FORM TP 2021056

TEST CODE **01212020**

MAY/JUNE 2021

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.

Copyright © 2019 Caribbean Examinations Council
All rights reserved.

"*"Barcode Area"*"
Sequential Bar Code

NOTHING HAS BEEN OMITTED.

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

SECTION A

Answer ALL questions.

DO NOT spend more than 30 minutes on Question 1.

1. A student conducted an experiment to determine the products formed from the electrolysis of aqueous copper(II) sulfate, using inert electrodes. Figure 1 shows a simplified diagram of the apparatus used.

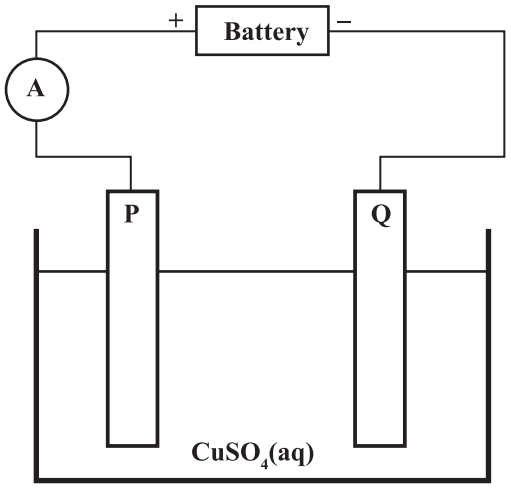


Figure 1. Apparatus used for electrolysis

"*"Barcode Area"*"
Sequential Bar Code

Procedure

A current was passed through the electrolyte and the starting time was recorded. At ten-minute intervals for one hour, the volume of oxygen gas evolved and the mass of copper deposited is measured. At the end of the reaction the total mass of copper deposited was 4.85 g. The volume of oxygen gas evolved is shown in Table 1 below.

TABLE 1: VOLUME OF OXYGEN MEASURED AT TEN-MINUTE INTERVALS

Time (Minutes)	Volume of Oxygen (cm^3)
10	2.40
20	3.60
30	4.80
40	6.00
50	7.20
60	8.40

(a) (i) Define the term 'electrolysis'.

.....

.....

.....

.....

(2 marks)

(ii) Suggest ONE material that could be used as an inert electrode in the electrolysis of aqueous copper(II) sulfate.

.....

.....

(1 mark)

(b) (i) Using the data in Table 1, plot a graph of volume of oxygen measured versus time using the axes in Figure 2 **on page 7**. Draw a line of best fit. **(5 marks)**

(ii) Use the graph to determine the time it took for 5.50 cm^3 of oxygen gas to be liberated.

.....

.....

(1 mark)

GO ON TO THE NEXT PAGE

"*"Barcode Area"*"
Sequential Bar Code

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

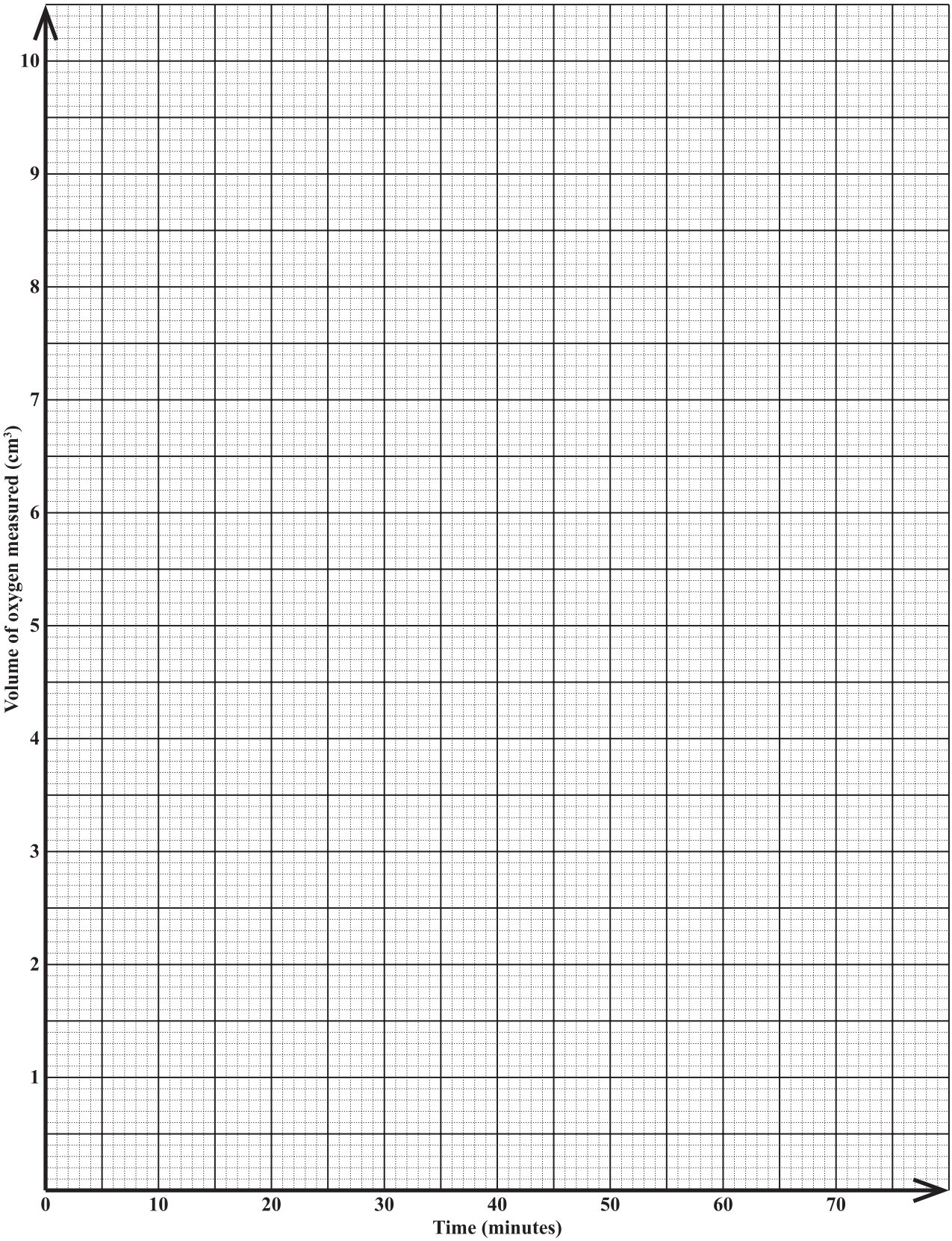


Figure 2. Volume of oxygen measured versus time

GO ON TO THE NEXT PAGE

"*"Barcode Area"*"
Sequential Bar Code

(c) (i) Identify ALL the ions present in the electrolyte used in the experiment.

.....

.....

(2 marks)

(ii) P and Q are electrodes shown in the apparatus used for electrolysis in Figure 1, **on page 5**. State which electrode is the anode and which is the cathode.

P .....

Q .....

(1 mark)

(iii) State ONE ion in the electrolyte that will drift towards the anode.

.....

(1 mark)

(iv) Write an ionic equation for the reaction taking place at the cathode.

.....

.....

(2 marks)

(d) (i) Calculate the quantity of electricity that passed through the copper(II) sulfate solution when 3.5 A of current flowed for one hour.

(Quantity of electricity = current × time; 1F = 96 500 C)

.....

.....

.....

.....

(2 marks)

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

"*"Barcode Area"*"
Sequential Bar Code

(ii) Calculate the number of moles of copper deposited.

.....

.....

.....

.....

.....

(3 marks)

(iii) Calculate the mass of copper deposited, given that the relative atomic mass of copper is 64.

.....

.....

(1 mark)

(iv) Suggest ONE reason for the difference in the mass of copper calculated in (d) (iii) and the mass measured by the student (4.85 g).

.....

.....

.....

(1 mark)

(e) State the colour change that would have taken place in the electrolyte after a few hours.

.....

(1 mark)

(f) The student was asked to use the same electrolyte to purify a piece of impure copper.

State how the electrodes in Figure 1, **on page 5**, can be modified to obtain pure copper from impure copper.

Anode .....

Cathode .....

(2 marks)

Total 25 marks

"*"Barcode Area"*"
Sequential Bar Code

DO NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AREA

2. Acids react with metals and bases to form salts. John conducted experiments to investigate the properties and reaction of acids using sulfuric acid, iron and sodium bicarbonate.

(a) Define EACH of the following terms:

(i) Acid .....

.....

.....

(1 mark)

(ii) Salt .....

.....

.....

(2 marks)

(b) John dissolved sodium bicarbonate in water and tested the solution with red and blue litmus paper. The red litmus paper turned blue; however, the blue litmus paper did not change colour.

(i) State ONE reason why the red litmus paper turned blue, but the blue litmus paper did not change colour.

.....

.....

(1 mark)

(ii) State whether the pH of sodium bicarbonate will fall within ranges of pH > 7.

.....

(1 mark)

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

"*"Barcode Area"*"
Sequential Bar Code

DO NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AREA

(c) In two separate experiments, iron metal (Fe) and sodium bicarbonate ($NaHCO_3$) were both treated with excess sulfuric acid (H_2SO_4). The results of both experiments are recorded in Table 2 below.

(i) Complete Table 2 by stating the TWO inferences that can be made from the observations in Experiment 1.

TABLE 2: RESULTS OF EXPERIMENTS 1 AND 2

Experiment No.	Observation	Inference
1	• Solution turned pale green.	• ....
	• Colourless gas evolved; splint goes off with a squeaky pop.	• ....
2	• Colourless gas evolved.	CO_2 present

(2 marks)

(ii) State TWO physical properties of iron metal (Fe).

.....

.....

.....

(2 marks)

(iii) Write a chemical equation for the reaction that occurred between iron metal (Fe) and sulfuric acid (H_2SO_4).

.....

.....

(1 mark)

"*"Barcode Area"*"
Sequential Bar Code

(iv) Describe a test that can be used to confirm the identity of the CO_2 in Experiment 2. Include your expected observation.

Test .....

.....

.....

.....

Observation .....

.....

.....

.....

(2 marks)

(v) Write a balanced equation, including state symbols, for the complete reaction between sodium bicarbonate and sulfuric acid.

.....

.....

(3 marks)

Total 15 marks

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

"*"Barcode Area"*"
Sequential Bar Code

DO NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AREA

3. Two organic compounds, A and B, have the following molecular formulae. Compound A is C_3H_8 and Compound B is C_4H_8.

(a) Write the general formula for the homologous series to which Compound A belongs.

.....

.....

(1 mark)

(b) List THREE general characteristics of a homologous series, other than the general formula.

.....

.....

.....

.....

(3 marks)

(c) (i) Identify the homologous series to which Compound B belongs.

.....

(1 mark)

(ii) In the spaces provided, write the fully displayed structural formulae for Compound A and Compound B.

Compound A **Compound B**

(4 marks)

GO ON TO THE NEXT PAGE

"*"Barcode Area"*"
Sequential Bar Code

(d) (i) A sample of Compound A was placed in Test tube 1, a sample of Compound B was placed in Test tube 2 and 1 cm^3 of acidified permanganate solution was placed in each test tube.

State what would be observed in EACH test tube.

Test tube 1 .....

.....

.....

(1 mark)

Test tube 2 .....

.....

.....

(2 marks)

(ii) State whether Compound B is a saturated or an unsaturated compound.

.....

.....

(1 mark)

(e) Give ONE use of each of the following compounds:

(i) Compound A

.....

.....

.....

(ii) Compound B

.....

.....

.....

(2 marks)

Total 15 marks

"*"Barcode Area"*"
Sequential Bar Code

DO NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AREA

SECTION B

Answer ALL questions.

4. The modern periodic table is arranged such that chemical elements are grouped according to the chemical properties they exhibit. Many of the elements in the periodic table exist as a mixture of isotopes. Table 3 shows the symbols of selected elements in the periodic table.

TABLE 3: SELECTED ELEMENTS IN THE PERIODIC TABLE

	Be			C		O	F	
	Mg			Si			Cl	
	Ca						Br	
	X						I	

(a) (i) State the electronic configuration of Si. Justify its placement in Period 3 of the periodic table.

.....

.....

(2 marks)

DO NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AREA

"*"Barcode Area"*"
Sequential Bar Code

(ii) In the space below, draw a dot (.) and cross (x) diagram to show the structure of the covalent bonding present in a fluorine (F_2) molecule.

(2 marks)

(b) (i) Define the term 'isotope'.

.....

.....

.....

(1 mark)

(ii) The element C has isotopes. From the list of atoms of C below, identify those that are isotopes.

$^{12}_{6}C$ $^{14}_{7}C$ $^{12}_{7}C$ $^{14}_{6}C$

.....

.....

(1 mark)

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

"*"Barcode Area"*"
Sequential Bar Code

(iii) Give TWO examples of radioisotopes and state ONE use of EACH.

.....

.....

.....

.....

.....

.....

(4 marks)

(c) Mg and Ca both react with water.

(i) Write a chemical equation, including state symbols, for the reaction of calcium (Ca) and water (H_2O).

.....

.....

(3 marks)

(ii) An unknown element, X, is shown in Table 3 **on page 15**. Predict the order of reactivity of X, magnesium (Mg) and calcium (Ca) with water.

.....

.....

(2 marks)

Total 15 marks

DO NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AREA

"*"Barcode Area"*"
Sequential Bar Code

5. (a) In many Caribbean countries hydrocarbons are used as a source of energy. State TWO natural sources of hydrocarbons.

.....

.....

.....

(2 marks)

(b) Fractional distillation of a long chain hydrocarbon produces several fractions with varying numbers of carbon atoms. Three of these fractions are shown in Table 4.

State the name of any TWO fractions of the long chain hydrocarbon in Table 4.

TABLE 4: THREE FRACTIONS FROM CRUDE OIL

Fraction	1	2	3
Number of Carbon Atoms	1–4 carbon atoms	4–12 carbon atoms	20–40 carbon atoms
Name			

(2 marks)

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

"*"Barcode Area"*"
Sequential Bar Code

(c) Figure 3 illustrates the process of converting long chain hydrocarbons obtained from the fractional distillation into short chain hydrocarbons in the absence of a catalyst.

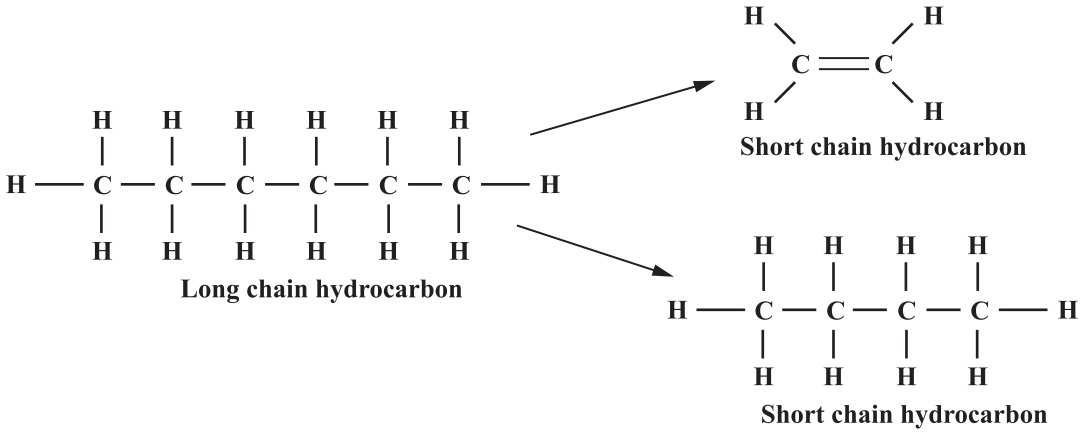


Figure 3. Hydrocarbon conversion process

(i) State the name of the process illustrated in Figure 3.

.....

.....

(1 mark)

(ii) State the conditions under which the process in Figure 3 occurs.

.....

.....

.....

(2 marks)

(iii) A hydrocarbon with molecular formula C_4H_{10} is often obtained in the process illustrated in Figure 3. State TWO uses of this hydrocarbon.

.....

.....

(2 marks)

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

"*"Barcode Area"*"
Sequential Bar Code

(iv) The hydrocarbon in (c) (iii) was allowed to react with bromine in the presence of sunlight. Draw a fully displayed structural formula of the monobromo-compound formed.

Monobromo-compound

(2 marks)

(v) State the type of reaction that occurs in (c) (iv) between the hydrocarbon C_4H_{10} and the bromine.

.....

.....

(1 mark)

(d) Propane is another hydrocarbon obtained in one of the fractions during fractional distillation. Write a balanced equation, including state symbols, for the complete combustion of propane.

.....

.....

(3 marks)

Total 15 marks

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

"*"Barcode Area"*"
Sequential Bar Code

DO NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AREA

6. (a) (i) The ores of aluminium and iron are both oxides. Discuss the difference in methods used to extract aluminium and iron from their ores in relation to their positions in the electrochemical series.

.....

.....

.....

.....

.....

.....

.....

.....

(4 marks)

(ii) Explain which of the methods discussed in (a) (i) would be MORE suitable for the extraction of lead from its ore.

.....

.....

.....

.....

.....

(3 marks)

(b) Write TWO balanced equations that show the process to produce Pb from PbO_2.

.....

.....

.....

.....

(4 marks)

GO ON TO THE NEXT PAGE

"*"Barcode Area"*"
Sequential Bar Code

(c) Some metals and their compounds are important to living systems whereas others could be harmful. Consider aluminium, lead, iron and their compounds. Explain the usefulness of ONE metal and the harmfulness of ONE metal to living systems.

Usefulness .....

.....

.....

.....

Harmfulness .....

.....

.....

.....

(4 marks)

Total 15 marks

END OF TEST

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

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA