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STEYN CITY SCHOOL

PHYSICAL SCIENCES: CHEMISTRY (P2) MID-YEAR EXAMINATION 22 SEPTEMBER 2022

GRADE 12

EXAMINER: Mrs. A NAIDU

MARKS: 200

MODERATORS: Ms Vickers

TIME: 3 Hours

NAME OF LEARNER: _____

This question paper consists of 28 pages. A formula sheet is provided separately.

Acknowledgements:

- Pictures, images, and questions have been taken and adapted from past IEB, DBE and Teacher User Group sites.

	Q 1	Q 2	Q 3	Q 4	Q 5	Q 6	Q 7	Q 8	Q 9	TOTAL
Question total	20	13	17	37	37	26	12	21	17	
Mark										

PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY

1. This question paper consists of **28 pages, 3 blank pages**, and a **Data Sheet** of **2 pages**. Please check 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. 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. **THREE** blank pages (pages 29-31) are included at the end of the paper. If you run out of space for a question, use these pages. Clearly indicate the question number of your answer should you use this extra space.

QUESTION 1 MULTIPLE CHOICE

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

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1.1 Which of the following is the correct chemical formula for zinc (II) permanganate?

- A $\text{Zn}(\text{MnO}_2)_2$
- B $\text{Zn}(\text{MnO}_4)_2$
- C ZnMnO_2
- D ZnMnO_4 (2)

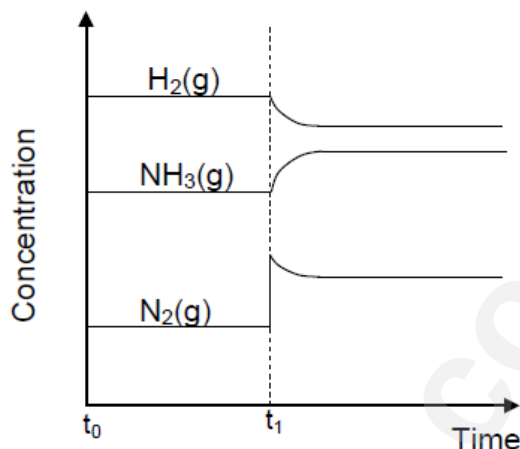
1.2 0,2 mol of sodium contains the same number of particles as:

- A 28 g iron
- B 2,8 g nitrogen gas
- C 5,5 g aluminium
- D 8 g neon (2)

1.3 The temperature of a substance is a measure of the ... of the particles.

- A average potential energy
- B average kinetic energy
- C total kinetic energy
- D total potential energy (2)

- 1.4 The graph below shows a change made to a chemical equilibrium in a closed container at time t_1 . The equation for the reaction is:



Which ONE of the following is the change made at time t_1 ?

- A Increase in pressure by decreasing the volume.
- B Increase in the concentration of $\text{N}_2(\text{g})$.
- C Increase in temperature.
- D Addition of a catalyst.

(2)

- 1.5 The balanced chemical equations for 3 reactions at equilibrium in a closed container are given below:

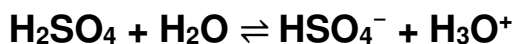
- (i) $\text{C}_2\text{H}_4(\text{g}) + \text{H}_2(\text{g}) \rightleftharpoons \text{C}_2\text{H}_6(\text{g})$
- (ii) $\text{Fe}_3\text{O}_4(\text{s}) + 4\text{H}_2(\text{g}) \rightleftharpoons 3\text{Fe}(\text{s}) + 4\text{H}_2\text{O}(\text{g})$
- (iii) $\text{SO}_3(\text{g}) + \text{NO}(\text{g}) \rightleftharpoons \text{NO}_2(\text{g}) + \text{SO}_2(\text{g})$

In which reaction(s) will the equilibrium position shift when the volume of the reaction vessel is decreased at constant temperature?

- A (i) only
- B (i), and (ii) Only
- C (i), and (iii) Only
- D (i), (ii) and (iii) Only

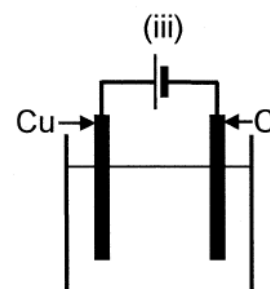
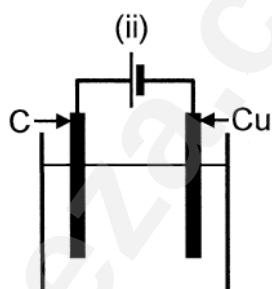
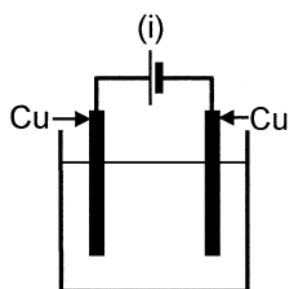
(2)

- 1.6 Identify two ampholytes (amphiprotic substances) in the given reaction below:



- A H_2O and HSO_4^-
 B H_2SO_4 and HSO_4^-
 C HSO_4^- and H_3O^+
 D H_2O and H_3O^+ (2)

- 1.7 In each of the electrolytic cells below, copper (II)sulphate is used as the electrolyte. The electrodes are either carbon (C) or copper (Cu).



In which cell(s) will the concentration of the electrolyte remain constant during the electrolytic process?

- A (i) only
 B (i), and (ii) Only
 C (i), and (iii) Only
 D (ii) and (iii) Only (2)
- 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	Cl_2 (g)	Na (s)
B	OH^- (aq)	Na (s)
C	O_2 (g)	H_2 (g)
D	Cl_2 (g)	H_2 (g)

(2)

1.9 Which one of the following statements is **INCORRECT**?

- A Haloalkanes can undergo substitution reactions.
- B Alkanes can undergo combustion reactions.
- C Alkenes undergo a substitution reaction to form alkanes.
- D Esters are formed from condensation reactions. (2)

1.10 When 2-bromobutane is strongly heated in the presence of an ethanolic solution of potassium hydroxide, a possible product is ...

- A butane
- B butan-2-ol
- C butan-1-ol
- D But-1-ene (2)

[TOTAL MARK: 20]

QUESTION 2:

- 2.1 Use only substances from the list below when answering Questions 2.1.1 to 2.1.8. The phase indicators (state symbols) represent the physical state of each of the substances at **room temperature**.

Graphite_(s)	CH₃COOK_(aq)	PH_{3(g)}	NH₄Cl_(aq)
Ne_(g)	HF_(l)	Br_{2(l)}	Cu

From the list select ONE: (Only write down the question number and the formula/name of the substance next to it. Substances may be used more than once or not at all.)

- 2.1.1 Substance that exists as individual atoms, which interact through London forces only.

- 2.1.2 Substance that can conduct electricity in both solid and liquid phases.

- 2.1.3 Substance that has a giant covalent network structure and is a conductor of an electric current in the solid phase.

- 2.1.4 **Compound** with pure covalent bonds.

- 2.1.5 Linear molecules with polar covalent bonds within the molecules.

- 2.1.6 A substance that produces an alkali salt during hydrolysis.

- 2.1.7 Molecules that experience hydrogen bond forces of attraction.

- 2.1.8 A substance that can only conduct an electric current in a molten or aqueous state but NOT in the solid state.

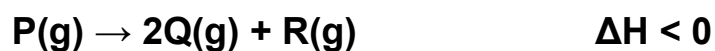
2.2 Define *intermolecular force*. (2)

2.3 $\text{PH}_{3(g)}$ and $\text{Br}_{2(l)}$ are BOTH nonpolar molecules. Using your knowledge of intermolecular forces, explain for the **difference in phases** at room temperature, for $\text{PH}_{3(g)}$ and $\text{Br}_{2(l)}$. (3)

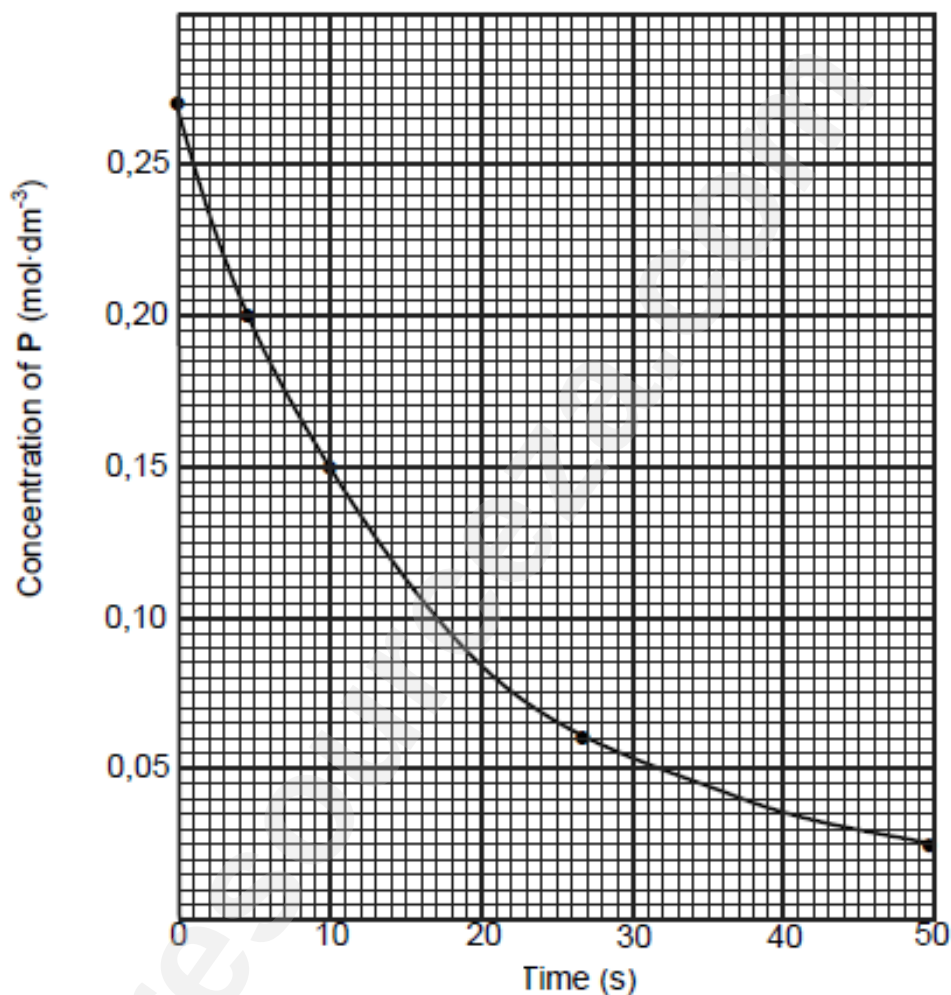
[13]

QUESTION 3:

The graph below shows the decomposition of gas **P** according to the following equation:



Graph of concentration of **P** versus time



(Question adapted from DBE February 2014)

3.1 Define the term *rate of reaction*.

(2)

- 3.2 At which time, 10 s or 30 s, does the decomposition take place at a higher rate? (2)
Refer to the graph to give a reason for the answer.

- 3.3 Write down the **initial** concentration of **P(g)**. (1)

- 3.4 The decomposition reaction is carried out in a 2 dm³ container.

- 3.4.1 Calculate the average rate (in mol·s⁻¹) at which **P(g)** is decomposed in the first 10 s. (5)

- 3.4.2 The same decomposition reaction is NOW carried out at a HIGHER (3)
temperature but in the same 2 dm³ container. Draw a labelled Maxwell-Boltzmann distribution curve to represent what changes would be observed at the different temperatures. $T_1 < T_2$ – please label the curves correctly.

- 3.5 A catalyst is added to the container. Using the collision theory, briefly explain (4)
what effect the catalyst would have on the rate of the chemical reaction AND on the CHANGE in ENTHALPY.

[17]

$$\text{CH}_4(\text{g}) + 2\text{H}_2\text{O}(\text{g}) \rightleftharpoons \text{CO}_2(\text{g}) + 4\text{H}_2(\text{g})$$

4.1.1 Draw the structural formula for a CH₄ molecule. (2)

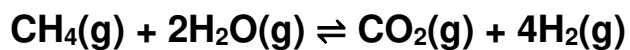
4.1.2 Water is a POLAR molecule. Using the VSEPR theory, explain why. (4)

This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and extend across the width of the page. A faint, diagonal watermark reading "resourcesourceza.com" is visible across the center of the page.

Using a suitable calculation show the type of bond that exists between the atoms of carbon and oxygen in the CO₂ molecule.

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- 4.2 Initially, 1 mol of methane and 2 mol of steam are sealed in a 5,0 dm³ container. When equilibrium is established at temperature T₁, the mixture contains 0,3 mol of CO₂(g).



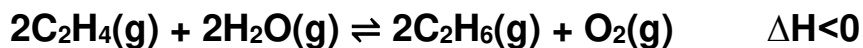
- 4.2.1 State *Le Chatelier's Principle*. (2)

- 4.2.2 Calculate the equilibrium constant (K_c) at T₁. (7)
(Leave your final answer to 3 decimal places)

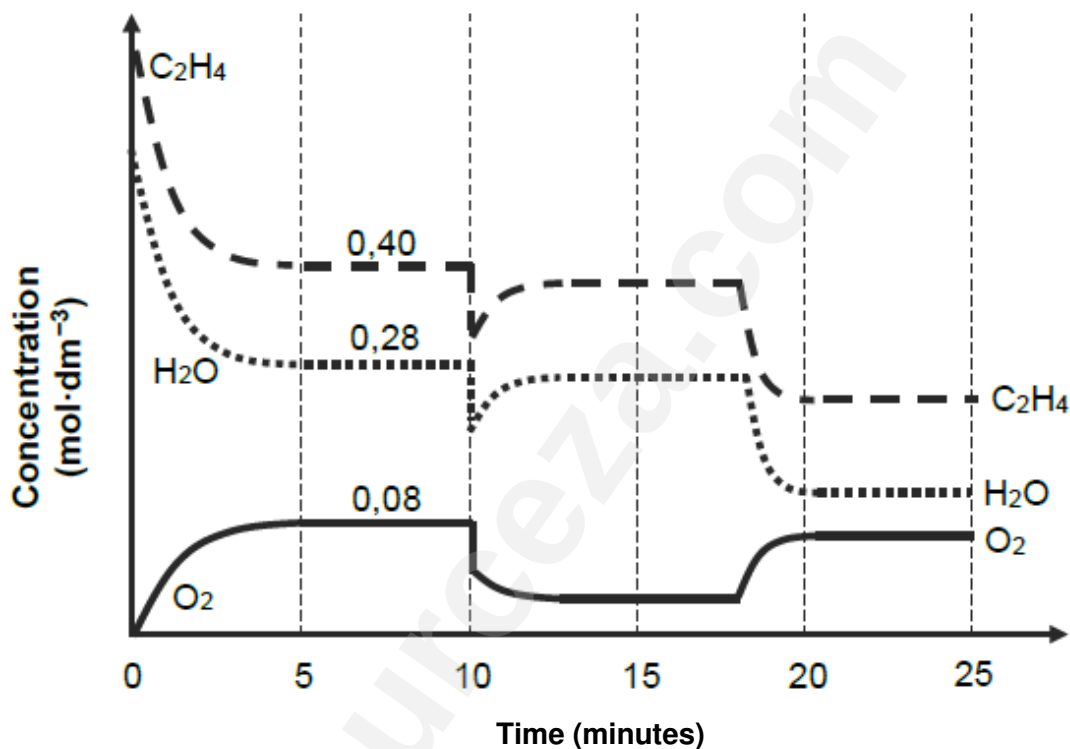
Is FORWARD reaction exothermic or endothermic? Use Le Chatelier's principle and the value of K_C at T_1 and T_2 to explain the answer.

Source: www.sourceza.com

4.3 Consider the reversible reaction of ethene with steam below:



The graph below (NOT to scale) shows the changes in concentration of C_2H_4 , H_2O and O_2 as a function of time.



(Question adapted from IEB-May 2022)

4.3.1 On the **above** graph show what the changes for C_2H_6 would be for the time $t = 0$ to $t = 10$ minutes. (2)

Show your answer on the graph above.

4.3.2 Identify clearly the change made to the system at 10 minutes. (2)

4.3.3 Use Le Chatelier's principle to explain your answer to question 4.3.2.

(4)

[37]

QUESTION 5:

Learners prepare a standard solution of a base, sodium hydroxide by dissolving 2 g pure sodium hydroxide crystals, NaOH, in water in a 250 cm³ volumetric flask. During the preparation of the sodium hydroxide the learners noted that the temperature of the solution increased.

5.1 Define *standard solution*. (2)

5.2 Define a *Brønsted- Lowry base*. (2)

5.3 Calculate the concentration of the sodium hydroxide solution. (4)

5.4 Draw a **FULLY LABELLED** energy profile for the dissolution of sodium hydroxide. (5)

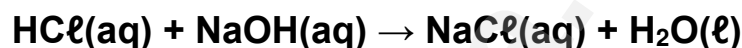
- 5.5 The learners now react 1,5 g of pure CaCO_3 with 50 cm^3 dilute HCl of **unknown** concentration according to the balanced chemical equation below.



- 5.5.1 Name the type of bond that exists between atoms of calcium and chlorine in CaCl_2 . (1)

- 5.5.2 Name the type of force that exists between molecules of HCl . (1)

- 5.6 The **EXCESS** HCl is neutralised with 25 cm^3 of the NaOH solution that they prepared. The endpoint was reached when solution turned pale green with the addition of indicator bromothymol blue.



- 5.6.1 Define neutralisation. (2)

- 5.6.2 Give reasons why bromothymol blue was used as the indicator during the titration? (2)

- 5.6.3 Write down a balanced chemical equation when hydrochloric acid (HCl) ionises in water. Include respective phases. (3)

- 5.6.4 Calculate the number of moles of HCl that reacted with the NaOH . (4)

5.6.5 Calculate the **initial** concentration of the dilute HCl(aq) .

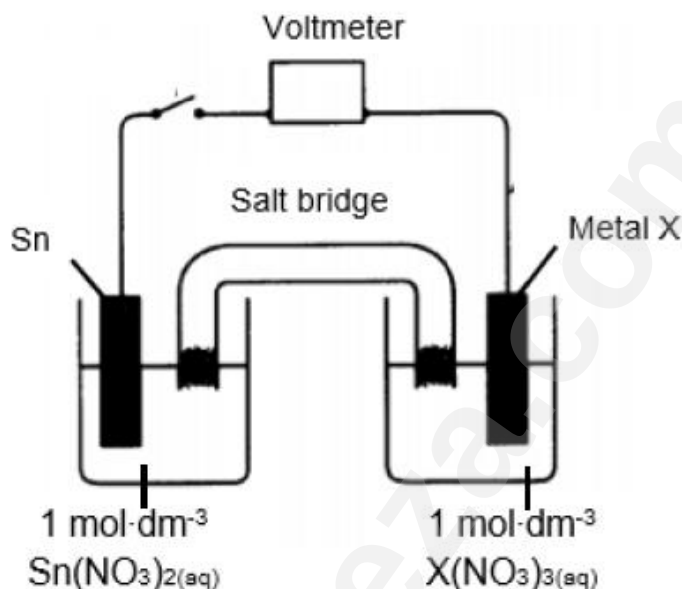
(6)

5.7 Explain, using suitable equation(s) and the concept of hydrolysis explain the type of salt produced (ACIDIC, BASIC, or NEUTRAL) when NaOH reacts with HCl . (5)

[37]

QUESTION 6

An electrochemical cell is constructed with an open switch as shown in the diagram below. A strip of tin (Sn) and a strip of unknown metal, **X** are used as electrodes. When the switch is closed, the mass of the tin (Sn) electrode **increases**.



(Question adapted from Crawford prelim-August 2020)

- 6.1 State the energy conversion that takes place in the above electrochemical cell. (2)

- 6.2 Calculate the mass of tin(II)nitrate required to prepare 1 dm³ of the electrolyte. (2)

- 6.3 **Name** a possible electrolyte that could be used in the salt bridge. (1)

- 6.4 Identify the cathode. Justify your answer. (2)

- 6.5 Write down the reduction half reaction taking place at the cathode. (2)

6.6 The reading on the voltmeter is +0,60 V.

6.6.1 Determine the standard potential of the X^{3+}/X electrode. (3)

6.6.2 Give the name of metal **X**. (1)

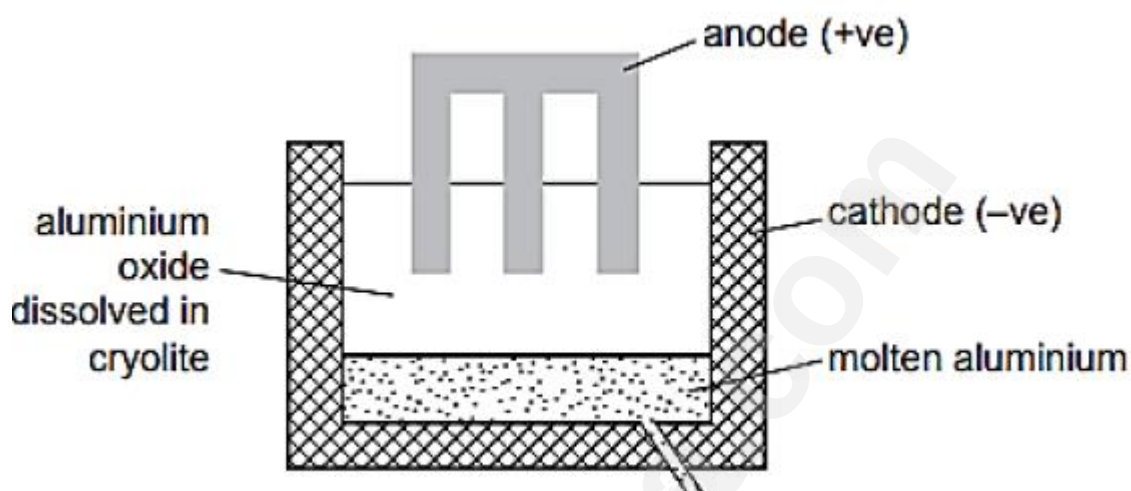
6.7 Write down the cell notation for this cell, including state symbols. (4)
Standard conditions need not be shown.

6.8 Briefly explain how the movement of ions in the salt bridge is used to ensure (3)
efficient functioning of the above cell by referring to the movement of cations.

6.9 Calculate the **gain in mass** of the tin (Sn) electrode if the electrochemical cell (6)
had a current of 2,5 A passing through for a period of 2 hours. ONLY round off
your answer to 3 decimal places in the final step. Show ALL working

QUESTION 7

Study the simplified diagram of an aluminium smelter.



7.1 Define the term *ionic bond*. (2)

7.2 Give the function of the cryolite used in the above cell. (1)

7.3 Write a balanced equation to show the dissociation of molten aluminium oxide. (3)

7.4 Write down the balanced half reaction that takes place at the anodes. (3)

7.5 Explain why the carbon anodes need regular replacing. Give a relevant chemical reaction equation to support your answer. (3)

[12]

QUESTION 8

Study the organic molecules that belong to different homologous series labeled **A-D**.

A	$\text{CH}_2=\underset{\text{CH}_3}{\text{C}}-\text{CH}_2-\text{CH}_2-\text{CH}_3$	B	$\text{CH}_3\text{CH}_2\text{CH}_2\underset{\text{OH}}{\text{CH}}\text{CH}_3$
C	$\text{C}_3\text{H}_7\text{Cl}$	D	Propanoic acid

Use the information in the table to answer the questions that follow:

8.1 Define *homologous series*. (3)

8.2 Write down the letter of the compound that ...

8.2.1 has a carboxyl group. (1)

8.2.2 is a haloalkane. (1)

8.3 Write down the...

8.3.1 IUPAC name of compound **A**. (2)

8.3.2 structural formula of compound **D**. (2)

8.4 Consider organic structure labelled **B**.

8.4.1 Define a positional isomer. (2)

8.4.2 Write down the condensed structural formula for one positional isomer of compound **B**. (2)

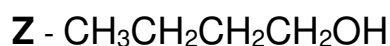
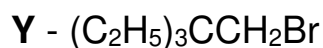
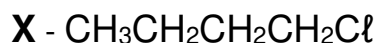
8.4.3 Using MOLECULAR formula, write down a BALANCED chemical equation for the reaction of compound **B** with excess oxygen. (4)

8.5 Compound **D** gives rise to functional isomers. (4)
Draw the **structural formula** and give the **IUPAC name** for ONE functional isomer of compound **D**.

[21]

QUESTION 9:

Consider the following organic compounds, labelled **X**, **Y**, and **Z** and then answer the questions below.



9.1 Define the term *saturated compound*. (2)

9.2 Write down the...

9.2.1 IUPAC name of compound **X**. (2)

9.2.2 Structural formula for compound **Y**. (2)

9.2.3 The solubility of compound **X** and compound **Y** in water is given below. The solubility of Compound **X** at 25 °C is 0,87 g·ℓ⁻¹ and the solubility of compound **Z** at 25 °C is 73,0 g·ℓ⁻¹. Use the concept of polarity, and strength, to explain for this difference. (4)

9.3 Compound **Z** now reacts with ethanoic acid in the presence of an acid and a water bath.

9.3.1 Name the type of reaction represented above. (1)

9.3.2 Give 2 functions of the acid in the above reaction. (2)

9.3.3 Why is it necessary for the reaction to take place using a water bath? (1)

9.3.4 Using structural formula, write down a BALANCED chemical equation for the reaction between Compound **Z** and ethanoic acid. (4)

[17]

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