FORM TP 2017005

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JANUARY 2017

CARIBBEAN EXAMINATIONS COUNCIL

CARIBBEAN SECONDARY EDUCATION CERTIFICATE® EXAMINATION

CHEMISTRY

Paper 02 – General Proficiency

2 hours and 30 minutes

READ THE FOLLOWING INSTRUCTIONS CAREFULLY.

1. This paper consists of SIX questions in TWO sections.
2. Answer ALL questions.
3. Write your answers in the spaces provided in this booklet.
4. Do NOT write in the margins.
5. Where appropriate, ALL WORKING MUST BE SHOWN in this booklet.
6. You may use a silent, non-programmable calculator to answer questions.
7. 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.**
8. **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.

SECTION A

Answer ALL questions in this section.

Write your responses in the spaces provided in this booklet.

Do NOT spend more than 30 minutes on Question 1.

1. An experiment was carried out to determine the number of moles of water of crystallization, ***n***, that are present in hydrated iron(II) sulfate, $FeSO_4 \cdot nH_2O$. A sample of the solid was analysed for its iron(II) sulfate content by titrating it with a standard solution of potassium manganate(VII), $KMnO_4$.

(a) Define the term 'standard solution'.

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(1 mark)

(b) A sample of the hydrated iron(II) sulfate was weighed, dissolved in excess sulfuric acid and made up to the mark with distilled water in a 250 cm^3 volumetric flask. The data are shown in Table 1.

Complete Table 1 by calculating the mass of the hydrated iron(II) sulfate used.

TABLE 1: WEIGHING THE SAMPLE OF HYDRATED IRON(II) SULFATE

Mass of beaker and sample (g)	17.11
Mass of beaker (g)	13.95
Mass of sample (g)	

(1 mark)

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(c) Three 25.0 cm^3 aliquots of the iron(II) sulfate solution were pipetted into three conical flasks and titrated with 0.010 mol dm^{-3} $KMnO_4$ solution. Figure 1 displays the final burette readings for EACH of the three titrations.

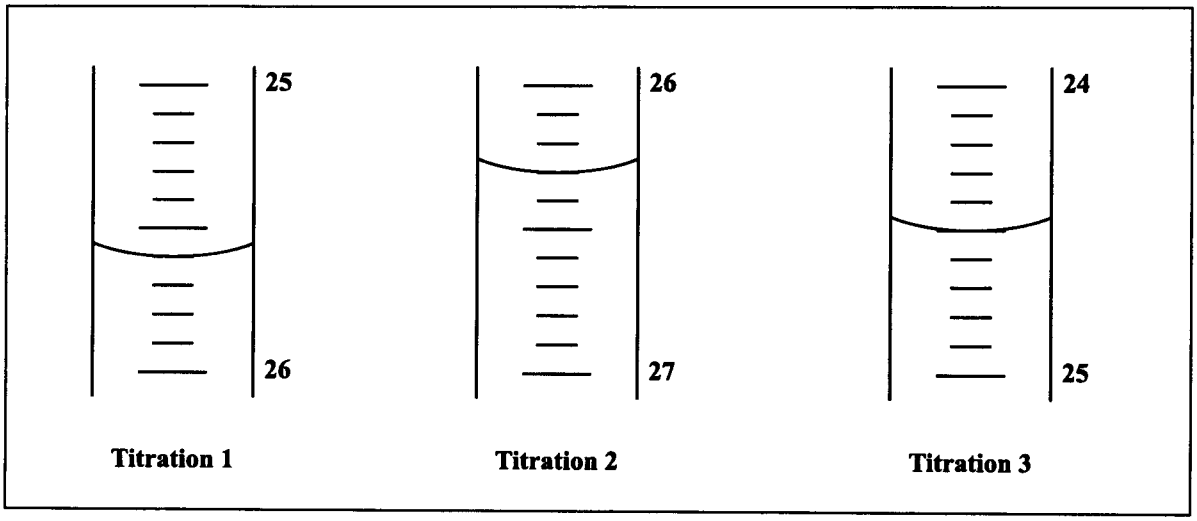

Figure 1. Final burette readings

(i) Record the final burette volumes from the diagrams in Figure 1 in the appropriate spaces in Table 2.

TABLE 2: TITRATION OF HYDRATED IRON(II) SULFATE SOLUTION WITH 0.010 MOL DM^{-3} POTASSIUM MANGANATE(VII)

Burette Readings (cm^3)	Titration 1	Titration 2	Titration 3
Final volume			
Initial volume	1.00	2.05	0.15
Volume used			

(3 marks)

(ii) Calculate the volume of $KMnO_4$ solution used in EACH titration and enter them in Table 2. **(3 marks)**

(iii) Determine the average volume of $KMnO_4$ solution used in the titrations.

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(1 mark)

(iv) Calculate the number of moles of $KMnO_4$ in the average volume determined in (c) (iii).

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(1 mark)

(d) The MnO_4^- ion reacts with Fe^{2+} ions to give Mn^{2+} ions according to the following equation:

$$MnO_4^-(aq) + 5Fe^{2+}(aq) + 8H^+(aq) \rightarrow Mn^{2+}(aq) + 5Fe^{3+}(aq) + 4H_2O(l).$$

(i) As shown in the equation, 1 mole MnO_4^- reacts with 5 moles of Fe^{2+}. Using the result in (c) (iv), calculate the number of moles of Fe^{2+} ions in the 25.0 cm^3 aliquot that reacted with the MnO_4^-.

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(1 mark)

(ii) Determine the number of moles of Fe^{2+} in the 250.0 cm^3 volumetric flask.

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(1 mark)

(e) Given that 1 mole of $FeSO_4$ contains 1 mole of Fe^{2+} ions, use the result from (d) (ii) to calculate the mass of anhydrous $FeSO_4$ in the 250 cm^3 volumetric flask.

[The relative molecular mass of anhydrous $FeSO_4$ is 152.]

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(1 mark)

(f) Calculate the mass of water in the hydrated $FeSO_4$ using the following formula.

$$\left(\text{Mass of water} = \underset{\text{[from (b)]}}{\text{mass of hydrated } FeSO_4} - \underset{\text{[from (e)]}}{\text{mass of anhydrous } FeSO_4} \right)$$

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(1 mark)

(g) Calculate the number of moles of water in the hydrated sample.

[The relative molecular mass of water is 18.0.]

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(1 mark)

(h) Using the results from (d) (ii) and (g), calculate the value of n in the formula $FeSO_4 \cdot nH_2O$.

$$\left(n = \frac{\text{number of moles of water in hydrated sample}}{\text{number of moles of anhydrous } FeSO_4} \right)$$

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(1 mark)

(i) What is the colour change at the endpoint of the titration of iron(II) sulfate with potassium manganate(VII)?

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(2 marks)

(j) State ONE reason why there was no need to add an indicator to this titration.

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(1 mark)

(k) A student carried out the following tests on a pale blue solution of Compound **X**. Complete Table 3 by filling in the expected observations.

TABLE 3: TESTS PERFORMED ON COMPOUND X

	Test	Observation	Inference
(i)	• Aqueous sodium hydroxide was added dropwise. • And then in excess.	• • **(2 marks)**	Fe^{2+} ions present.
(ii)	• The resulting mixture from (i) was left to stand in air.	• **(2 marks)**	Fe^{2+} ions oxidized to Fe^{3+}.
(iii)	• Aqueous barium nitrate was added. • Followed by dilute nitric acid.	• • **(2 marks)**	SO_4^{2-} ions present.

Total 25 marks

2. (a) Electrolysis has a wide range of industrial applications. Electroplating is one such application that is commonly used to make metals more attractive.

(i) Define the term 'electrolysis'.

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(2 marks)

(ii) Define the term 'electroplating'.

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(2 marks)

(iii) List THREE **other** applications of electrolysis.

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(3 marks)

(b) Desiree wanted to set up apparatus in the laboratory for the electrolysis of molten lead bromide, $PbBr_2$.

(i) Draw a fully labelled diagram of the apparatus she should use and state the material from which the electrodes are made.

Material:

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(4 marks)

(ii) Write balanced equations to indicate the reactions which occur at EACH electrode.

Equation at anode: .....

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Equation at cathode: .....

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(4 marks)

Total 15 marks

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3. Compound **A**, C_4H_{10}, and Compound **B**, C_3H_6, are both hydrocarbons.

(a) (i) State whether Compound **A** is an alkane or alkene.

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(1 mark)

(ii) State ONE use of Compound **A**.

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(1 mark)

(iii) Compound **A** reacts with chlorine gas to produce a colourless compound and a gaseous by-product. State ONE condition that is necessary for this reaction to take place.

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(1 mark)

(iv) Draw the FULLY DISPLAYED structural formula of the product (colourless compound) formed when one mole of Compound **A** reacts with one mole of chlorine gas.

Structure of product

(2 marks)

(v) Briefly describe ONE test that can be used to identify the gaseous by-product.

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(1 mark)

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

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(2 marks)

(ii) Compound **B** undergoes polymerization to form a colourless, hard solid. State the type of polymerization reaction, the name of the polymer formed, and ONE possible use for this polymer.

Type of polymerization: .....

(1 mark)

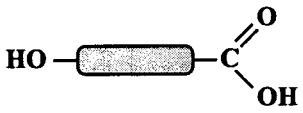
Name of polymer: .....

(1 mark)

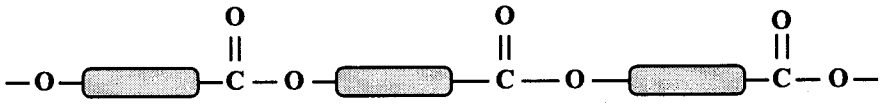
Use of polymer: .....

(1 mark)

(c) The molecule shown below can be used to produce polymers which are very useful in industry.



A partial structure of the polymer is shown below.



(i) Name the functional group (link) present in the polymer.

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(1 mark)

(ii) Name the type of polymerization reaction that has taken place, and state ONE possible use of these types of polymers.

Type of polymerization: .....

(1 mark)

Use of polymer: .....

(1 mark)

(iii) Name the by-product that is formed in this polymerization reaction.

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(1 mark)

Total 15 marks

SECTION B

Answer ALL questions in this section.

Write your responses in the spaces provided in this booklet.

4. (a) Two isotopes of carbon are ${}^{12}_{6}C$ and ${}^{13}_{6}C$. Define the term 'isotope' and hence show by calculation that ${}^{12}_{6}C$ and ${}^{13}_{6}C$ are isotopes.

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(3 marks)

(b) Radioisotopes are very useful in everyday life. For example, the Uranium-235 isotope is used in energy generation because it produces large amounts of energy when the atoms split.

State THREE **other** uses of radioisotopes.

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(3 marks)

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(c) Elements **W** and **X** react together to form a compound. The electronic configurations of the elements **W** and **X** are shown below.

W: 2,7 **X**: 2,8,2

(i) State the appropriate group and period to which EACH element, **W** and **X**, belongs. Hence, indicate the type of bonding that occurs between **W** and **X** and write the formula of the compound formed.

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(6 marks)

(ii) Suggest whether the resulting compound will dissolve in water. Explain your answer.

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(3 marks)

Total 15 marks

5. Ammonia is a raw material used in the manufacture of fertilizers such as ammonium nitrate.

(a) State TWO physical properties of ammonia gas.

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(2 marks)

(b) (i) Draw a labelled diagram to show the apparatus used for the laboratory preparation of ammonia gas.

(3 marks)

(ii) Write a balanced chemical equation for the reaction taking place in the laboratory preparation of ammonia gas.

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(2 marks)

(iii) Explain why concentrated sulfuric acid, a typical drying agent, CANNOT be used in this preparation and identify an appropriate alternative drying agent that could be used.

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(3 marks)

(c) Briefly describe a laboratory test for ammonia gas.

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(2 marks)

(d) The excessive use of fertilizers may lead to harmful levels of nitrates in the environment. List THREE harmful effects of excessive nitrates in the environment.

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(3 marks)

Total 15 marks

6. (a) State TWO properties of water and explain how EACH property assists in sustaining life on Earth.

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(4 marks)

(b) When water passes over rocks made of calcium carbonate, water becomes hard but it can be softened by several methods.

(i) Write a balanced equation showing how hard water, formed as stated above, can be softened using sodium carbonate.

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(2 marks)

(ii) Name and describe ONE **other** method by which water can be softened.

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(4 marks)

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(c) Describe a method which can be used to distinguish between hard water and soft water using soap.

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(5 marks)

Total 15 marks

END OF TEST

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