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KING DAVID HIGH SCHOOL
VICTORY PARK

PHYSICAL SCIENCES GRADE 12 PRELIMINARY EXAMINATION
PAPER 2 - CHEMISTRY

MARKS: 200

TIME: 3 HOURS

EXAMINER: Mrs I Govender

MODERATOR: Ms S Nargaroo

NAME: _____

PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY

1. This question paper consists of 26 pages as well as a green DATA SHEET of 3 pages (i–iii). Please make sure that your question paper is complete.
2. Read the questions carefully.
3. **Answer ALL the questions on the question paper and hand it in at the end of the examination.**
4. Unless instructed otherwise, you do NOT have to give state symbols (phase indicators) when asked to write a balanced chemical equation.
5. Use the data and formulae whenever necessary.
6. Show all the necessary steps in calculations.
7. Where appropriate, take your answers to two decimal places.
8. It is in your interest to write legibly and to present your work neatly.
9. Two blank pages (page 27 and page 28) are included at the end of the exam paper. If you run out of space for an answer, use this page. If you use this extra space, make sure that you indicate this clearly at the question to ensure that your answer is marked in full.

QUESTION 1 – MULTIPLE CHOICE

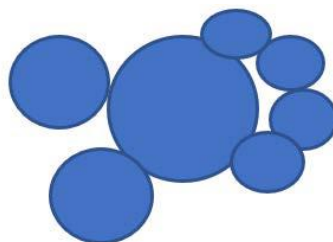
Answer these questions on the multiple-choice answer grid below. Make a clear cross (X) in the box corresponding to the letter that you consider to be correct. Every question has only one correct answer.

Here the option C has been marked as an example.

A	B	☒ C	D
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1.1	A	B	C	D
1.2	A	B	C	D
1.3	A	B	C	D
1.4	A	B	C	D
1.5	A	B	C	D
1.6	A	B	C	D
1.7	A	B	C	D
1.8	A	B	C	D
1.9	A	B	C	D
1.10	A	B	C	D

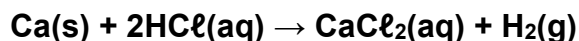
1.1 Which one of the substances can be represented by the following diagram?



- A Potassium permanganate
- B Sulfuric acid
- C Aluminium phosphate
- D Calcium phosphate

1.2 A standard solution

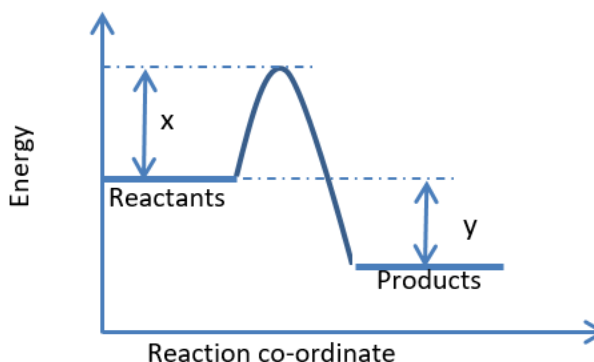
- A always has a concentration of exactly $1 \text{ mol} \cdot \text{dm}^{-3}$
- B is always at 25°C
- C always has a volume of 1 dm^3
- D is a solution of precisely known concentration

1.3 10 g of calcium granules is added to 50 cm^3 of $2 \text{ mol} \cdot \text{dm}^{-3}$ hydrochloric acid. The reaction equation is shown below.

Which of the following statements is true when this reaction is completed?

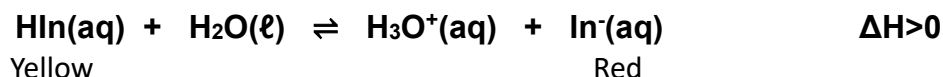
- A 8 g of calcium will remain unreacted.
 - B no calcium will remain unreacted.
 - C $22,24 \text{ dm}^3$ of hydrogen gas will be given off at STP.
 - D 225 cm^3 of hydrochloric acid will remain unreacted
- 1.4 Which one of the following combinations correctly shows the substances in order of increasing boiling point?
- A water, calcium chloride, potassium chloride, diamond
 - B potassium chloride, water, diamond, calcium chloride
 - C water, potassium chloride, calcium chloride, diamond
 - D potassium chloride, water, calcium chloride, diamond

1.5 What is the activation energy of the reverse reaction as shown in the given energy profile diagram?



- A $X + Y$
- B Y
- C X
- D $X - Y$

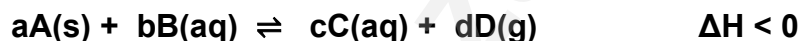
- 1.6 An acid-base indicator represented as HIn(aq) , reaches dynamic chemical equilibrium when added to water as shown in the equation below:



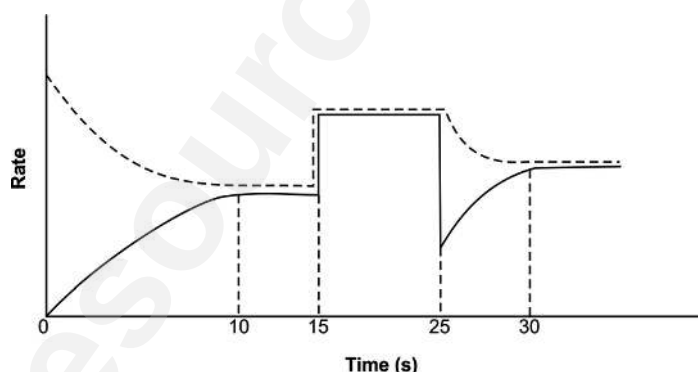
At chemical equilibrium the colour of the solution is orange.

Which one of the following will turn the colour of the solution yellow?

- A The addition of NaOH.
 B The addition of H_2O .
 C An increase in the temperature.
 D The addition of HCl.
- 1.7 A hypothetical chemical reaction in a closed container is represented by the following chemical equation:



The graph below represents the rates of the forward and reverse reactions plotted as a function of time.



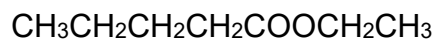
Which one of the following could describe the change in the rates of the reactions at $t = 15 \text{ s}$ and $t = 25 \text{ s}$ respectively?

	Disturbance at $t = 15 \text{ s}$	Disturbance at $t = 25 \text{ s}$
A	Surface area of A was increased	The pressure in the system was increased
B	A catalyst was added	The temperature of the system was decreased
C	The temperature of the system was increased	The surface area of A was decreased
D	The pressure of the system was decreased	The temperature of the system was increased

- 1.8 Brine is pumped into the membrane cell and is used in the chlor-alkali industry. Which of the following correctly indicate the products formed at the respective electrodes?

	positive electrode	negative electrode
A	$\text{Cl}_2(\text{g})$	$\text{Na}(\text{s})$
B	$\text{OH}^-(\text{aq})$	$\text{Na}(\text{s})$
C	$\text{O}_2(\text{g})$	$\text{H}_2(\text{g})$
D	$\text{Cl}_2(\text{g})$	$\text{H}_2(\text{g})$

- 1.9 The organic compound below can be called:



- A pentyl ethanoate
B ethyl pentanoate
C butyl ethanoate
D ethyl butanoate
- 1.10 Which one of the following would decolourise bromine water most rapidly?
- A C_4H_8
B HCOOH
C C_4H_{10}
D $\text{CH}_3\text{CH}_2\text{OH}$

[20]

QUESTION 2

SiCl_4 reacts with water to form SiO_2 and HCl as shown in the equation below.



- 2.1 Explain what is meant by an intermolecular force. (2)

- 2.2 Name the predominant intermolecular forces responsible for keeping water as a liquid. (1)

- 2.3 SiO_2 has a very high melting point of 1 710 °C.
Explain the high melting point of SiO_2 by referring to the bonding and structure of this substance. (3)

- 2.4 SiCl_4 and HCl are formed by covalent bonding.
2.3.1 Define electronegativity. (2)

- 2.3.2 Use a calculation to explain why the bonds in SiCl_4 are more polar than the bonds in HCl . (3)

2.5 The boiling point of SiCl_4 is 58°C and HCl has a boiling point of -85°C .

The melting point of SiCl_4 is -70°C .

2.5.1 In what phase would SiCl_4 be at room temperature? (1)

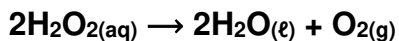
2.5.2 Explain the origin of the London type van der Waals forces. (3)

2.5.3 Explain the difference in the boiling points of SiCl_4 and HCl . (4)

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QUESTION 3

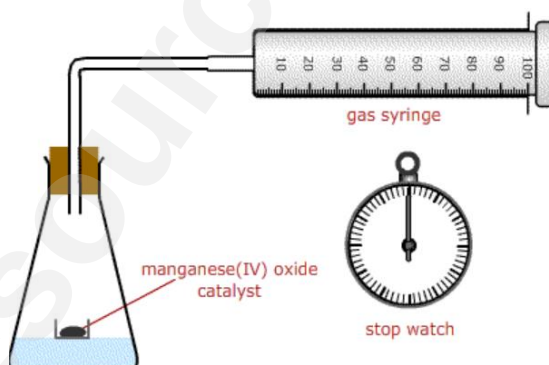
Hydrogen peroxide solution decomposes slowly to form water and oxygen. The reaction is much faster in the presence of a manganese (IV) oxide catalyst.



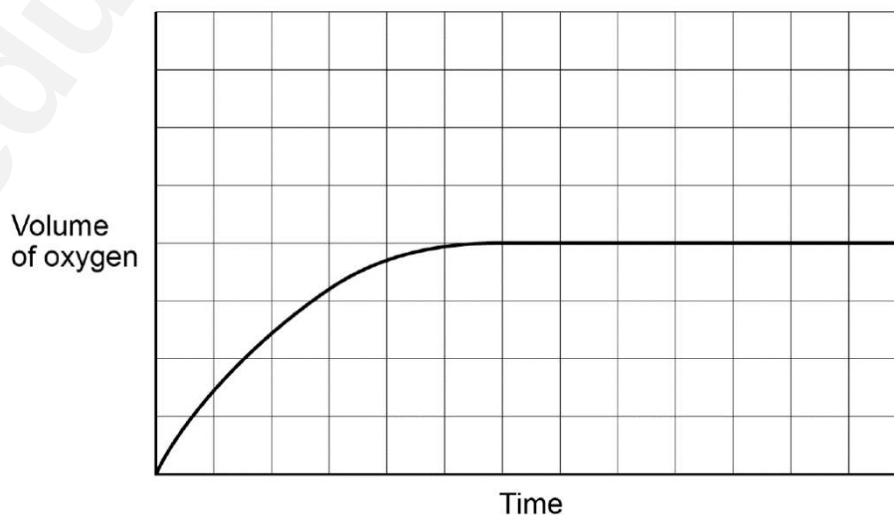
Jaiden performs a series of three experiments, shown in the table below, which were carried out to investigate how the volume of oxygen produced varied over time under different conditions. The same mass of catalyst was used.

Experiment	Concentration of $\text{H}_2\text{O}_{2(\text{aq})}$ ($\text{mol}\cdot\text{dm}^{-3}$)	Volume of $\text{H}_2\text{O}_{2(\text{aq})}$ (cm^3)	Temperature ($^{\circ}\text{C}$)	Catalyst
1	1,0	50	20	lumps
2	1,0	50	20	powder
3	0,5	50	20	lumps

Jaiden collects the gas using a gas syringe and records the volume per unit time.



He obtains the following graph showing how the volume of oxygen collected varied with time in **Experiment 1**.



3.1 Define *catalyst*. (2)

3.2 Ben, another student, suggests that the experiment could be improved by placing a conical flask containing hydrogen peroxide on an electronic balance and then adding the catalyst to the conical flask immediately.

3.2.1 How would this method measure the rate of the reaction? (2)

3.2.2 Suggest **one** way this method is more accurate when compared to the gas collection method (2)

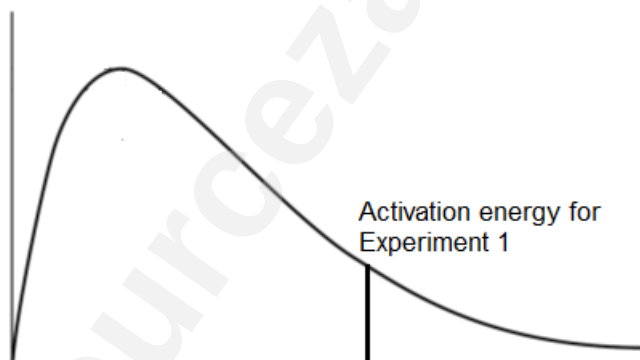
3.3 On the graph on page 8, draw AND LABEL the graph that would result for

3.3.1 Experiment 2 (2)

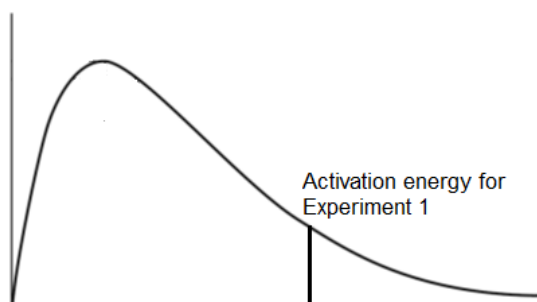
3.3.2 Experiment 3 (2)

- 3.4 Explain, in terms of collision theory, the effect of increasing the concentration of hydrogen peroxide on the rate of reaction. (4)

- 3.5 Below is the Maxwell–Boltzmann distribution for **Experiment 1**.



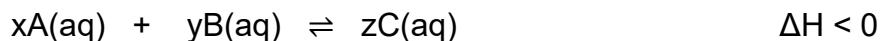
- 3.5.1 Write down the labels for the x-axis and y-axis on the above diagram. (2)
- 3.5.2 Draw in a line for **Experiment 1** without a catalyst. Label it 3.5.2 (2)
- 3.5.3 Draw the graph that would result from **Experiment 3** on the graph below. (2)



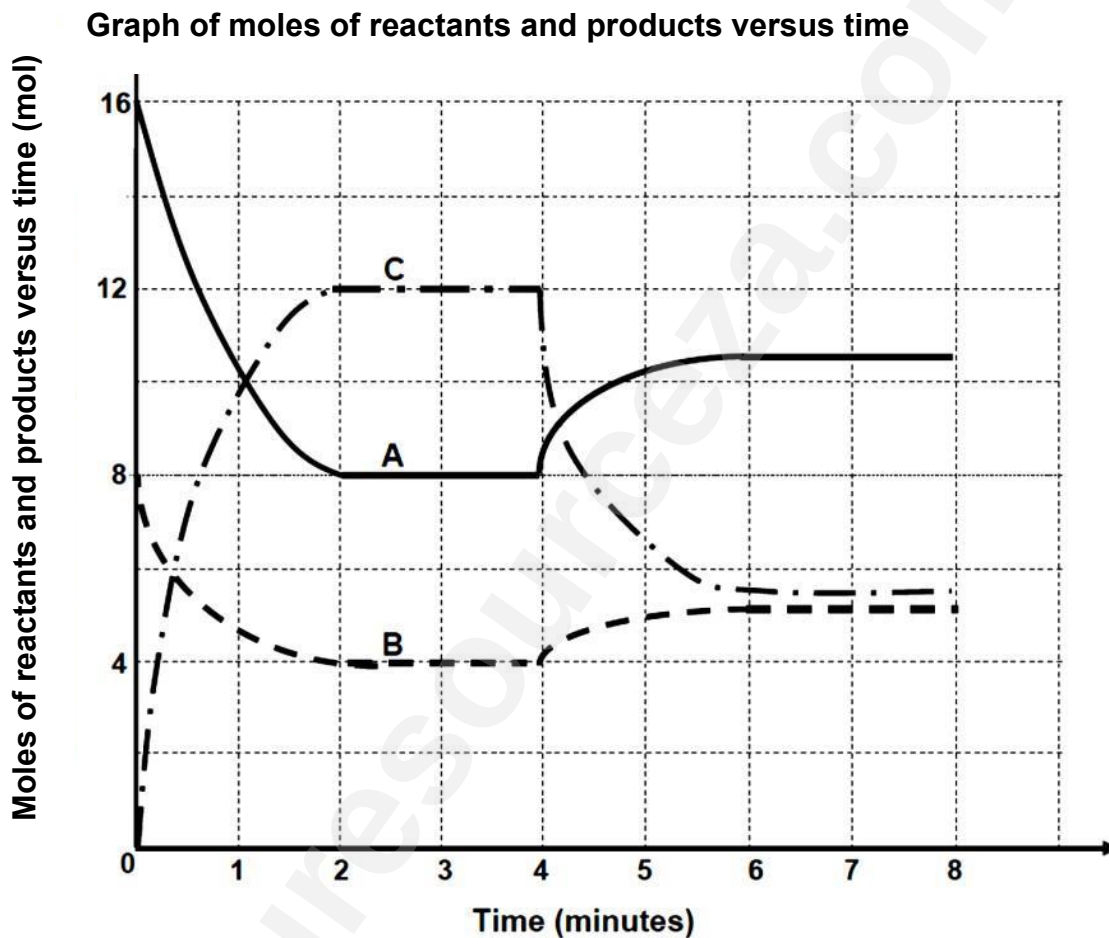
[20]

QUESTION 4

- 4.1 The equation below represents a hypothetical reaction that reaches equilibrium in a closed system in 2 minutes at room temperature. The letters x, y and z represent the number of moles in the equation.



The graph below shows the change in the moles of reactants and products versus time during the reaction.



- 4.1.1 Explain what is meant by dynamic chemical equilibrium. (2)

- 4.1.2 Use the information from the graph to write down the value of

4.1.2.1 **x** _____ (1)

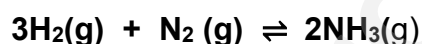
4.1.2.2 **y** _____ (1)

4.1.2.3 **z** _____ (1)

4.1.3 State Le Châtelier's principle. (2)

4.1.4 Explain the change experienced by the system at $t = 4$ minutes (4)

4.2 Samantha places 0,4 mol of hydrogen gas and 0,2 mol of nitrogen gas in an empty 250 cm³ container.



After the gases react, it is found that 0,34 g of ammonia gas is present in the equilibrium mixture at 25°C. Calculate the equilibrium constant, K_c , for this reaction at this temperature. (7)

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QUESTION 5

- 5.1 Gabriel finds two bottles of basic solutions in the chemical storeroom - KOH(aq) and NH₄OH(aq). The concentration of each base is the same and is given as 0,5 mol.dm⁻³ at 25°C.



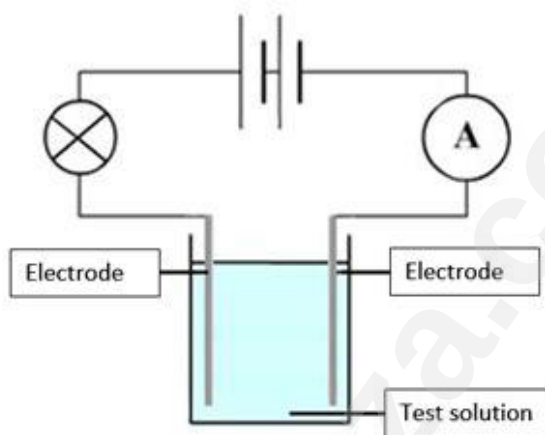
- 5.1.1 Define a strong base. (2)

- 5.1.2 Write down the dissociation equation of KOH. (3)

- 5.1.3 Calculate the concentration of H₃O⁺ ions in the KOH solution at 25°C. (4)

5.1.4 Gabriel decides to carry out some tests on the two basic solutions.

He sets up the apparatus shown in the diagram below to test how well the solutions conduct electricity and he records the brightness of the bulb for each base respectively. He uses the same volume of each basic solution.



Write down the:

a) Independent variable: (1)

b) **One** Fixed variable: (1)

c) Why is it important to have fixed variables? (1)

d) Which solution (KOH or NH_4OH) would the bulb glow brighter and why? (3)

- 5.2 The acid ionisation constant K_a for the ionisation of each of the hypothetical acids H_2X , HY and HZ in water at $25\text{ }^\circ\text{C}$ is given in the table below.

Acid	K_a
H_2X	$2,8 \times 10^{-3}$
HY	$1,2 \times 10^6$
HZ	6×10^{-4}

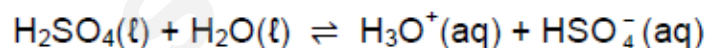
Write down the FORMULA(E) of the acid(s) which correspond(s) to the following descriptions:

- 5.2.1 the strongest acid. (1)

- 5.2.2 a polyprotic acid. (1)

- 5.2.3 the acid with the lowest pH in water. (Assume that the concentration of each acid is the same.) (1)

- 5.3 The balanced equation below represents the first step in the ionisation of sulfuric acid (H_2SO_4) in water:



Use the above equation to answer the following questions.

Write down the formula of:

- 5.3.1 the TWO bases (2)

- 5.3.2 an amphoteric substance. (1)

5.4 Ammonium hydroxide is titrated with nitric acid.

5.4.1 Write down a balanced equation to show the reaction of ammonium hydroxide and nitric acid (2)

5.4.2 Which indicator (from the table below) will be most suitable for this titration? (1)

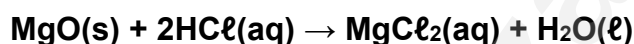
Indicator	pH Range
phenolphthalein	8.2 - 10
methyl orange	3.1 - 4.4
bromothymol blue	6 - 7.6

5.4.3 Explain your answer in 5.4.2 above. Write down a hydrolysis equation to support your answer. (4)

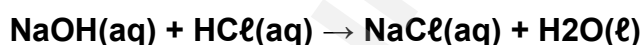
- 5.5 Hannah is given the task of determining the percentage of magnesium oxide in a health tablet. She dissolves the tablet in $0,05 \text{ dm}^3$ of $0,8 \text{ mol.dm}^{-3}$ hydrochloric acid.

- 5.5.1 Calculate the number of moles of acid present in $0,05 \text{ dm}^3$ of $0,8 \text{ mol.dm}^{-3}$ hydrochloric acid solution. (3)

All of the magnesium oxide in the tablet reacts with the hydrochloric acid as shown in the balanced chemical equation below.



Not all of the hydrochloric acid reacts. Hannah titrates the excess hydrochloric acid with a solution of sodium hydroxide. It takes $0,02 \text{ dm}^3$ of $0,5 \text{ mol.dm}^{-3}$ sodium hydroxide to neutralise the excess hydrochloric acid. The hydrochloric acid and sodium hydroxide react as shown in the balanced chemical equation below.

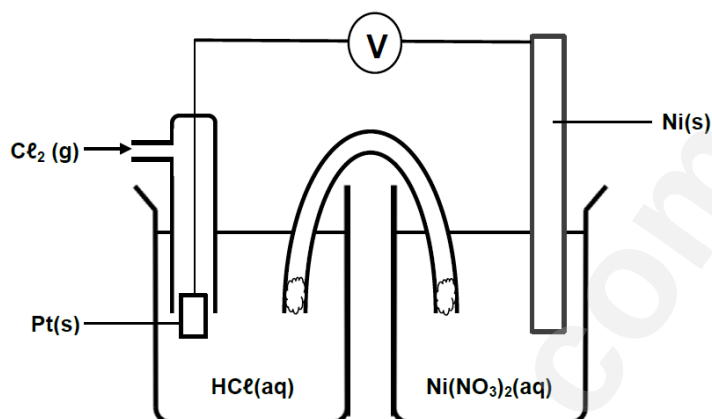


- 5.5.2 The original mass of the tablet is $0,96 \text{ g}$. Calculate the percentage of magnesium oxide in the tablet. (7)

[38]

QUESTION 6

A galvanic cell is constructed using a standard $\text{Cl}_2|\text{Cl}^-$ half-cell and a standard $\text{Ni}|\text{Ni}^{2+}$ half-cell, as shown in the diagram below.



- 6.1 Give the standard conditions for the above cell. (3)

- 6.2 Consider the HCl solution.

- 6.2.1 Write an equation for the ionisation reaction of $\text{HCl}(\text{aq})$. (2)

- 6.2.2 Hence, explain why this solution provides the necessary condition for the electrolyte. (2)

- 6.3 Can ethanoic acid be used as the electrolyte the chlorine half cell instead of HCl .

- 6.3.1 Circle the correct answer between the brackets. YES /NO (1)

- 6.3.2 Explain your answer. (2)

- 6.4 Circle the correct words between brackets in the statement below: (2)
(IONS / ELECTRONS) will move through the wire to the (PLATINUM / CHLORIDE) electrode
- 6.5 Write the cell notation for this cell, including relevant conditions. State symbols need not be shown. (5)
- _____
- _____
- 6.6 Calculate the emf for this cell (3)
- _____
- _____
- _____
- 6.7 Jolie accidentally drops some concentrated AgNO_3 solution into the chlorine half-cell, causing a white precipitate of AgCl to form.
How would this affect the initial cell emf?
Circle one of: INCREASES, DECREASES or NO CHANGE. (2)
- 6.8 Give the formula for a suitable salt solution for the salt bridge. (1)
- _____
- 6.9 The saturated salt solution given in 6.8 is replaced with a dilute salt solution.
How would this affect the maximum current the cell can deliver?
Circle one of: INCREASES, DECREASES or NO CHANGE. (1)

[24]

QUESTION 7

The grade 12 students set out to investigate the reaction of bromine water with solutions of sodium chloride and sodium iodide.

7.1 Identify the specific type of chemical bond found in:

7.1.1 Br_2 _____ (1)

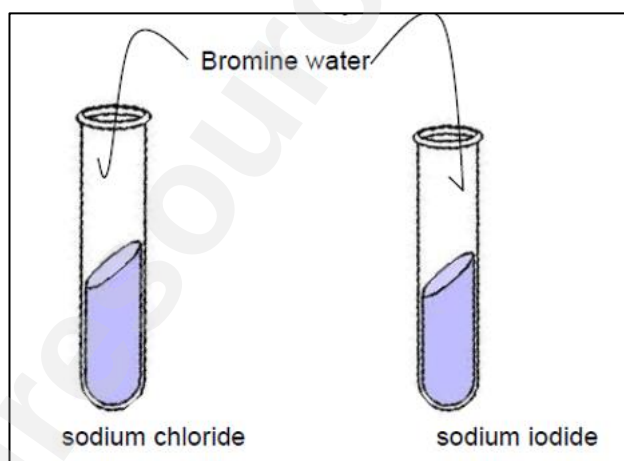
7.1.2 NaI _____ (1)

7.2 Identify the forces in the following molecules/salt respectively:

7.2.1 Br_2 _____ (1)

7.2.2 NaI _____ (1)

7.3 The diagram shows bromine water being added to test tubes containing sodium chloride and sodium iodide respectively. The organic solvent hexane is added to the aqueous solutions to indicate if any reaction has occurred.



In which test tube will a reaction occur spontaneously? Circle the correct answer: test tube containing sodium chloride/ sodium iodide. (1)

Substantiate your answer with a balanced net ionic reaction. (Spectators ions don't need to be included.) (3)

7.4 Once the bromine water is added, the test tube is shaken and there are two distinct layers formed.

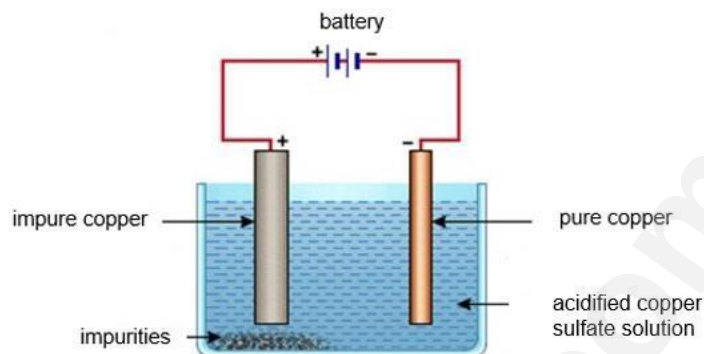
7.4.1 In terms of intermolecular forces, explain why there are two layers formed? (4)

7.4.2 Name the gas that is formed that will dissolve in the hexane layer. (1)

[13]

QUESTION 8

The diagram below shows the experimental setup for the electrolytic refining of copper



8.1 Give the energy conversion in the above cell. (2)

8.2 Why is the copper sulfate solution acidified? (2)

8.3 Gold and chromium are two of the impurities found in impure copper.

8.3.1 Explain why the chromium will be oxidised but the gold not. (3)

8.3.2 Explain why the chromium ions formed during this process do not interfere with the refining process of copper. (3)

- 8.4 After some time the mass of the pure copper electrode is found to have changed by 19,6 g.

8.4.1 **Circle** the correct words between brackets in the statement below:

The pure copper electrode (GAINED / LOST) mass due to
(OXIDATION / REDUCTION) taking place at this electrode. (2)

- 8.4.2 The mass change took place during a time of 36 minutes. Calculate the average current that was used during this time. (7)

[19]

QUESTION 9

A <pre> H H H H H-C=C-C-C-H H H H </pre>	B <pre> H H-C-H H H H-C-C-C-H Br H H </pre>	C <pre> H H-C-H H H H H H H H-C-C-C-C-C-C-H H H H H H H H-C-H H </pre>
D Pentan-2,3-ol	E <pre> H O H-C-C-O-H H </pre>	F Ethyl propanoate

9.1 Give the IUPAC names of:

(a) Compound **B**. (2)

(b) Compound **C**. (2)

9.2 Give the structural formula of the positional isomer of compound **A**. (2)

9.3 Correct the name shown for compound **D**. (2)

9.4 Name the homologous series to which compound **B** belongs. (1)

9.5 Name the functional group of compound **E**. (1)

9.6 Which one of compounds **A** to **F** is an unsaturated hydrocarbon? (1)

9.7.1 Give the IUPAC name of a functional isomer of compound **F**. (1)

9.7.2 Will compound **F** or the functional isomer of compound **F** have a higher boiling point. Explain your answer. (4)

9.8 Compound **B** can undergo two different reactions. Name the **SPECIFIC** reaction type AND give the condensed structural formula/e of the product/s when **B** reacts in...

9.8.1 dilute aqueous NaOH (3)

9.8.2 hot concentrated NaOH in ethanol (3)

9.9.1 Explain why compound **A** is a gas at room temperature. (2)

9.9.2 Write out a balanced reaction using molecular formulae to show the combustion of compound **A**. (3)

9.9.3 Give the energy conversion for the reaction in 9.9.1. (2)

[29]

TOTAL: 200 MARKS

**REMEMBER TO CLEARLY INDICATE AT THE QUESTION THAT YOU USED THE
ADDITIONAL SPACE TO ENSURE THAT ANSWERS ARE MARKED.**

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King David Victory Park

Prelim Paper 2 Chemistry 2024