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Penryn
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Name:

Teacher's name:

GRADE 12

Physical Sciences Examination – Paper 2

Date: 05/09/2023

ASSESSOR: Mrs N Jones

TIME: 180 Minutes

MODERATOR: Mr J Bredenkamp

MARKS: 200 Marks

Instructions:

1. This question paper consists of 32 pages and a Data Sheet of 3 pages (i – iii). Please check that your question paper is complete.
 2. Read the questions carefully.
 3. Answer ALL the questions on the questions paper and hand it in at the end of the test. Remember to write your name in the space provided above.
 4. Use the data and formulae whenever necessary.
 5. Show your working in all calculations.
 6. Units need not be included in the working of calculations, but appropriate units should be shown in the answer.
 7. Answers must be expressed in decimal format, not left as proper fractions.
 8. Where appropriate, express answers to TWO decimal places.
 9. It is in your own interest to write legibly and to present your work neatly.
 10. TWO blank pages (pages 31 & 32) are included at the end of the paper. If you run out of space for a question, use these pages. 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.
-

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Answer these questions on the multiple-choice answer sheet below. Make a cross (X) in the box corresponding to the letter that you consider to be correct.

A	B	~~C~~	D
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Here the option C has been marked as an example.

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 What is the correct name for the following compound?



- A Aluminium carbonate
- B Aluminium hydrocarbonate
- C Aluminium hydrogen carbonate
- D Aluminium dichromate

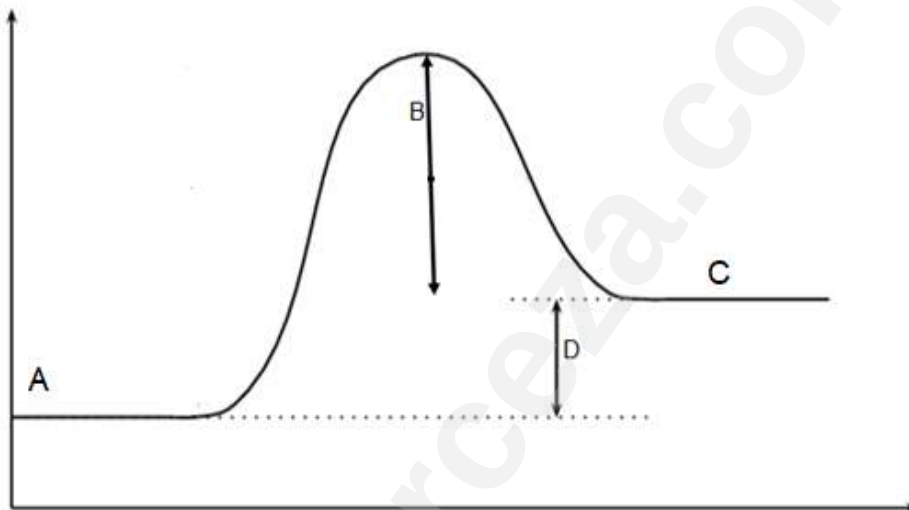
1.2 The number of chlorine atoms in 3 dm³ of chlorine gas at STP will be:

- A $1,61 \times 10^{23}$
- B $1,81 \times 10^{24}$
- C $4,1 \times 10^{25}$
- D $8,09 \times 10^{25}$

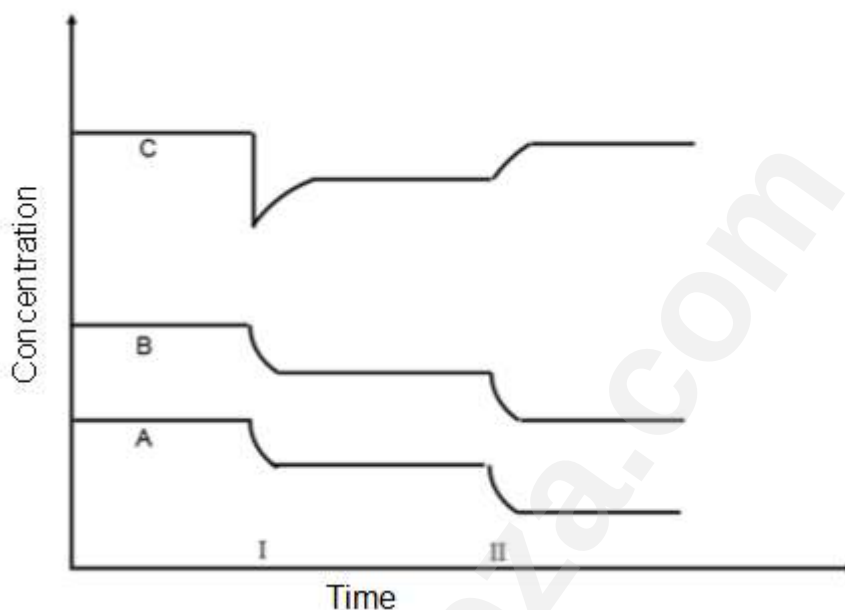
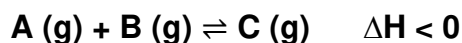
1.3 Which of the following is NOT a condition for hydrogen bonding?

- A Hydrogen bonded to Oxygen, Nitrogen or Fluorine.
- B Hydrogen bonded to a small atom.
- C Hydrogen bonded to an atom of high electronegativity.
- D Hydrogen bonded to an atom with at least one lone pair of electrons.

1.4 Which variable on the following energy profile diagram will change if a positive catalyst were added to the reaction system?

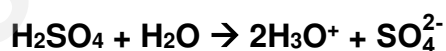


- 1.5 The following concentration vs. time graph for the following hypothetical reaction is given below:



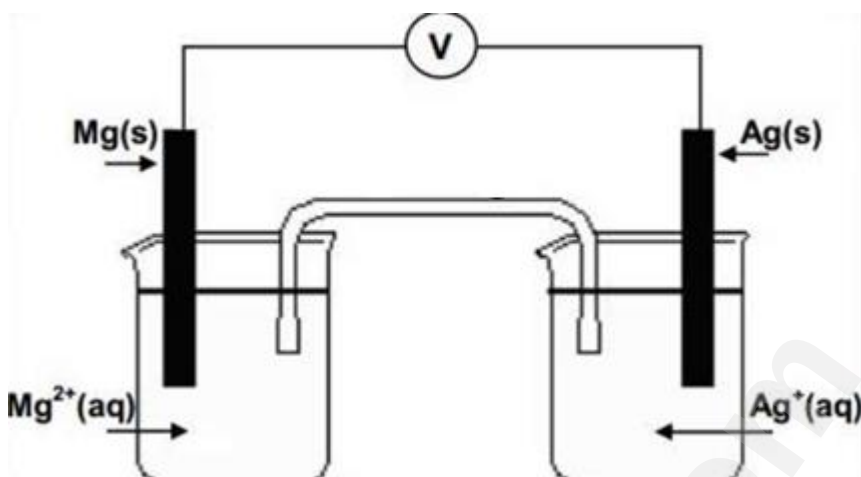
Which two changes took place at time I and time II respectively?

- A Decrease in C; increase in temperature
 - B Decrease in C; decrease in temperature
 - C Increase in C; increase in temperature
 - D Increase in C; decrease in temperature
- 1.6 Identify the conjugate acid base pairs in the following acid-base reaction.



	Acid	Conjugate Base	Base	Conjugate Acid
A	H_2SO_4	H_3O^+	H_2O	SO_4^{2-}
B	H_2O	H_3O^+	H_2SO_4	SO_4^{2-}
C	H_2SO_4	SO_4^{2-}	H_2O	H_3O^+
D	H_2O	SO_4^{2-}	H_2SO_4	H_3O^+

1.7 Which of the following cell notations correctly denotes the following galvanic cell?



- A $\text{Mg}^{2+} \mid \text{Mg} \parallel \text{Ag}^+ \mid \text{Ag}$
- B $\text{Ag} \mid \text{Ag}^+ \parallel \text{Mg}^+ \mid \text{Mg}$
- C $\text{Mg} \mid \text{Mg}^{2+} \parallel \text{Ag} \mid \text{Ag}^+$
- D $\text{Mg} \mid \text{Mg}^{2+} \parallel \text{Ag}^+ \mid \text{Ag}$

1.8 Refer to the cell given in question 1.7. How will the emf of the cell be affected if the salt bridge were to be filled with KCl?

- A No effect
- B Increase
- C Decrease
- D Go immediately to zero

1.9 The study of organic chemistry does NOT involve the study of:

- A Esters
- B Carboxylic Acids
- C Carbides
- D Alcohols

1.10 If only two products are obtained from the cracking of $C_{14}H_{30}$ they could be:

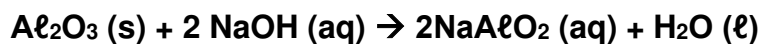
- A heptane and heptene
- B two heptane molecules
- C octane and hexane
- D octene and hexene

{10 x 2} [20]

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QUESTION 2

- 2.1 The mining of aluminium involves the purification of bauxite. One of the steps involves the reaction of Aluminium oxide with sodium hydroxide to form sodium aluminium oxide and water. The balanced equation is given below:



1500 kg of aluminium oxide is reacted with an excess of sodium hydroxide.

- 2.1.1 Define *solution*. (2)

- 2.1.2 Determine the mass of sodium aluminium oxide produced in the final slurry. (6)

- 2.1.3 What volume of water is required in the final slurry to make a concentration of $0,5 \text{ mol} \cdot \text{dm}^{-3}$ sodium aluminium oxide? (3)

- 2.1.4 If only 1 900 000 g of sodium aluminium oxide is produced, determine the percentage yield of this reaction. (3)

- 2.1.5 You are told that economically viable reactions need to have percentage yields above 80%. Would you recommend this reaction to the managing direction of the aluminium refinery? (1)
-

2.2 The reaction between hydrochloric acid (HCl) and sodium hydrogen carbonate (NaHCO_3) is known as a gas forming reaction. This reaction is carried out at standard temperature and pressure.

- 2.2.1 Write a balanced equation for the reaction between hydrochloric acid and sodium hydrogen carbonate. (3)
-

- 2.2.2 In the reaction carried out (at STP) in a laboratory $0,37 \text{ dm}^3$ of carbon dioxide is produced. The HCl used in the reaction is marked as $0,5 \text{ mol} \cdot \text{dm}^{-3}$. Determine the volume of HCl required for this reaction. (5)
-
-
-
-
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-
-

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QUESTION 3

3.1 Water exists in the solid form as an ice-crystal.

3.1.1 Name the intermolecular force(s) in water. (1)

3.1.2 Name the intramolecular bond(s) in water. (1)

3.1.3 When ice melts, which of the two above mentioned forces/bonds are being weakened? (1)

3.1.4 The intermolecular force mentioned in 3.1.1. is generally regarded as stronger than London forces, yet iodine has a melting point of 114°C while water's melting point is 0°C . Explain this phenomenon. (3)

3.2 The following table gives the melting points of various hydrides:

Hydride	Melting point
HI	-50°C
NH_3	-78°C
H_2S	-83°C
CH_4	-184°C

3.2.1 In which of these hydrides does hydrogen bonding occur? (1)

3.2.2 In which of these hydrides do London forces occur? Explain your answer. (2)

3.3 3.3.1 Name the type of bonding between copper atoms in a sheet of copper. (1)

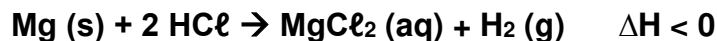
3.3.2 Draw a simple labelled sketch showing the bonding between copper atoms in a sheet of copper. (3)

3.3.3. Use the features sketched in question 2.3.2 to explain why copper is such a good conductor of electricity. (2)

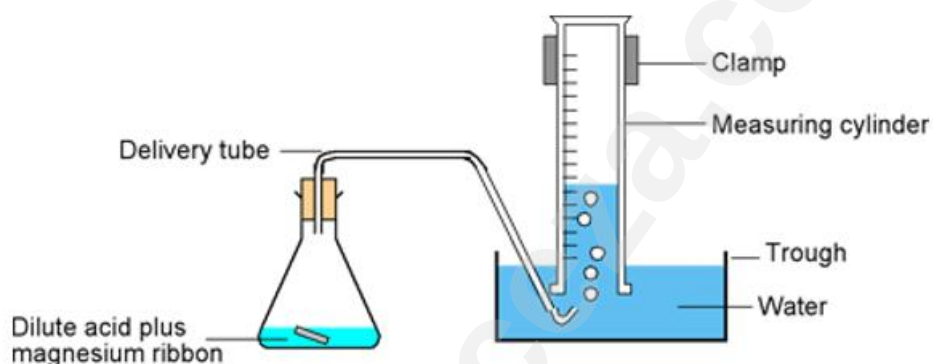
[15]

QUESTION 4

As a Matric learner you are instructed to investigate the factors that influence the rate of a chemical reaction. You decide to use the reaction between magnesium metal and hydrochloric acid, based on the following equation:



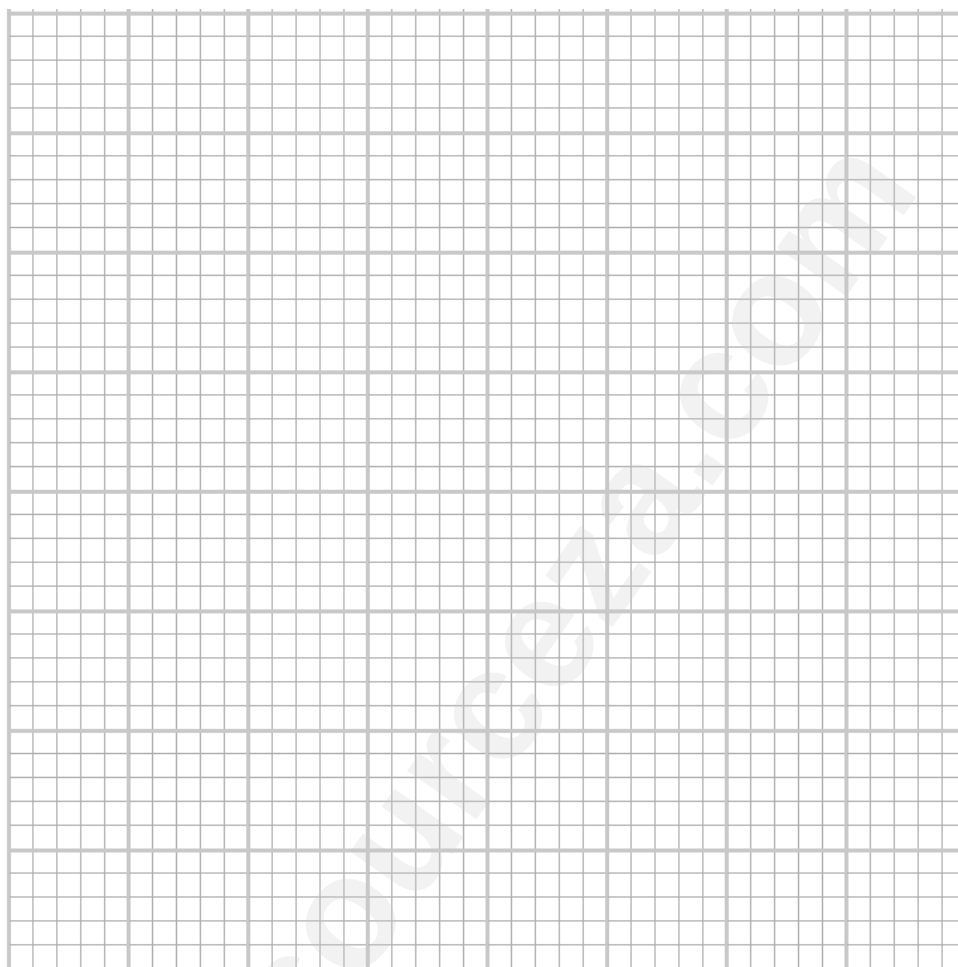
Magnesium is the limiting reagent. You decide to measure the volume of hydrogen gas produced using the downward displacement of water. The apparatus set-up is shown below:



The results from your first experiment (Experiment A) are recorded in the table below:

Time (minutes)	Volume of gas (cm ³)
0,25	1
0,5	5
1,0	18
2,0	28
2,5	31
3,0	33
3,5	35
4,0	35
4,5	35,5
5,0	36
5,5	36
6,0	36

- 4.1 Draw a graph to represent the results of this experiment. Draw a freehand line of best fit. (6)



- 4.2 Calculate the average reaction rate (in cm.s^{-1}) for the first minute of the reaction. (2)

- 4.3 Give a reason for why the reaction rate:

- 4.3.1 Increases during the 1st minute: (2)

4.3.2 Decreases in the 4th minute: (2)

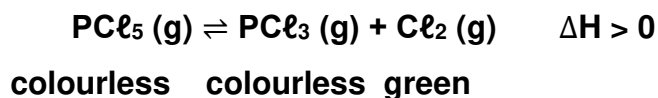
4.4 You now repeat the experiment using the SAME volume of a LESS concentrated HCl. All other conditions were kept the same. Draw a second line on the same set of axes above, to represent the predicted results for this experiment. Label this new line B. (2)

4.5 You perform a 3rd experiment in which you use powdered magnesium instead of magnesium ribbon. All other conditions were kept the same as Experiment A. Explain how the use of magnesium powder would affect the reaction rate by referring to collision theory. (4)

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QUESTION 5

Phosphorus pentachloride decomposes into phosphorous trichloride and chlorine gas. When gaseous phosphorus pentachloride is sealed in a closed container the following equilibrium is established:



5.1 State *Le Chatelier's Principle*.

(2)

5.2 The equilibrium position can be disturbed by heating or cooling the system. What change in temperature should one make, in order to change the colour of the gas in the container from a dark green to a very pale green? Explain your answer with reference to *Le Chatelier's Principle*.

(3)

5.3 An unknown mass of phosphorous pentachloride is sealed in an empty 2000 cm³ container. The system is allowed to reach equilibrium at 250 °C.

(5)

When the equilibrium mixture was analysed, the concentration of PCl₅ and Cl₂ was 0,7 mol·dm⁻³ and 0,5 mol·dm⁻³ respectively. Calculate the initial concentration of the phosphorous pentachloride.

- 5.4 Calculate the mass of phosphorous pentachloride that was originally placed in the container. (3)

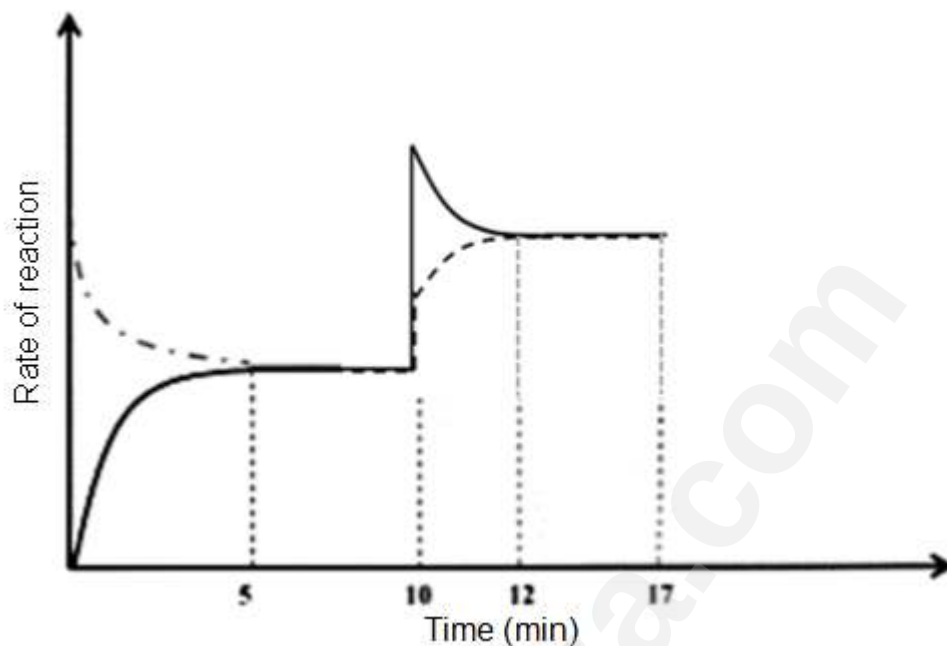
- 5.5 Calculate the K_c value at 250 °C. (3)

- 5.6 The pressure of the container is increased without affecting the temperature. How would the following be affected? (State only INCREASES, DECREASES or REMAINS THE SAME)

- 5.6.1 The yield of PCl_3 . (1)

- 5.6.2 The value of K_c . (1)

- 5.7 PCl_5 is added to another sealed container and allowed to reach equilibrium at 200°C . The rate of the reaction is plotted on the graph below:



- 5.7.1 Which reaction (FORWARD or REVERSE) is represented by the solid line in the graph? Explain fully. (2)

- 5.7.2 What happened at 5 minutes? (1)

- 5.7.3 What possible change was made at 10 minutes? Explain fully. (3)

- 5.7.4 At 17 minutes, the concentration of chlorine is decreased by the removal of chlorine. (2)

Complete the rest of the graph from 17 min to 20 min.

- 5.8 The following equations may be used to represent the rates of the forward and the reverse reaction:

$$\text{Rate of forward reaction} = k_1[\text{PCl}_5]$$

$$\text{Rate of reverse reaction} = k_2[\text{PCl}_3][\text{Cl}_2]$$

where k_1 and k_2 are constants.

If the pressure of the system is decreased by increasing the volume of the container, both the forward and reverse reaction rates will decrease, but the reverse rate will decrease more than the forward.

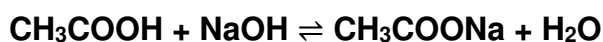
- 5.8.1 Consider the rate equations provided and state why a decrease in pressure (1) causes both reaction rates to decrease.

- 5.8.2 **With reference to the rate equations provided**, explain why a decrease (2) in pressure causes the reverse reaction rate to decrease more than the forward.

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QUESTION 6

- 6.1 A food scientist tests the quality of a specific brand of vinegar. He uses 20 ml vinegar and determines the amount of sodium hydroxide required to neutralise the acid.



- 6.1.1 Define the term *neutralisation*. (2)

- 6.1.2 What process would this food scientist use to neutralise the acid? (1)

- 6.1.3 The standard solution of sodium hydroxide used had a concentration of 0,05 mol·dm³. The following results were obtained: (3)

	Volume vinegar (cm ³)	Volume NaOH (cm ³)
Run 1	20	12,7
Run 2	20	12,6
Run 3	20	12,65

Calculate the concentration of the ethanoic acid in the vinegar.

- 6.1.4 The label on the bottle of vinegar states that there are 6 g ethanoic acid in every 100 ml vinegar. Is this statement true? Motivate your answer using suitable calculations. (3)

- 6.2 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:

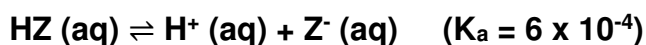
Acid	K_a
H_2X	$2,8 \times 10^{-3}$
HY	$1,2 \times 10^6$
HZ	6×10^{-4}

- 6.2.1 State the difference between a *strong acid* and a *weak acid*. Give one example of each. (Choose from H_2X , HY or HZ) (3)

- 6.2.2 Which acid, H_2X , HY or HZ , has the lowest pH in water? Justify your choice. Assume that the concentration of each acid is the same. (3)

- 6.2.3 Which acid, H_2X , HY or HZ , is the weakest electrical conductor in water? Justify your choice. Assume that the concentration of each acid is the same. (3)

- 6.2.4 The equation for the ionisation of HZ in an aqueous solution is:



The concentration of the un-ionised HZ in a solution at $25\text{ }^\circ\text{C}$ is $0,2\text{ mol}\cdot\text{dm}^{-3}$.

- (a) Write an expression for K_a for HZ . (1)

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(b) Calculate the concentration of Z^{-} ions in the solution.

(4)

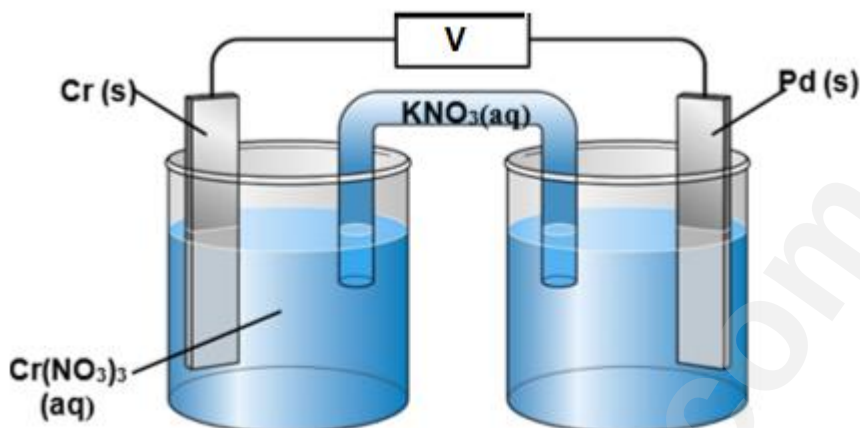
6.3 Given a solution of sodium ethanoate (CH_3COONa), will the solution be acidic or basic? Use hydrolysis principles to answer this question.

(4)

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QUESTION 7

A standard galvanic cell using chromium and palladium electrodes is set up as shown in the diagram below.



The electrode potential for palladium is shown below:



Cr^{3+} ions are green and Pd^{2+} ions are colourless. Each electrolyte has a constant volume of 500 cm^3 .

7.1 What energy conversion occurs in this cell? (2)

7.2 Write down the formula for a suitable electrolyte for the palladium half-cell. (1)

7.3 Explain how one would obtain the electrode potential of palladium. (3)

7.4 Write down the oxidation half-reaction. (2)

7.5 Write down the reduction half-reaction. (2)

7.6 Write down the net ionic cell reaction equation. (2)

7.7 Write the cell notation for this cell. (2)

7.8 Calculate the standard emf of this cell. (3)

7.9 Concentrated sodium hydroxide solution is added to the palladium half-cell electrolyte. (Note: palladium hydroxide is insoluble in water)

7.9.1 State what happens to the emf calculated in 5.8. Choose from: (1)
INCREASES, DECREASE or REMAINS THE SAME.

7.9.2 Explain your answer to Question 7.9.1. (3)

[21]

QUESTION 8

Rhodium (Rh) is a very white, brilliantly shiny metal, but is far too hard to work into jewelry itself. It is also the most expensive precious metal. So, nowadays, so called “white gold” jewelry is actually normal “yellow gold” coated with rhodium to create a bright white, highly durable and tarnish resistant surface. The most frequently used method of applying rhodium finishes is the electroplating process.

In order to plate a particular wedding ring with rhodium, an electroplating cell is used with a concentrated rhodium (III) chloride (RhCl_3) solution and sulphuric acid electrolyte. The Rhodium half reaction emf is +0,87 V.

- 8.1 Give TWO reasons, other than appearance, for electroplating. (2)

- 8.2 Which electrode will the ring be? (1)

- 8.3 Write down the reduction half-reaction that occurs in this cell. (2)

- 8.4 What is the reason for using the sulphuric acid in the electrolyte? (2)

- 8.5 Jewelers suggest that a gold, and not a steel, hook should be used to suspend the ring in the electrolyte. Explain the reason for this. (Note: iron is the main substituent in steel) (2)

- 8.6 In order for the rhodium plating to last a sufficiently long time, the ring needs to be coated with 288 mg of rhodium. Considering that a current of 1,5 A is used in the cell, calculate how long it would take to coat the ring. (6)

[15]

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QUESTION 9

Consider the various carbon compounds and their boiling points given in the table below and answer the questions that follow:

Compound	Name or structural formulae	Boiling point (°C)
A	Pentanoic acid	187
B	<pre> H H H H H - C - C - C - C - H H H H H - C - H H </pre>	-161
C	$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$	138
D	$\text{CH}_3\text{CH}_2\text{CH}_2\text{COOCH}_3$	102
E	<pre> H Br H H H H - C - C - C - C - C - H H H H C H H - C - H H </pre>	154
F	<pre> H H H H H H - C - C - C - C - C - H H H H H H </pre>	-130

G	<pre> H H H H O H H - C - C - C - C - C - H H H H H H </pre>	119
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9.1 Describe an organic molecule. (2)

9.2 To which homologous series does compound D belong? (1)

9.3 Give the IUPAC name of compound E. (2)

9.4 From the compounds in the table on the previous page, select all the positional isomers of compound G. Give only the letter/s of the correct compound/s. (1)

9.5 Give the IUPAC name of compound D. (2)

9.6 Explain why compounds B and F are chain isomers of each other. (3)

- 9.7 Explain why compound B has a lower boiling point than compound F. Include reference to specific intermolecular forces in your answer. (4)

[15]

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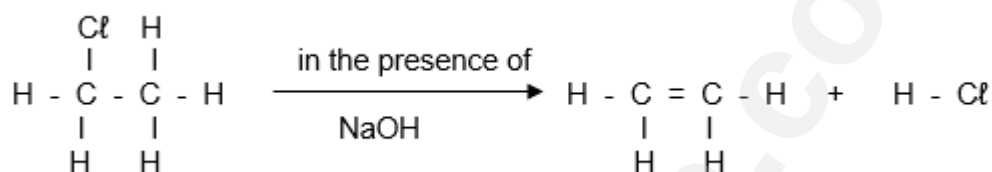
Consider the following reactions. Unidentified compounds are labelled with letters W, X and Y within boxes. Not all of the relevant conditions have been included in the reactions.

Reactions A and B:

Under different conditions, a haloalkane will either react to form an alkene or an alcohol. Both reactions require the presence of a strong base such as sodium hydroxide to allow each reaction to take place.

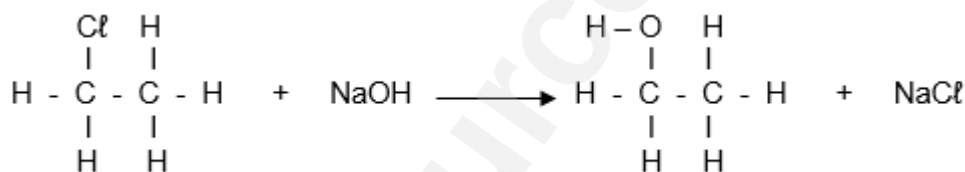
Reaction A:

A haloalkane can be converted into ethene according to the following reaction:



Reaction B:

A haloalkane can alternatively be converted into an alcohol according to the following reaction:



10.1 What type of general reaction is Reaction A? (1)

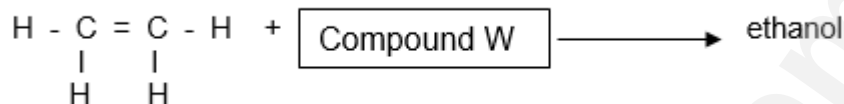
10.2 What type of specific reaction is Reaction B? (1)

10.3 Reaction A produces two gaseous products, ethene and hydrogen chloride. (2)
Suggest a practical way to separate these two products from each other and explain why this is a suitable method.

- 10.4 Which reaction (Reaction A or Reaction B) will take place when the sodium hydroxide is present in the form of a dilute aqueous solution? (1)
-

Reaction C:

Ethene further reacts in a hydration reaction to form ethanol according to the following chemical reaction equation:

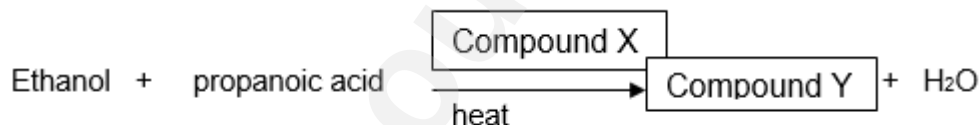


- 10.5 Reaction C is a hydration reaction. What general type of reaction is this? (1)
-

- 10.6 Give the formula for compound W. (1)
-

Reaction D:

Ethanol further reacts with propanoic acid forming compound Y according to the following chemical reaction equation:

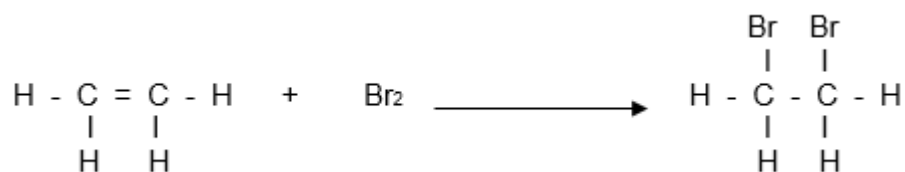


- 10.7 Give the IUPAC name of compound Y. (2)
-

- 10.8 Identify compound X which is needed for Reaction D to form compound Y. (1)
-

Reaction E: Downloaded from eduresourceza.com

In another reaction, ethene is bubbled through liquid bromine and a reaction takes place according to the following chemical reaction equation:



10.9 What observation can be made when Reaction E takes place? (2)

10.10 Give the IUPAC name for the product of Reaction E. (2)

Reaction F:

Ethene will also burn in the presence of oxygen. It is a fossil fuel.

10.11 Give the balanced chemical equation for the complete combustion of ethene. Use (3)
molecular formulae for all substances in the reaction. Phases need not be shown.

[17]

GRAND TOTAL: {200 marks}

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Ballard, E. (2017). Physical Sciences Trials Examinations, Paper II (Chemistry).

Jones, N. (2018). June Examination - Physical Sciences P2: Chemistry. Curro.

Strydom, D., Snyman, E., & Jones, N. (2017). Preliminary Examination - Physical Sciences P2: Chemistry. Curro.