FORM TP 2023005

TEST CODE 01212020

JANUARY 2023

CARIBBEAN EXAMINATIONS COUNCIL

CARIBBEAN SECONDARY EDUCATION CERTIFICATE® EXAMINATION

CHEMISTRY

Paper 02 – General Proficiency

2 hours 30 minutes

READ THE FOLLOWING INSTRUCTIONS CAREFULLY.

1. This paper consists of SIX questions in TWO sections. Answer ALL questions.
2. Write your answers in the spaces provided in this booklet.
3. Do NOT write in the margins.
4. Where appropriate, ALL WORKING MUST BE SHOWN in this booklet.
5. You may use a silent, non-programmable calculator to answer questions.
6. If you need to rewrite any answer and there is not enough space to do so on the original page, you must use the extra lined page(s) provided at the back of this booklet. **Remember to draw a line through your original answer.**
7. **If you use the extra page(s) you MUST write the question number clearly in the box provided at the top of the extra page(s) and, where relevant, include the question part beside the answer.**

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO.

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NOTHING HAS BEEN OMITTED.

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SECTION A

Answer ALL questions.

DO NOT spend more than 30 minutes on Question 1.

1. (a) Students were required to prepare a sample of the normal salt produced when aqueous sodium hydroxide reacts with dilute sulfuric acid.

(i) Define the term 'normal salt'.

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(2 marks)

(ii) Identify ONE **other** type of salt that can be formed from the reaction between dilute sulfuric acid and aqueous sodium hydroxide.

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(1 mark)

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(b) The normal salt was produced by conducting a titration. The students were provided with

- a dilute solution of 4.9 g dm^{-3} of sulfuric acid
- 5 g of sodium hydroxide
- methyl orange indicator.

They carried out the procedure outlined in Parts A and B. The titration results for Part A are presented in Figure 1.

Review the procedure in Part A for the preparation of a normal salt and answer the questions that follow.

Part A — Procedure

1. Place 5 g of sodium hydroxide solution in the volumetric flask and add distilled water to make 250 cm^3 of solution.

2. Pipette 25 cm^3 of the sodium hydroxide solution and transfer the solution to a conical flask.

3. Add 2 drops of methyl orange indicator to the sodium hydroxide solution in the conical flask.

4. Place the sulfuric acid in the burette and titrate the sodium hydroxide solution until the end point is reached.

5. Repeat Steps 2–4 until consistent results are obtained.

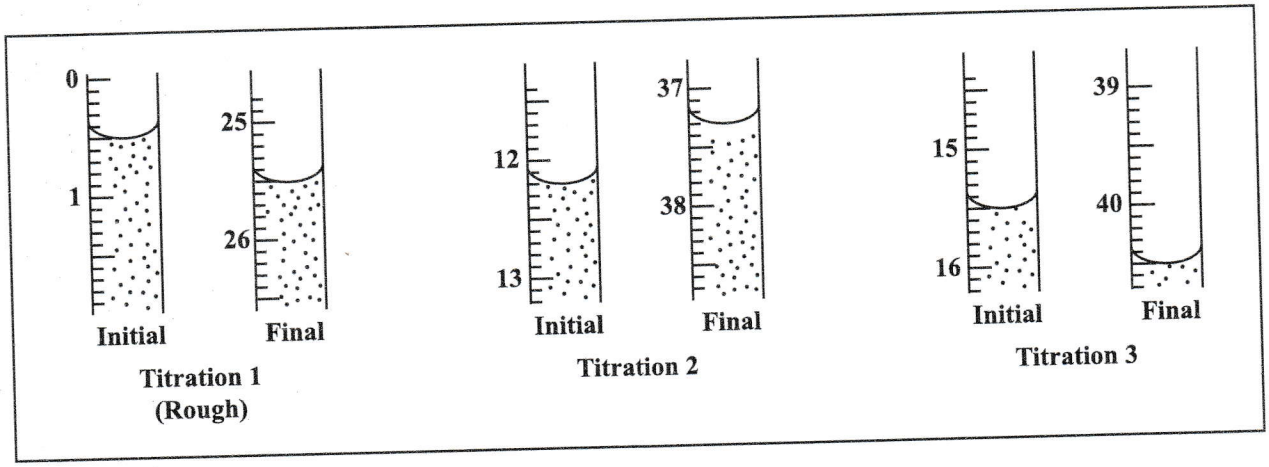

Figure 1. Burette readings

(i) Complete Table 1 by using the readings shown in Figure 1 **on page 6**.

TABLE 1: TITRATION OF SODIUM HYDROXIDE SOLUTION WITH SULFURIC ACID

Burette Reading/cm^3	Titration 1	Titration 2	Titration 3
Final reading			
Initial reading			
Volume of acid used			

(9 marks)

(ii) In Table 1, indicate using asterisks (*), the titration volumes that will be used to calculate the average volume of sulfuric acid. **(1 mark)**

(iii) Calculate the average volume of sulfuric acid used in the titration.

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(1 mark)

(iv) Complete the procedure for Part B by stating the steps required to obtain a dry sample of the normal salt.

Part B — Procedure

1. Pipette 25 cm^3 of the sodium hydroxide solution and transfer the solution to a conical flask.

2. Using the burette, add the volume of sulfuric acid used to neutralize the base from Part A to the sodium hydroxide solution in the conical flask.

3. .....

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4. .....

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(2 marks)

GO ON TO THE NEXT PAGE

(v) Write a balanced equation, including state symbols, for the formation of the normal salt from sulfuric acid and sodium hydroxide.

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(3 marks)

(vi) Calculate the number of moles of sulfuric acid used to neutralize the sodium hydroxide. (Molar mass: sulfuric acid = 98 g/mol; sodium hydroxide = 40 g/mol)

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(2 marks)

(vii) Calculate the mass of the normal salt expected from the reaction. (R.A.M. Na = 23; O = 16; S = 32.)

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(3 marks)

(viii) The actual mass of salt obtained by the student was 0.09 g. Suggest ONE possible reason for the difference in the expected mass of the salt and the mass obtained.

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(1 mark)

Total 25 marks

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2. One of the MAIN active ingredients in chlorine bleach is the oxidizing agent, sodium hypochlorite (NaClO). By adding sodium hypochlorite to water, hypochlorous acid (HOCl) is formed, according to the equation below.

$$NaClO + H_2O \rightarrow HOCl + NaOH$$

(a) State ONE use of bleach in the laundering of clothing.

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(1 mark)

(b) Define EACH of the following terms.

(i) Oxidizing agent

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(1 mark)

(ii) Oxidation

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(1 mark)

(c) Deduce the oxidation number of Cl in the formula NaClO.

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(3 marks)

(d) Chlorine gas also reacts with water to form hypochlorous acid (HOCl) as shown in the equation below and in which the Cl_2, has become a chloride ion, Cl^-.

$$Cl_2 + H_2O \rightarrow H^+ + Cl^- + HOCl$$

(i) What is the change in oxidation number of Cl for the process?

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(2 marks)

(ii) Which process occurred when the chlorine gas, Cl_2, became a chlorine ion, Cl^-?

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(1 mark)

(iii) Describe a simple laboratory test for chlorine gas.

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(2 marks)

DO NOT WRITE IN THIS AREA

(e) A more natural alternative to chlorine bleach is the use of detergents which release hydrogen peroxide in water. The bleaching action of hydrogen peroxide is also a redox reaction and is represented by the following equation.

$2H_2O_2(aq) \rightarrow 2H_2O(l) + O_2(g)$

During one stage of the reaction, $H_2O_2(aq)$ is converted to $H_2O(l)$. Show the changes in the oxidation number for oxygen in $H_2O_2(aq)$ and $H_2O(l)$, and deduce whether this is an oxidation or reduction reaction.

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(4 marks)

Total 15 marks

3. (a) Cracking is a very important process in the petroleum industry. What is meant by the term 'cracking'?

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(1 mark)

(b) Compound A (C_4H_8) and Compound B (C_4H_{10}) are both hydrocarbons that can be obtained from cracking.

(i) State the names of Compound A and Compound B.

Compound A .....

Compound B .....

(2 marks)

(ii) Draw the FULLY displayed structure of Compound A.

(2 marks)

(iii) State the homologous series to which Compound B belongs.

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(1 mark)

(iv) Describe briefly ONE test that could be used to distinguish between Compound A and Compound B. Write the expected observations.

Test .....

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Observations .....

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(3 marks)

(c) Compound B (C_4H_{10}) can exist as structural isomers.

(i) Define the term 'structural isomers'.

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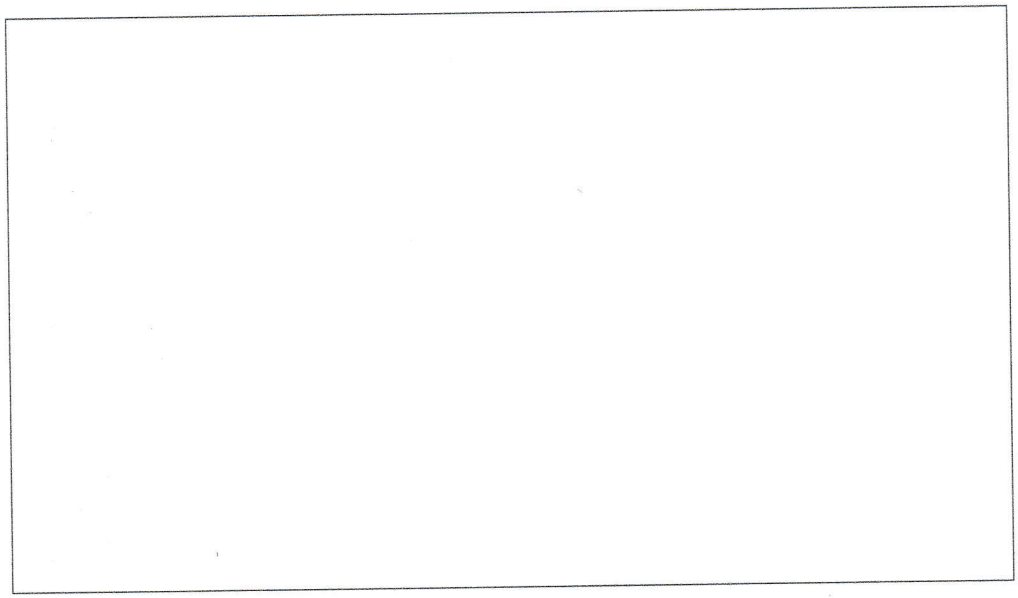
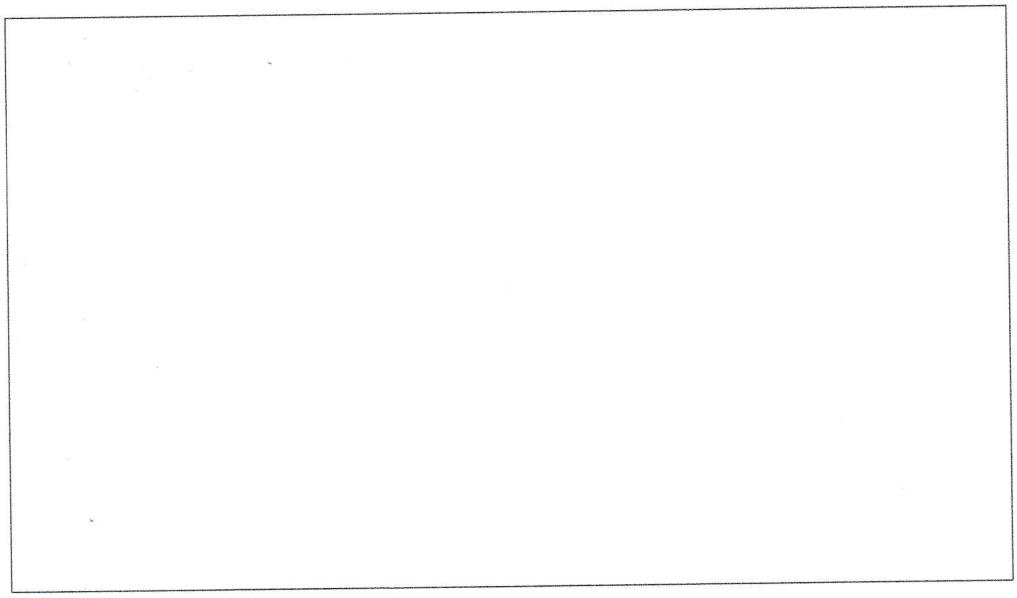
(2 marks)

(ii) In the space provided below, draw FULLY displayed structures of TWO isomers of Compound B.



Isomer 1



Isomer 2

(2 marks)

(d) Compound A burns in oxygen with a sooty flame.

Write a balanced chemical equation for the complete combustion of Compound A in excess oxygen.

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(2 marks)

Total 15 marks

SECTION B

Answer ALL questions.

4. (a) (i) Graphite and diamond are two allotropes of carbon. Define the term 'allotrope'.

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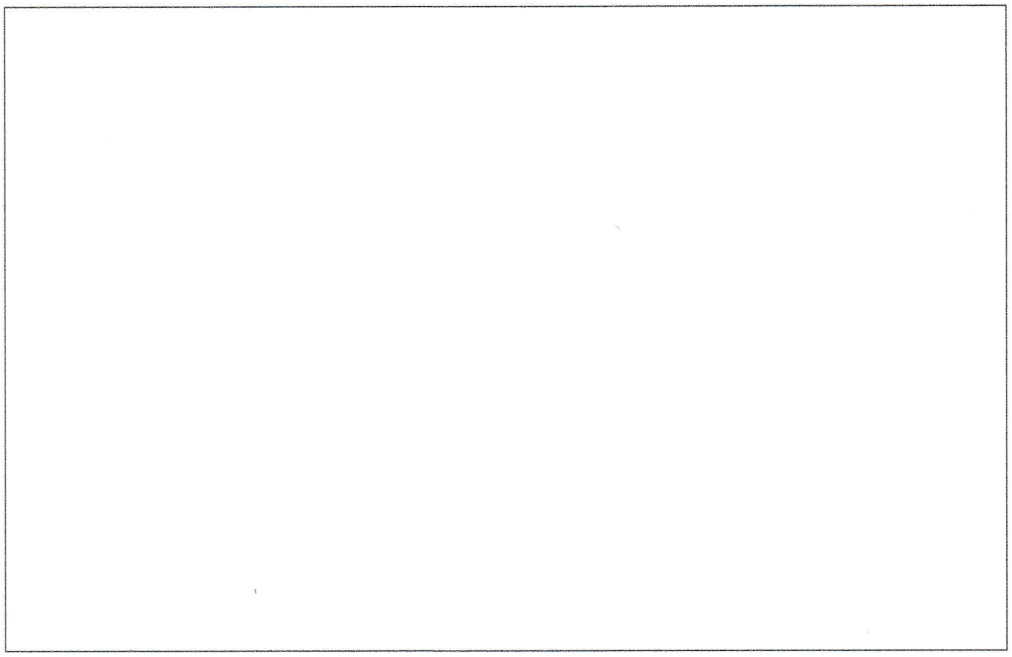
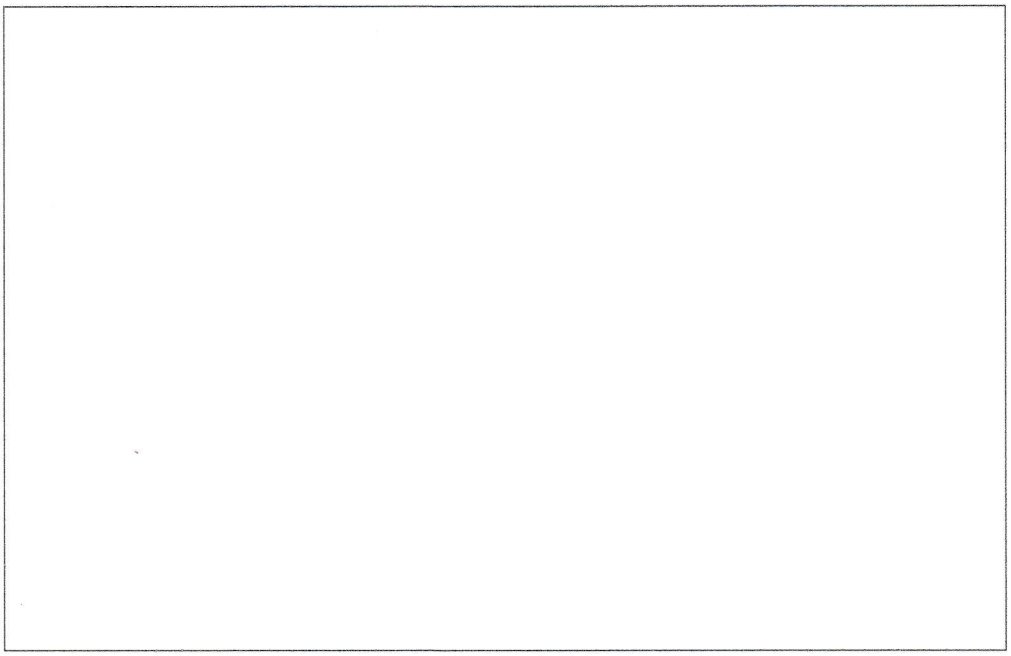
(1 mark)

(ii) Draw the lattice structures for diamond and graphite.



Diamond

(3 marks)



Graphite

(3 marks)

(b) Like metals, graphite can conduct electricity but diamond cannot.

(i) Explain, in terms of bonding, why graphite conducts electricity but diamond does not.

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(2 marks)

(ii) Describe the bonding present in metals.

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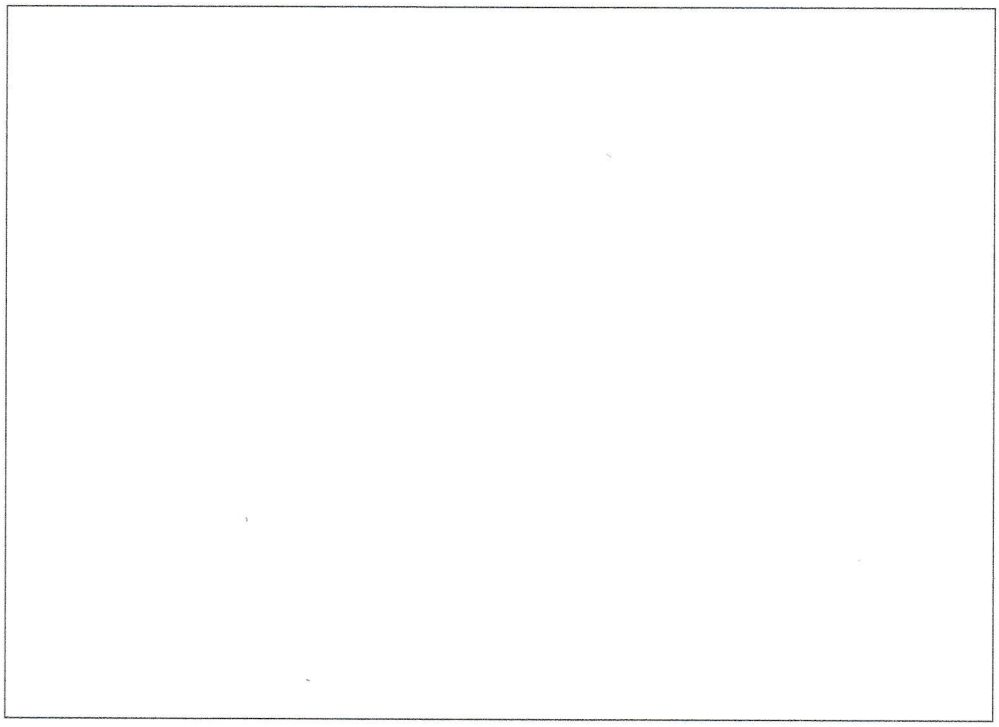
(2 marks)

(c) Sodium chloride is solid at room temperature.

(i) Sketch the lattice structure for sodium chloride.



Sodium chloride

(3 marks)

(ii) Which type of bonding exists in sodium chloride?

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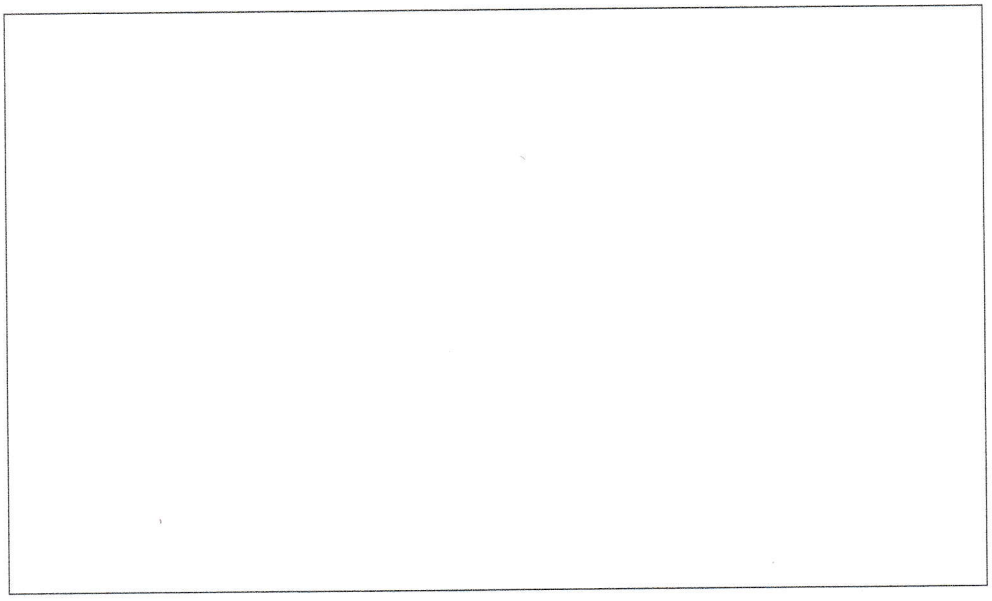
(1 mark)

Total 15 marks

5. (a) Ethene undergoes a halogenation reaction to form 1,2-dibromoethane.

(i) Draw the FULLY displayed structure of ethene.



Ethene

(2 marks)

(ii) Write the molecular formula for 1,2-dibromoethane.

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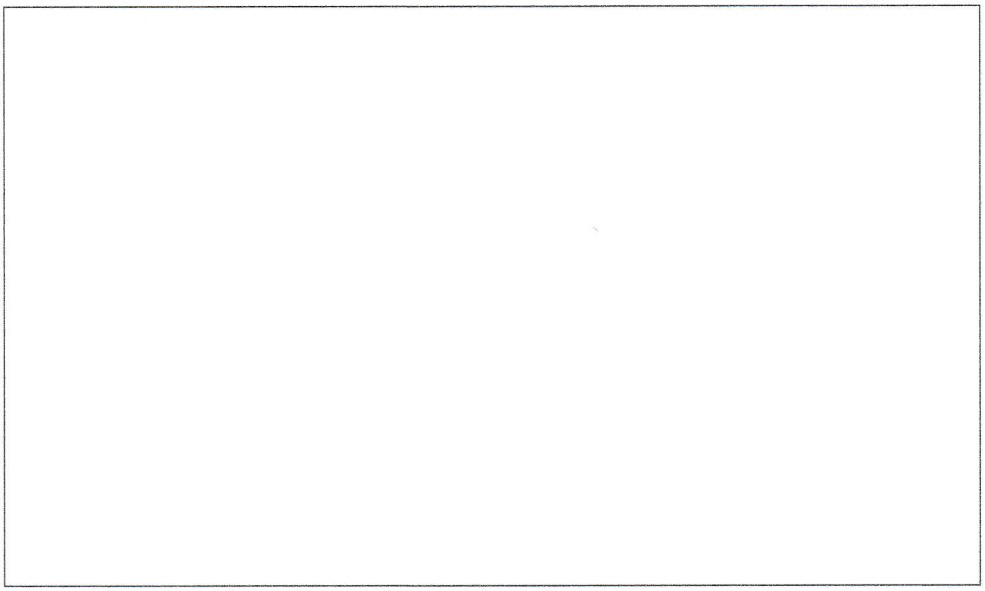
(1 mark)

(iii) Draw the FULLY displayed structure of 1,2-dibromoethane.



1,2-dibromoethane

(2 marks)

(iv) State whether the halogenation of ethene is an addition or substitution reaction.

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(1 mark)

(b) Dibromomethane can be obtained from methane. This reaction takes place in two steps.

(i) Write balanced chemical equations to show EACH step in the formation of dibromomethane.

Step 1 .....

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Step 2 .....

.....

(4 marks)

(ii) State whether the halogenation of methane is an addition or substitution reaction.

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(1 mark)

(c) Ethene and propene are typical monomers which are used as starting materials for making polymers. In forming polymers, ethene and propene undergo addition polymerization.

(i) Define the term 'polymer'.

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(1 mark)

(ii) Define the term 'addition polymerization'.

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(1 mark)

(iii) State ONE use of EACH of the following polymers.

Polyvinyl chloride .....

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Teflon .....

.....

(2 marks)

Total 15 marks

6. (a) The most abundant gas in the air by volume is nitrogen. List ONE physical property and ONE chemical property of nitrogen.

Physical property .....

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Chemical property .....

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(2 marks)

(b) When gases are produced in a school laboratory, there are THREE main methods in which they can be collected: upward delivery, downward delivery and displacement of water.

(i) List the TWO factors that should be considered when choosing an appropriate method for the collection of gases in the laboratory.

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(2 marks)

(ii) State which ONE of the three methods is best suited for the collection of ammonia gas in the laboratory. Explain why EACH of the other two methods would NOT be appropriate.

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(5 marks)

(c) Draw a labelled diagram of the apparatus which could be used for the preparation of dry ammonia in the laboratory.

Ensure that you identify on your diagram the location of the reagents to be used and the drying and collection areas of the ammonia gas.

(4 marks)

(d) Ammonia is mainly used in fertilizers such as ammonium nitrate. Explain how nitrate fertilizers can be harmful to the environment.

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(2 marks)

Total 15 marks

END OF TEST

IF YOU FINISH BEFORE TIME IS CALLED, CHECK YOUR WORK ON THIS TEST.