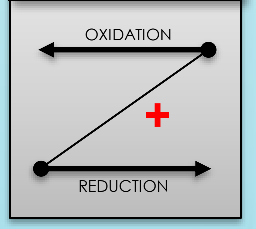
$$E^{\theta}_{cell} = E^{\theta}_{reduction} - E^{\theta}_{oxidation}$$

TABLE 4A

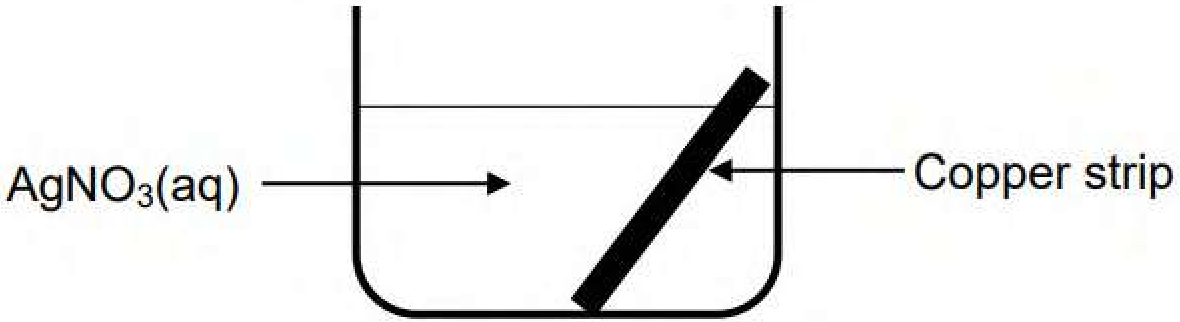


Spontaneous Reaction

TABLE 4B



A cleaned pure copper strip, Cu(s), is placed in a beaker containing a colourless silver nitrate solution, $AgNO_3(aq)$, at 25 °C, as shown below.



After a while, it is observed that the solution in the beaker becomes blue.

8.2 Explain the answer to QUESTION 8.1.1 by referring to the relative strengths of the oxidising agents or reducing agents.

TABLE *4A*

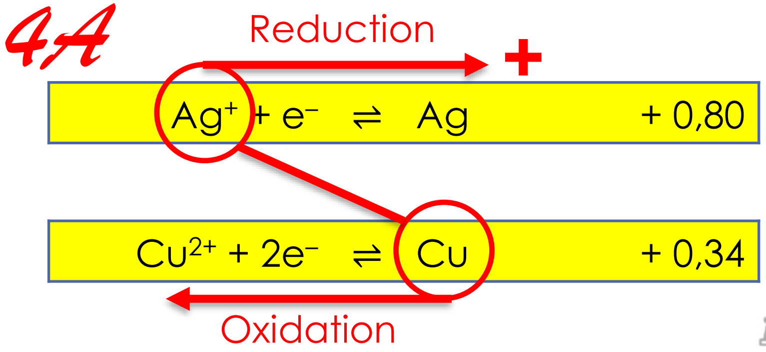
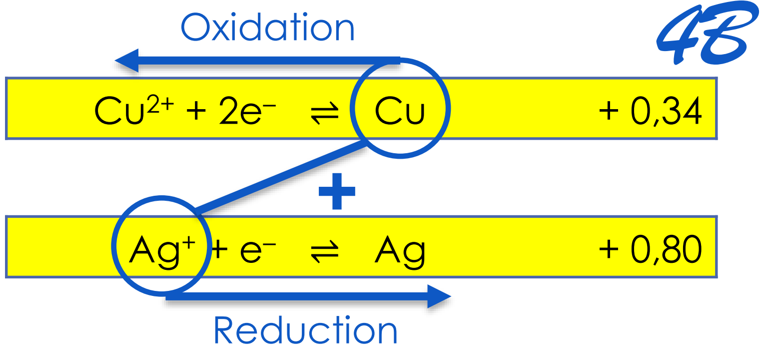
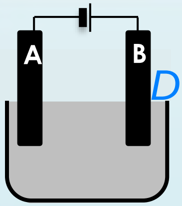


TABLE *4B*



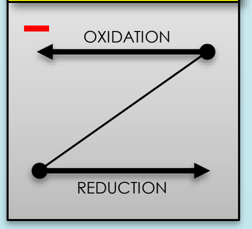


ELECTROLYTIC CELLS

Make sure you know the correct wording of all definitions!

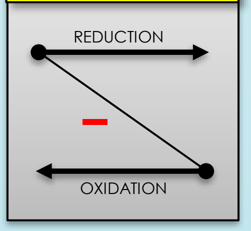
EXPLAIN STRENGTH OF **REDUCING AGENTS** AND **OXIDIZING AGENTS** IN REDOX REACTIONS.

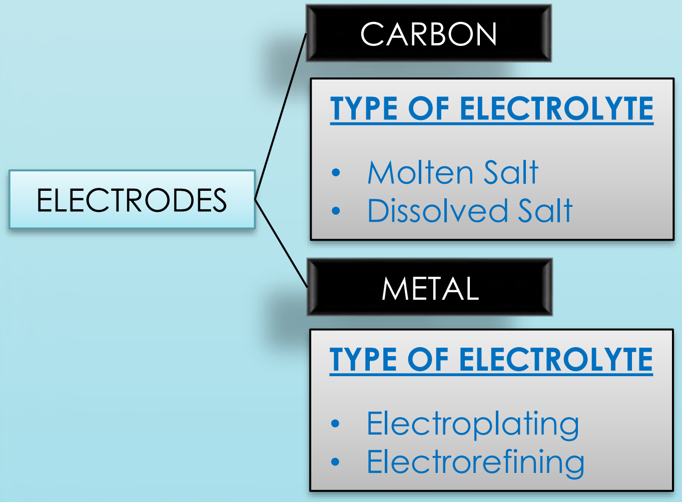
TABLE 4A



Non - Spontaneous Reaction

TABLE 4B





ELECTRODES

CARBON

TYPE OF ELECTROLYTE

- Molten Salt
- Dissolved Salt

METAL

TYPE OF ELECTROLYTE

- Electroplating
- Electrorefining

TABLE 4A

INCREASING STRENGTH OF OXIDIZING AGENTS

Half-reactions/*Halfreaksies*			E^{θ} (V)
$F_2(g) + 2e^-$	⇌	$2F^-$	+ 2,87
$Co^{3+} + e^-$	⇌	Co^{2+}	+ 1,81
$H_2O_2 + 2H^+ + 2e^-$	⇌	$2H_2O$	+1,77
$MnO_4^- + 8H^+ + 5e^-$	⇌	$Mn^{2+} + 4H_2O$	+ 1,51
$Cl_2(g) + 2e^-$	⇌	$2Cl^-$	+ 1,36
$Cr_2O_7^{2-} + 14H^+ + 6e^-$	⇌	$2Cr^{3+} + 7H_2O$	+ 1,33
$Pt^{2+} + 2e^-$	⇌	Pt	+ 1,20
$Br_2(l) + 2e^-$	⇌	$2Br^-$	+ 1,07
$NO_3^- + 4H^+ + 3e^-$	⇌	$NO(g) + 2H_2O$	+ 0,96
$Hg^{2+} + 2e^-$	⇌	$Hg(l)$	+ 0,85
$Ag^+ + e^-$	⇌	Ag	+ 0,80
$NO_3^- + 2H^+ + e^-$	⇌	$NO_2(g) + H_2O$	+ 0,80
$Fe^{3+} + e^-$	⇌	Fe^{2+}	+ 0,77
$O_2(g) + 2H^+ + 2e^-$	⇌	H_2O_2	+ 0,68
$I_2 + 2e^-$	⇌	$2I^-$	+ 0,54
$Cu^+ + e^-$	⇌	Cu	+ 0,52
$SO_2 + 4H^+ + 4e^-$	⇌	$S + 2H_2O$	+ 0,45
$2H_2O + O_2 + 4e^-$	⇌	$4OH^-$	+ 0,40
$Cu^{2+} + 2e^-$	⇌	Cu	+ 0,34
$SO_4^{2-} + 4H^+ + 2e^-$	⇌	$SO_2(g) + 2H_2O$	+ 0,17
$Cu^{2+} + e^-$	⇌	Cu^+	+ 0,16
$Sn^{4+} + 2e^-$	⇌	Sn^{2+}	+ 0,15
$Fe^{3+} + 3e^-$	⇌	Fe	– 0,06
$Pb^{2+} + 2e^-$	⇌	Pb	– 0,13
$Sn^{2+} + 2e^-$	⇌	Sn	– 0,14
$Ni^{2+} + 2e^-$	⇌	Ni	– 0,27
$Co^{2+} + 2e^-$	⇌	Co	– 0,28
$Cd^{2+} + 2e^-$	⇌	Cd	– 0,40
$Cr^{3+} + e^-$	⇌	Cr^{2+}	– 0,41
$Fe^{2+} + 2e^-$	⇌	Fe	– 0,44
$Cr^{3+} + 3e^-$	⇌	Cr	– 0,74
$Zn^{2+} + 2e^-$	⇌	Zn	– 0,76
$2H_2O + 2e^-$	⇌	$H_2(g) + 2OH^-$	– 0,83
$Cr^{2+} + 2e^-$	⇌	Cr	– 0,91
$Mn^{2+} + 2e^-$	⇌	Mn	– 1,18
$Al^{3+} + 3e^-$	⇌	Al	– 1,66
$Mg^{2+} + 2e^-$	⇌	Mg	– 2,36
$Na^+ + e^-$	⇌	Na	– 2,71
$Ca^{2+} + 2e^-$	⇌	Ca	– 2,87
$Sr^{2+} + 2e^-$	⇌	Sr	– 2,89
$Ba^{2+} + 2e^-$	⇌	Ba	– 2,90
$Cs^+ + e^-$	⇌	Cs	- 2,92
$K^+ + e^-$	⇌	K	– 2,93
$Li^+ + e^-$	⇌	Li	– 3,05

Reduction

Oxidation

Ag

Cu

INCREASING STRENGTH OF REDUCING AGENTS

INCREASING STRENGTH OF OXIDIZING AGENTS

Half-reactions/*Halfreaksies*			E^{θ} (V)
$Li^+ + e^-$	⇌	Li	– 3,05
$K^+ + e^-$	⇌	K	– 2,93
$Cs^+ + e^-$	⇌	Cs	– 2,92
$Ba^{2+} + 2e^-$	⇌	Ba	– 2,90
$Sr^{2+} + 2e^-$	⇌	Sr	– 2,89
$Ca^{2+} + 2e^-$	⇌	Ca	– 2,87
$Na^+ + e^-$	⇌	Na	– 2,71
$Mg^{2+} + 2e^-$	⇌	Mg	– 2,36
$Al^{3+} + 3e^-$	⇌	Al	– 1,66
$Mn^{2+} + 2e^-$	⇌	Mn	– 1,18
$Cr^{2+} + 2e^-$	⇌	Cr	– 0,91
$2H_2O + 2e^-$	⇌	$H_2(g) + 2OH^-$	– 0,83
$Zn^{2+} + 2e^-$	⇌	Zn	– 0,76
$Cr^{3+} + 3e^-$	⇌	Cr	– 0,74
$Fe^{2+} + 2e^-$	⇌	Fe	– 0,44
$Cr^{3+} + e^-$	⇌	Cr^{2+}	– 0,41
$Cd^{2+} + 2e^-$	⇌	Cd	– 0,40
$Co^{2+} + 2e^-$	⇌	Co	– 0,28
$Ni^{2+} + 2e^-$	⇌	Ni	– 0,27
$Sn^{2+} + 2e^-$	⇌	Sn	– 0,14
$Pb^{2+} + 2e^-$	⇌	Pb	– 0,13
$Fe^{3+} + 3e^-$	⇌	Fe	– 0,06
$Sn^{4+} + 2e^-$	⇌	Sn^{2+}	+ 0,15
$Cu^{2+} + e^-$	⇌	Cu^+	+ 0,16
$SO_4^{2-} + 4H^+ + 2e^-$	⇌	$SO_2(g) + 2H_2O$	+ 0,17
$Cu^{2+} + 2e^-$	⇌	Cu	+ 0,34
$2H_2O + O_2 + 4e^-$	⇌	$4OH^-$	+ 0,40
$SO_2 + 4H^+ + 4e^-$	⇌	$S + 2H_2O$	+ 0,45
$Cu^+ + e^-$	⇌	Cu	+ 0,52
$I_2 + 2e^-$	⇌	$2I^-$	+ 0,54
$O_2(g) + 2H^+ + 2e^-$	⇌	H_2O_2	+ 0,68
$Fe^{3+} + e^-$	⇌	Fe^{2+}	+ 0,77
$NO_3^- + 2H^+ + e^-$	⇌	$NO_2(g) + H_2O$	+ 0,80
$Ag^+ + e^-$	⇌	Ag	+ 0,80
$Hg^{2+} + 2e^-$	⇌	$Hg(l)$	+ 0,85
$NO_3^- + 4H^+ + 3e^-$	⇌	$NO(g) + 2H_2O$	+ 0,96
$Pt^{2+} + 2e^-$	⇌	Pt	+ 1,20
$MnO_2 + 4H^+ + 2e^-$	⇌	$Mn^{2+} + 2H_2O$	+ 1,23
$O_2(g) + 4H^+ + 4e^-$	⇌	$2H_2O$	+ 1,23
$Cr_2O_7^{2-} + 14H^+ + 6e^-$	⇌	$2Cr^{3+} + 7H_2O$	+ 1,33
$Cl_2(g) + 2e^-$	⇌	$2Cl^-$	+ 1,36
$MnO_4^- + 8H^+ + 5e^-$	⇌	$Mn^{2+} + 4H_2O$	+ 1,51
$H_2O_2 + 2H^+ + 2e^-$	⇌	$2H_2O$	+1,77
$Co^{3+} + e^-$	⇌	Co^{2+}	+ 1,81
$F_2(g) + 2e^-$	⇌	$2F^-$	+ 2,87

Oxidation

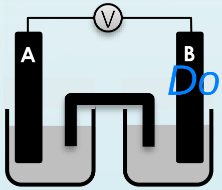
Reduction

Cu

Ag

TABLE 4B

INCREASING STRENGTH OF REDUCING AGENTS



GALVANIC CELLS

Make sure you know the correct wording of all definitions!

CELL NOTATION:
Anode // Cathode
Element / Ion // Ion / Element
$Zn / Zn^{2+} // Cu^{2+} / Cu$

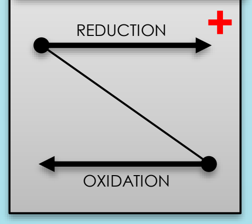
STANDARD CONDITIONS
Temp. 25 °C (298 K)
Concentration 1 $mol \cdot dm^{-3}$
Pressure 101,3 kPa.

ELECTRODES
Metal
Gas

$$E^{\theta}_{cell} = E^{\theta}_{cathode} - E^{\theta}_{anode}$$

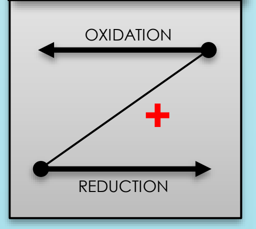
$$E^{\theta}_{cell} = E^{\theta}_{reduction} - E^{\theta}_{oxidation}$$

TABLE 4A



Spontaneous Reaction

TABLE 4B



QUESTION 8

NSC 2023

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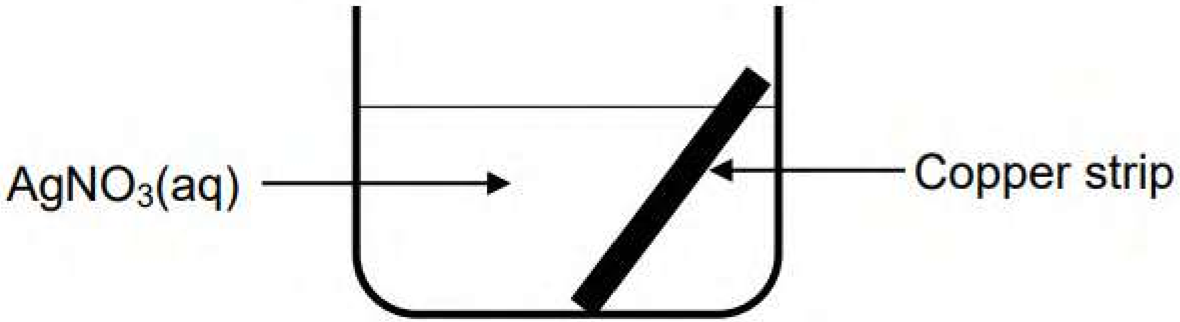
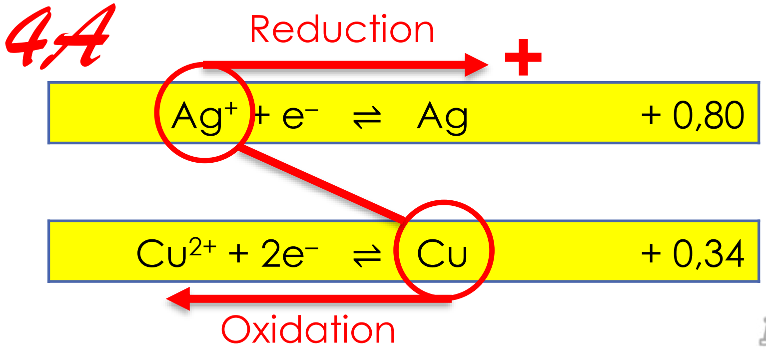


After a while, it is observed that the solution in the beaker becomes blue.

8.2 Explain the answer to QUESTION 8.1.1 by referring to the relative strengths of the oxidising agents or reducing agents.

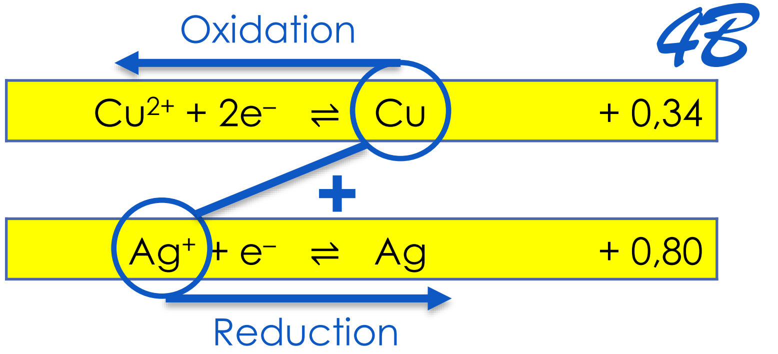
Cu is a stronger reducing agent than Ag and will therefore reduce Ag to Ag^+.
Ag^+ is a stronger oxidizing agent than Cu^{2+} and will therefore oxidize Cu^{2+} to Cu.

TABLE *4A*



$Ag^+ + e^- \rightleftharpoons Ag$ + 0,80
$Cu^{2+} + 2e^- \rightleftharpoons Cu$ + 0,34

TABLE *4B*



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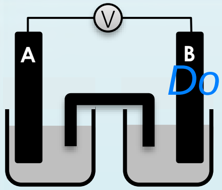
$Ag^+ + e^- \rightleftharpoons Ag$ + 0,80



GALVANIC CELLS

Make sure you know the correct wording of all definitions!

CELL NOTATION:

Anode // Cathode

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$Zn / Zn^{2+} // Cu^{2+} / Cu$

STANDARD CONDITIONS
Temp. 25 °C (298 K)
Concentration 1 mol·dm^{-3}
Pressure 101,3 kPa.

ELECTRODES
Metal
Gas

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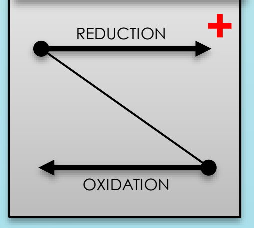
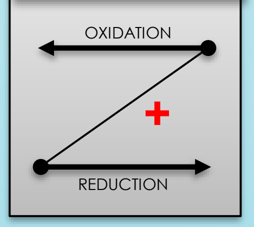
TABLE 4A



Spontaneous Reaction

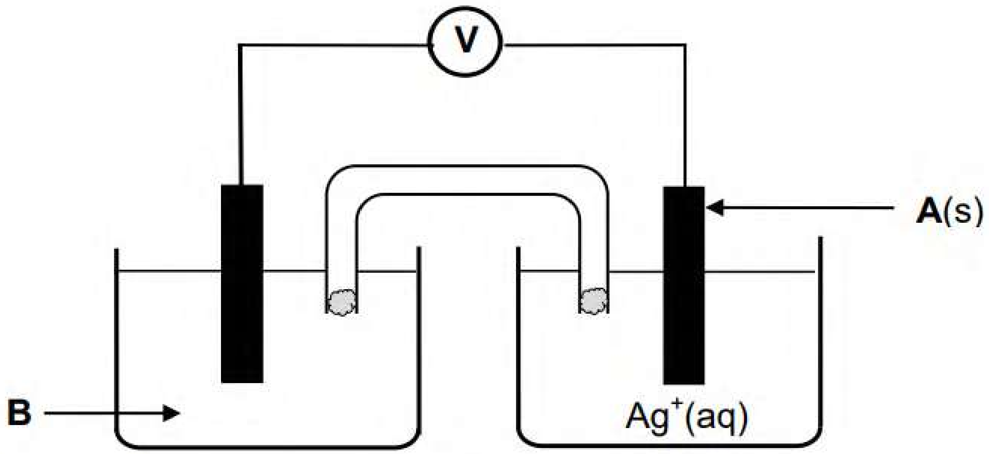
TABLE 4B



QUESTION 8

NSC 2023

A galvanic cell is now set up using Cu and Ag strips as electrodes. A simplified diagram of the cell is shown below.



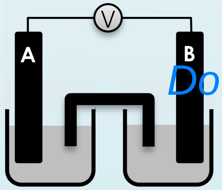
8.3 Write down the:

8.3.1 NAME or FORMULA of electrode A

8.3.2 NAME or FORMULA of solution B

8.3.3 Overall (net) balanced equation for the cell reaction

8.4 The salt bridge contains potassium nitrate, $KNO_3(aq)$. Write down the FORMULA of the ion in the salt bridge that will move into the silver ion solution. Choose from K^+ (aq) or NO_3^- (aq). Give a reason for the answer.



GALVANIC CELLS

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Zn / Zn^{2+} // Cu^{2+} / Cu

STANDARD CONDITIONS
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ELECTRODES
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Gas

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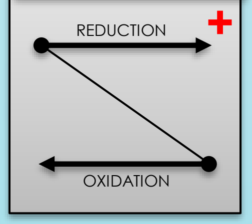
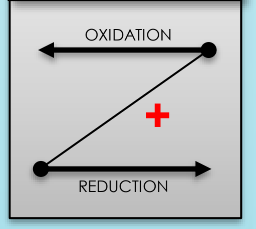


Spontaneous Reaction

TABLE 4B



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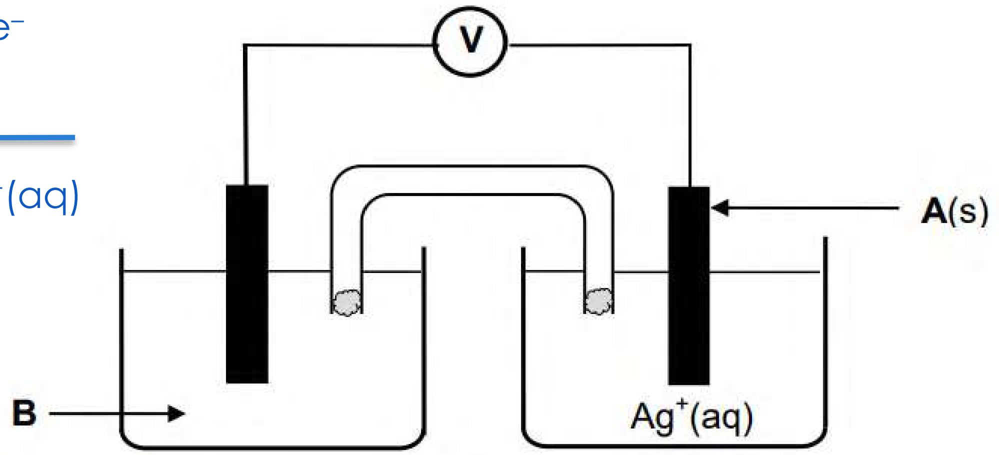
NSC 2023

A galvanic cell is now set up using Cu and Ag strips as electrodes. A simplified diagram of the cell is shown below.

$$Cu(s) \rightarrow Cu^{2+}(aq) + 2e^-$$

$$2Ag^+(aq) + 2e^- \rightarrow 2Ag(s)$$

$$2Ag^+(aq) + Cu(s) \rightarrow 2Ag(s) + Cu^{2+}(aq)$$



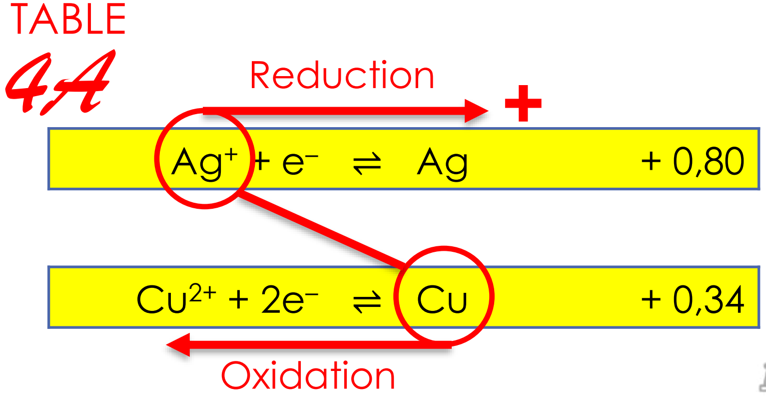
8.3 Write down the:

8.3.1 NAME or FORMULA of electrode A Silver / Ag

8.3.2 NAME or FORMULA of solution B Copper nitrate / $Cu(NO_3)_2$

8.3.3 Overall (net) balanced equation for the cell reaction

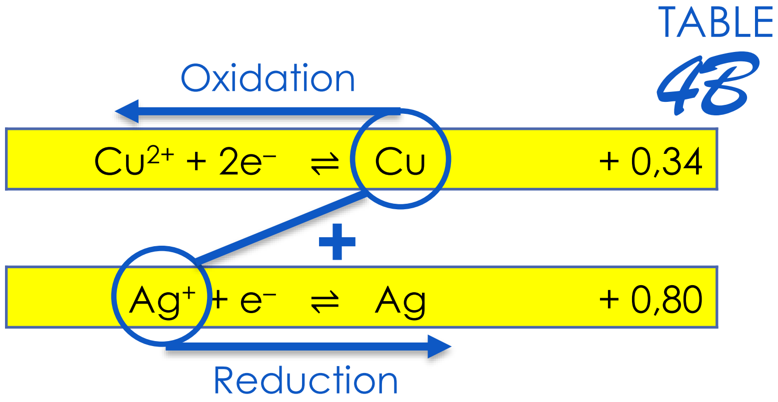
TABLE 4A



$Ag^+ + e^- \rightleftharpoons Ag$ + 0,80

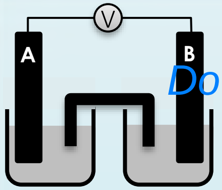
$Cu^{2+} + 2e^- \rightleftharpoons Cu$ + 0,34

TABLE 4B



$Cu^{2+} + 2e^- \rightleftharpoons Cu$ + 0,34

$Ag^+ + e^- \rightleftharpoons Ag$ + 0,80



GALVANIC CELLS

Make sure you know the correct wording of all definitions!

CELL NOTATION: Anode // Cathode

Element / Ion // Ion / Element

Zn / Zn^{2+} // Cu^{2+} / Cu

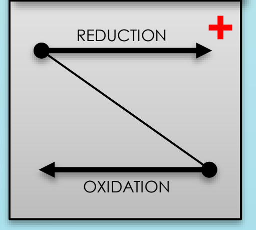
STANDARD CONDITIONS
Temp. 25 °C (298 K)
Concentration 1 mol·dm^{-3}
Pressure 101,3 kPa.

ELECTRODES
Metal
Gas

$$E^{\theta}_{cell} = E^{\theta}_{cathode} - E^{\theta}_{anode}$$

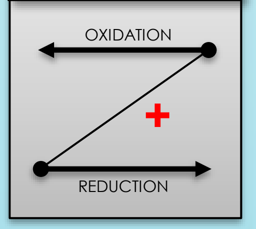
$$E^{\theta}_{cell} = E^{\theta}_{reduction} - E^{\theta}_{oxidation}$$

TABLE 4A



Spontaneous Reaction

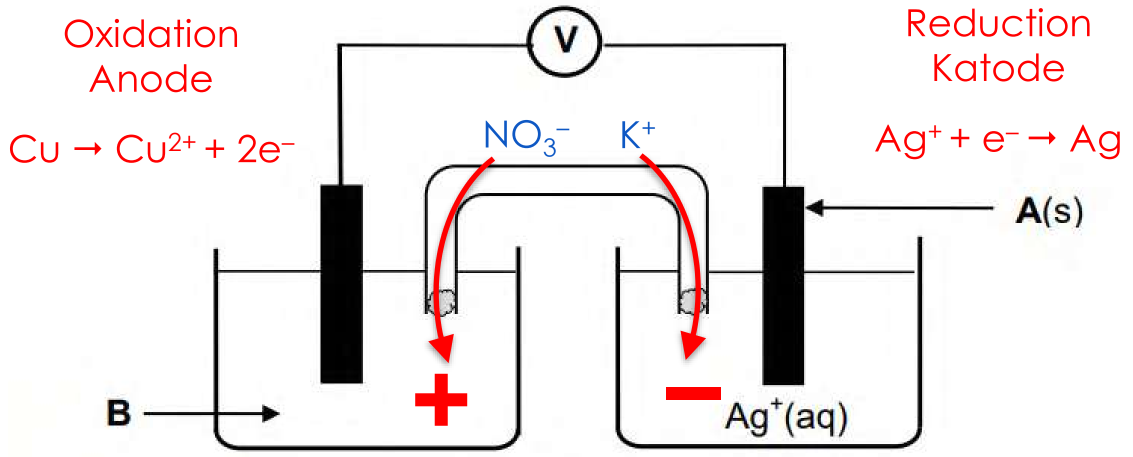
TABLE 4B



QUESTION 8

NSC 2023

A galvanic cell is now set up using Cu and Ag strips as electrodes. A simplified diagram of the cell is shown below.



8.4 The salt bridge contains potassium nitrate, $KNO_3(aq)$. Write down the FORMULA of the ion in the salt bridge that will move into the silver ion solution. Choose from K^+ (aq) or NO_3^- (aq). Give a reason for the answer.

Answer: K^+

TABLE *4A*

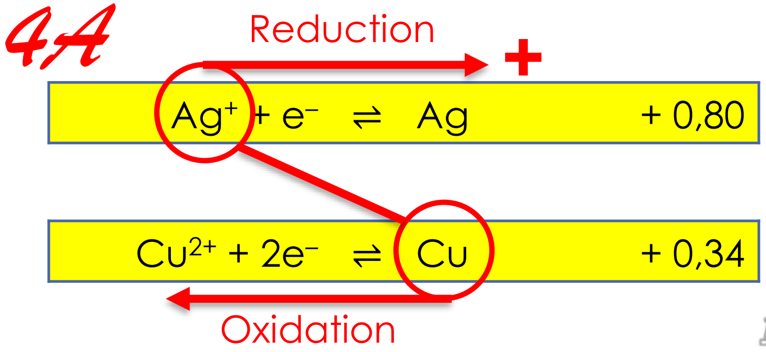
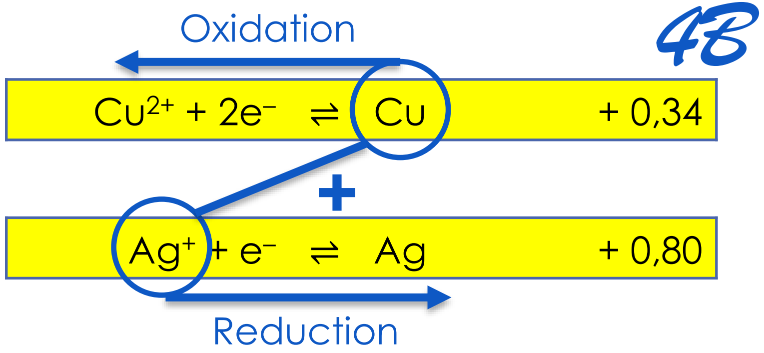
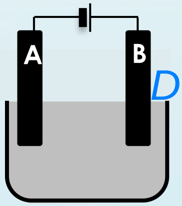


TABLE *4B*



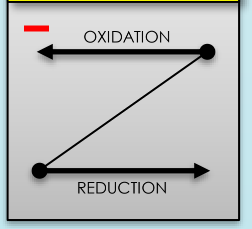


ELECTROLYTIC CELLS

Make sure you know the correct wording of all definitions!

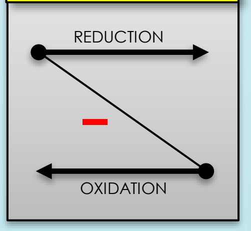
EXPLAIN STRENGTH OF **REDUCING AGENTS** AND **OXIDIZING AGENTS** IN REDOX REACTIONS.

TABLE 4A



Non-Spontaneous Reaction

TABLE 4B



ELECTRODES

CARBON

TYPE OF ELECTROLYTE

- Molten Salt
- Dissolved Salt

METAL

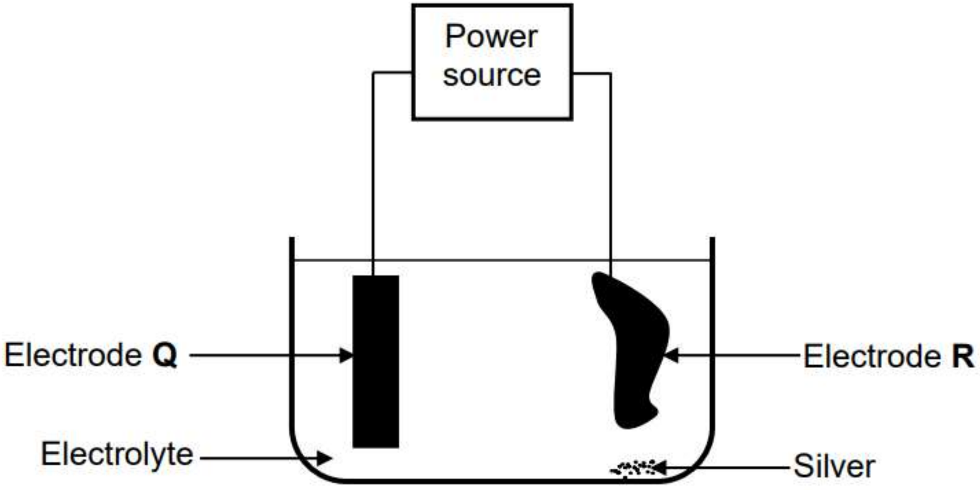
TYPE OF ELECTROLYTE

- Electroplating
- Electrorefining

QUESTION 9

NSC 2023

An electrolytic cell is set up to purify a piece of copper that contains silver and zinc as impurities. A simplified diagram of the cell is shown below. Electrode R is impure copper.



9.1 Define the term electrolysis.

9.2 Write down the reaction taking place at electrode Q.

9.3 In which direction do the electrons flow in the external circuit? Choose from Q to R or R to Q.

9.4 Calculate the current needed to form 16 g of copper when the cell operates for five hours.

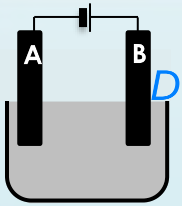
9.5 During this electrolysis, only copper and zinc are oxidised. Give a reason why the silver is not oxidised.

TABLE 4A: REDOX HALF REACTIONS

			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
$Cl_2(g) + 2e^-$	$\rightleftharpoons$	$2Cl^-$	+ 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
$Br_2(l) + 2e^-$	$\rightleftharpoons$	$2Br^-$	+ 1,07
$NO_3^- + 4H^+ + 3e^-$	$\rightleftharpoons$	$NO(g) + 2H_2O$	+ 0,96
$Hg^{2+} + 2e^-$	$\rightleftharpoons$	$Hg(l)$	+ 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
$SO_4^{-2} + 4H^+ + e^-$	$\rightleftharpoons$	$SO_2(g) + 2H_2O$	+ 0,17

TABLE 4B: REDOX HALF REACTIONS

			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
$Al^{3+} + 3e^-$	$\rightleftharpoons$	Al	– 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

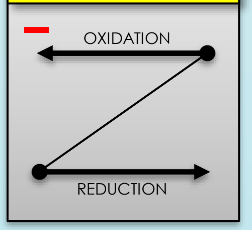


ELECTROLYTIC CELLS

Make sure you know the correct wording of all definitions!

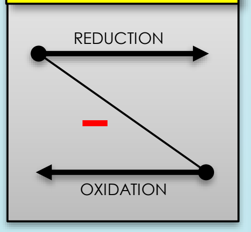
EXPLAIN STRENGTH OF **REDUCING AGENTS** AND **OXIDIZING AGENTS** IN REDOX REACTIONS.

TABLE 4A



Non-Spontaneous Reaction

TABLE 4B



ELECTRODES

CARBON

TYPE OF ELECTROLYTE

- Molten Salt
- Dissolved Salt

METAL

TYPE OF ELECTROLYTE

- Electroplating
- Electrorefining

QUESTION 9

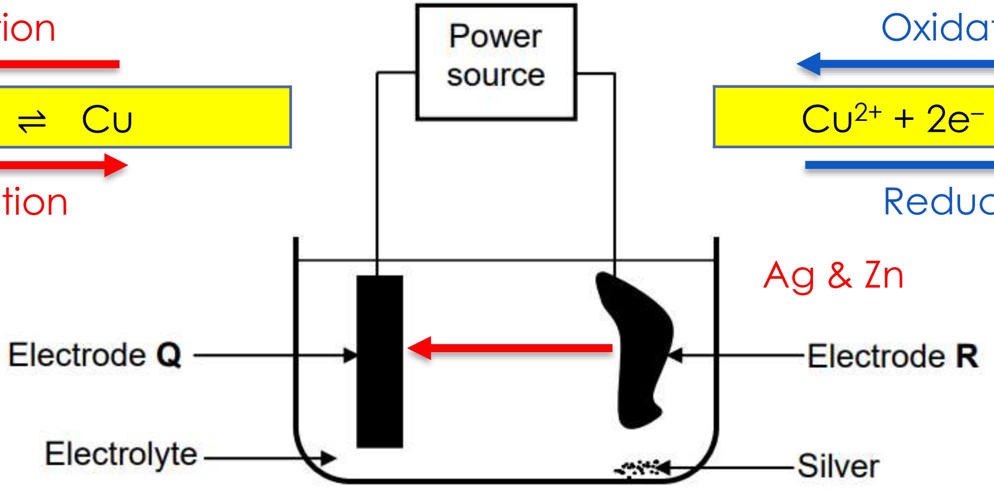
NSC 2023

An electrolytic cell is set up to purify a piece of copper that contains silver and zinc as impurities. A simplified diagram of the cell is shown below. Electrode R is impure copper.

Oxidation

$Cu^{2+} + 2e^- \rightleftharpoons Cu$

Reduction



Oxidation

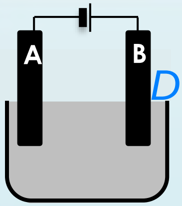
$Cu^{2+} + 2e^- \rightleftharpoons Cu$

Reduction

9.1 Define the term electrolysis.

.

ELECTROLYTIC: A chemical process in which electrical energy is converted into chemical energy.



ELECTROLYTIC CELLS

Make sure you know the correct wording of all definitions!

EXPLAIN STRENGTH OF **REDUCING AGENTS** AND **OXIDIZING AGENTS** IN REDOX REACTIONS.

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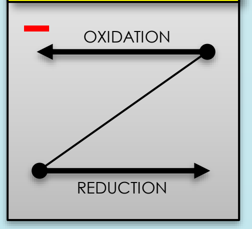
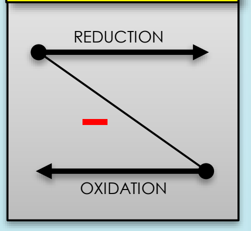


Non-Spontaneous Reaction

TABLE 4B



ELECTRODES

- CARBON
  - **TYPE OF ELECTROLYTE**
    - Molten Salt
    - Dissolved Salt
- METAL
  - **TYPE OF ELECTROLYTE**
    - Electroplating
    - Electrorefining

QUESTION 9

NSC 2023

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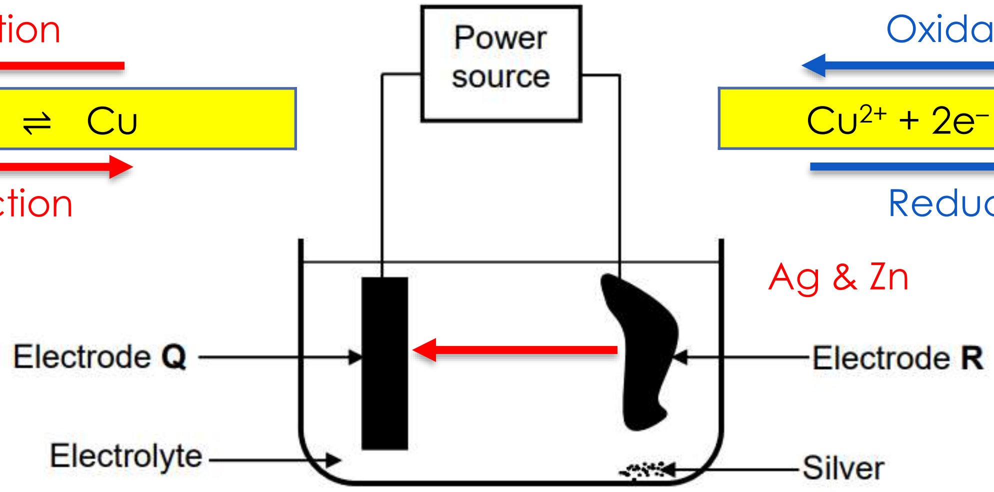
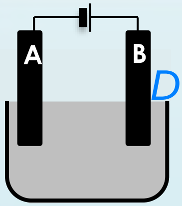
Reduction



9.2 Write down the reaction taking place at electrode Q.

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

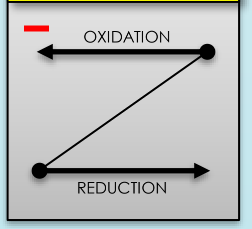


ELECTROLYTIC CELLS

Make sure you know the correct wording of all definitions!

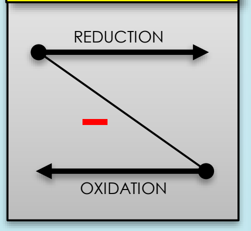
EXPLAIN STRENGTH OF **REDUCING AGENTS** AND **OXIDIZING AGENTS** IN REDOX REACTIONS.

TABLE 4A



Non-Spontaneous Reaction

TABLE 4B



ELECTRODES

CARBON

TYPE OF ELECTROLYTE

- Molten Salt
- Dissolved Salt

METAL

TYPE OF ELECTROLYTE

- Electroplating
- Electrorefining

QUESTION 9

NSC 2023

An electrolytic cell is set up to purify a piece of copper that contains silver and zinc as impurities. A simplified diagram of the cell is shown below. Electrode R is impure copper.

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Reduction

Oxidation

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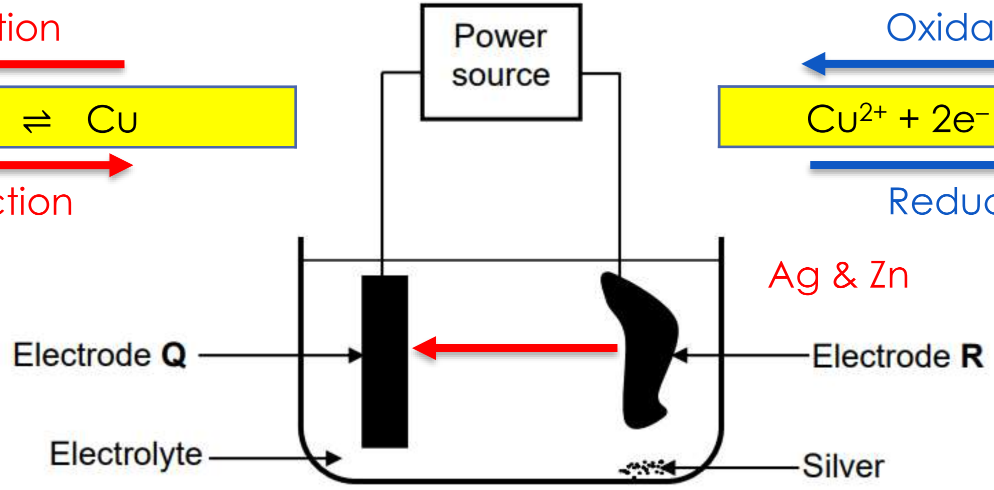
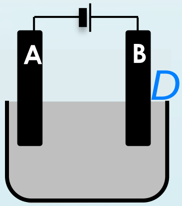
Reduction



9.3 In which direction do the electrons flow in the external circuit? Choose from Q to R or R to Q.

R to Q

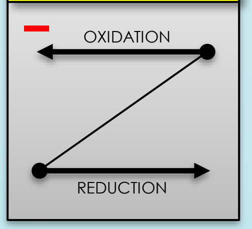


ELECTROLYTIC CELLS

Make sure you know the correct wording of all definitions!

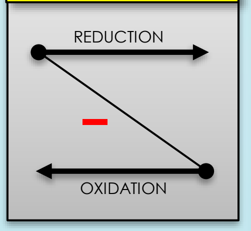
EXPLAIN STRENGTH OF **REDUCING AGENTS** AND **OXIDIZING AGENTS** IN REDOX REACTIONS.

TABLE 4A



Non-Spontaneous Reaction

TABLE 4B



ELECTRODES

- CARBON
  - **TYPE OF ELECTROLYTE**
    - Molten Salt
    - Dissolved Salt
- METAL
  - **TYPE OF ELECTROLYTE**
    - Electroplating
    - Electrorefining

QUESTION 9

NSC 2023

An electrolytic cell is set up to purify a piece of copper that contains silver and zinc as impurities. A simplified diagram of the cell is shown below. Electrode R is impure copper.

Oxidation ←

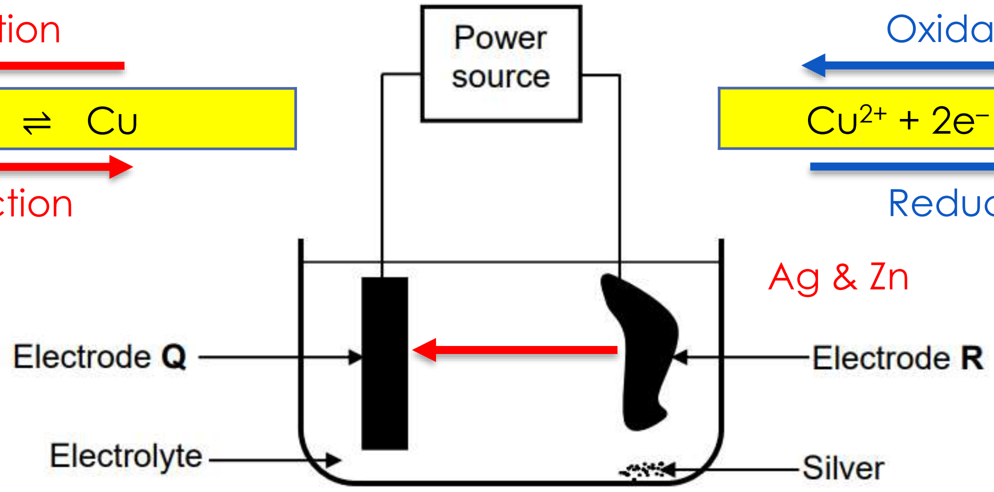
$Cu^{2+} + 2e^- \rightleftharpoons Cu$

→ Reduction

Oxidation ←

$Cu^{2+} + 2e^- \rightleftharpoons Cu$

→ Reduction



STEPS:

1. Mol Cu
2. Mol e⁻
3. Number of e⁻
4. Charge
5. Current

9.4 Calculate the current needed to form 16 g of copper when the cell operates for five hours.

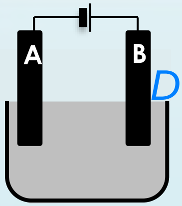
❶ $n(Cu) = \frac{m}{M} = \frac{16}{63,5} = 0,25 \text{ mol}$

❷ $n(e^-) = 2 \times 0,25 = 0,5 \text{ mol}$

❸ $n = \frac{N}{N_A} \quad \therefore N = n.N_A = (0,5)(6,02\text{x}10^{23}) = 3,034\text{x}10^{23}\ e^-$

❹ $n = \frac{Q}{q_e} \quad \therefore Q = (3,034\text{x}10^{23})(1,6\text{x}10^{-19)} = 48539,21 \text{ C}$

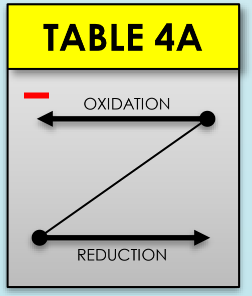
❺ $I = \frac{Q}{\triangle t} = \frac{48539,21}{18000} = 2,68\ A$



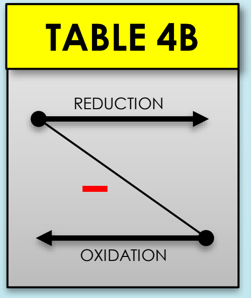
ELECTROLYTIC CELLS

Make sure you know the correct wording of all definitions!

EXPLAIN STRENGTH OF **REDUCING AGENTS** AND **OXIDIZING AGENTS** IN REDOX REACTIONS.



Non-Spontaneous Reaction



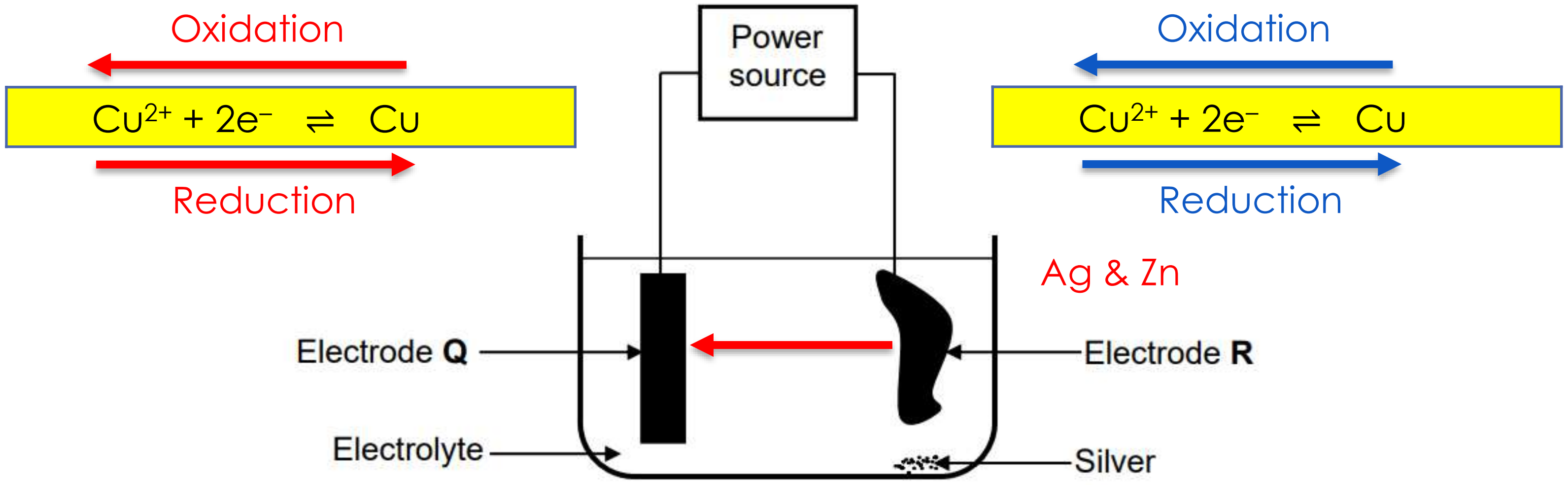
ELECTRODES

- CARBON
  - TYPE OF ELECTROLYTE
    - Molten Salt
    - Dissolved Salt
- METAL
  - TYPE OF ELECTROLYTE
    - Electroplating
    - Electrorefining

QUESTION 9

NSC 2023

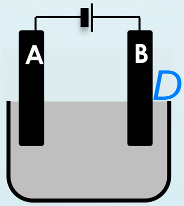
An electrolytic cell is set up to purify a piece of copper that contains silver and zinc as impurities. A simplified diagram of the cell is shown below. Electrode R is impure copper.



$Cu^{2+} + 2e^- \rightleftharpoons Cu$

$Cu^{2+} + 2e^- \rightleftharpoons Cu$

9.5 During this electrolysis, only copper and zinc are oxidised. Give a reason why the silver is not oxidised.



ELECTROLYTIC CELLS

Make sure you know the correct wording of all definitions!

EXPLAIN STRENGTH OF **REDUCING AGENTS** AND **OXIDIZING AGENTS** IN REDOX REACTIONS.

TABLE 4A

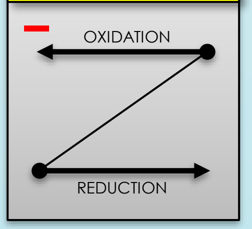
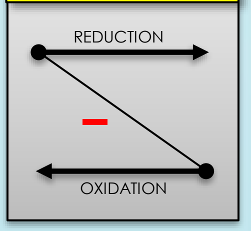


TABLE 4B



Non - Spontaneous Reaction

ELECTRODES

CARBON

TYPE OF ELECTROLYTE

- Molten Salt
- Dissolved Salt

METAL

TYPE OF ELECTROLYTE

- Electroplating
- Electrorefining

TABLE 4A

Oxidation

Half-reactions/*Halfreaksies*			**E^θ (V)**
$F_2(g) + 2e^-$	$\rightleftharpoons$	$2F^-$	+ 2,87
$MnO_4^- + 8H^+ + 5e^-$	$\rightleftharpoons$	$Mn^{2+} + 4H_2O$	+ 1,51
$Cl_2(g) + 2e^-$	$\rightleftharpoons$	$2Cl^-$	+ 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
$Al^{3+} + 3e^-$	$\rightleftharpoons$	Al	– 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

Ag

Zn

INCREASING STRENGTH OF **OXIDIZING AGENTS**

INCREASING STRENGTH OF **REDUCING AGENTS**

TABLE 4B

Oxidation

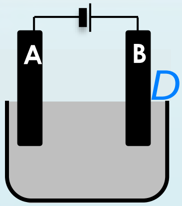
Half-reactions/*Halfreaksies*			**E^θ (V)**
$Li^+ + e^-$	$\rightleftharpoons$	Li	– 3,05
$Sr^{2+} + 2e^-$	$\rightleftharpoons$	Sr	– 2,89
$Ca^{2+} + 2e^-$	$\rightleftharpoons$	Ca	– 2,87
$Na^+ + e^-$	$\rightleftharpoons$	Na	– 2,71
$Mg^{2+} + 2e^-$	$\rightleftharpoons$	Mg	– 2,36
$Al^{3+} + 3e^-$	$\rightleftharpoons$	Al	– 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
$Cl_2(g) + 2e^-$	$\rightleftharpoons$	$2Cl^-$	+ 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

Zn

Ag

INCREASING STRENGTH OF **OXIDIZING AGENTS**

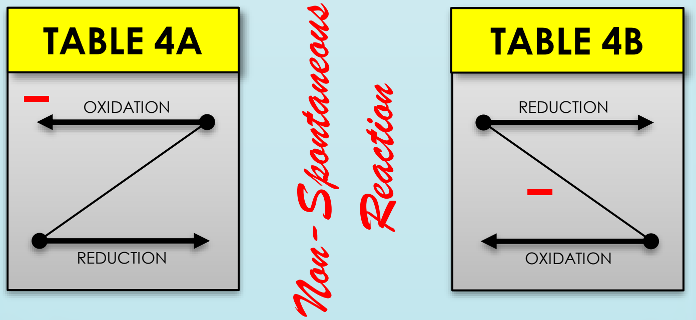
INCREASING STRENGTH OF **REDUCING AGENTS**



ELECTROLYTIC CELLS

Make sure you know the correct wording of all definitions!

EXPLAIN STRENGTH OF **REDUCING AGENTS** AND **OXIDIZING AGENTS** IN REDOX REACTIONS.



ELECTRODES

CARBON

TYPE OF ELECTROLYTE
- Molten Salt
- Dissolved Salt

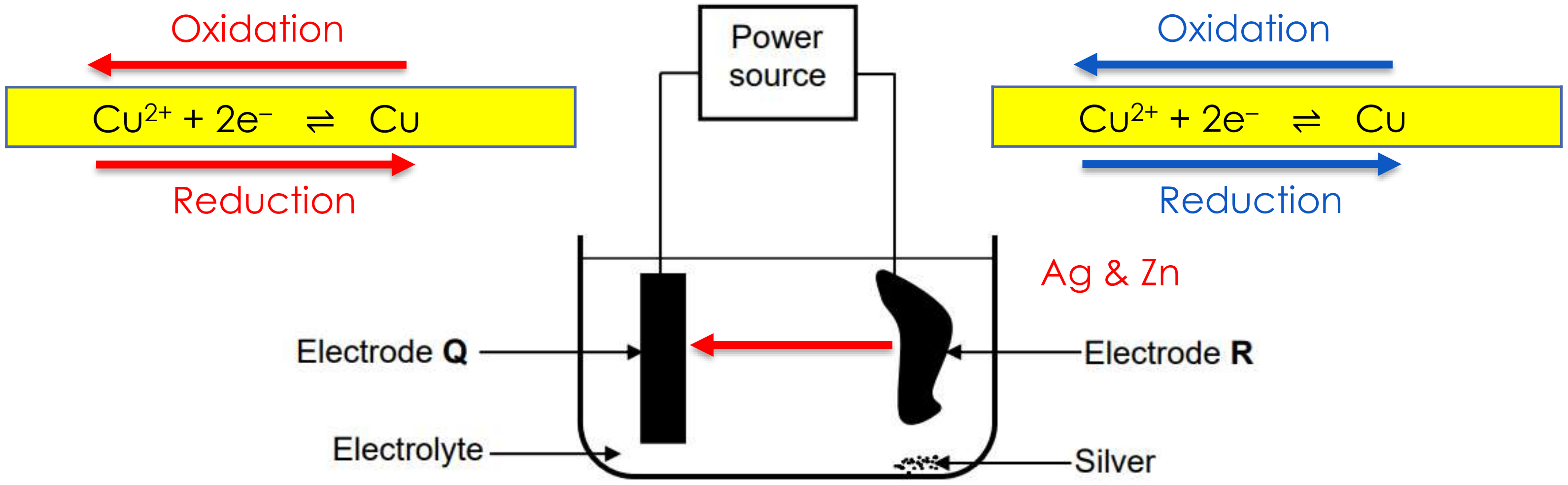
METAL

TYPE OF ELECTROLYTE
- Electroplating
- Electrorefining

QUESTION 9

NSC 2023

An electrolytic cell is set up to purify a piece of copper that contains silver and zinc as impurities. A simplified diagram of the cell is shown below. Electrode R is impure copper.



$Cu^{2+} + 2e^- \rightleftharpoons Cu$

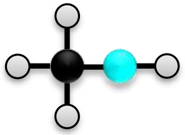
$Cu^{2+} + 2e^- \rightleftharpoons Cu$

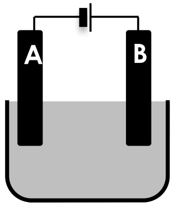
9.5 During this electrolysis, only copper and zinc are oxidised. Give a reason why the silver is not oxidised.

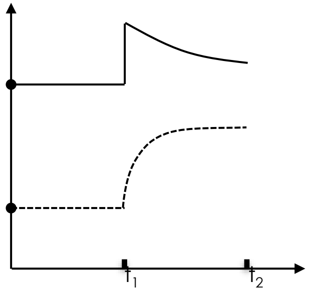
Silver is a **WEAKER REDUCING AGENT** than Cu and will therefore not be oxidized.

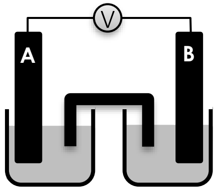
Good luck with the Chemistry Exam!

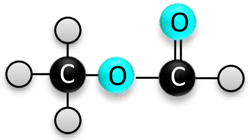
	H_2SO_4	2NaOH	Na_2SO_4	$2H_2O$
n : n	1	2	1	2
n_i				
▲n				
n_f				

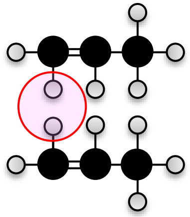


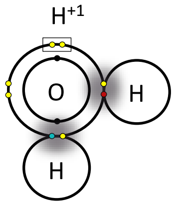


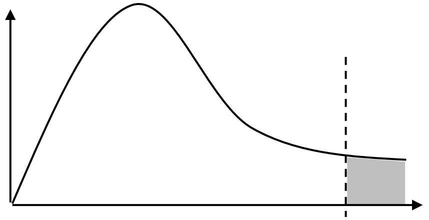












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