

**Insert School Logo**

**Semester One**

**Task 5 2023**

**Question/Answer booklet**

**CHEMISTRY**

**UNIT 1**

Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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***TIME ALLOWED FOR THIS PAPER***

Working time for the paper: Sixty minutes

# MARKS ALLOWED FOR EACH SECTION

Section One: Investigation 0 marks

Section Two: Discussion 20 marks

Total: 20 marks

***MATERIALS REQUIRED/RECOMMENDED FOR THIS PAPER***

**To be provided by the supervisor:**

This Question/Answer Booklet

Chemistry Data Book

**To be provided by the candidate:**

Standard items: pens (blue/black preferred), pencils (including coloured), sharpener, eraser, correction tape/fluid, ruler, highlighters

Special items: up to three non-programmable calculators approved for use in the WACE examinations

***IMPORTANT NOTE TO CANDIDATES***

No other items may be taken into the examination room. It is **your** responsibility to ensure that you do not have any unauthorised notes or other items of a non-personal nature in the examination room. If you have any unauthorised material with you, hand it to the supervisor **before** reading any further

**SECTION ONE - INVESTIGATION**

Cold packs, also known as ice packs or gel packs, provide therapeutic cold therapy for medical and personal use. Stored in the freezer, they reduce pain, swelling, inflammation, and discomfort from injuries or conditions. Chemical cold packs use an endothermic reaction with two compartments – one holds water, the other a solid substance like ammonium nitrate. Activated by squeezing or breaking a barrier, the solid dissolves in water, absorbing heat and rapidly cooling the pack for immediate relief.

One company is instead interested in using a chemical reaction to produce the endothermic reaction. When citric acid is added to sodium bicarbonate, they react according to the following equation:

C6H8O7 + 3NaHCO3 🡪 3CO2 + 3H2O + Na3C6H5O7

Your task will be to determine the ratio of sodium bicarbonate and citric acid that will optimise (i.e., create the ‘coldest’) cold pack.

**Method:**

1. Weigh out an amount of citric acid and sodium carbonate from the table below and place them both into a beaker.
2. Measure 50mL of water and place it in the calorimeter.
3. Place the temperature probe into the water and start the graphing software.
4. After the probe has equilibrated (reading a constant temperature), add the solid mass into the water.
5. Using the graph, determine the change in temperature and write it in the results table below.

**Results:**

|  |  |  |  |
| --- | --- | --- | --- |
| Mass of citric acid (g) | Mass of sodium bicarbonate (g) | Mass fraction of citric acid | Temperature change (oC) |
| 0.0 | 4.0 | 0.00 |  |
| 1.0 | 3.0 | 0.25 |  |
| 1.7 | 2.3 | 0.43 |  |
| 2.0 | 2.0 | 0.50 |  |
| 3.0 | 1.0 | 0.75 |  |
| 4.0 | 0.0 | 1.00 |  |

**SECTION TWO – DISCUSSION**

1. Identify the independent variable for this experiment.(1 mark)

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1. Identify the dependent variable for this experiment.(1 mark)

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1. Identify two controlled variables for this experiment.(2 marks)

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1. In the space below, create a graph for the mass ratio of citric acid versus the temperature change observed in that reaction. Make sure to draw a curve-of-best-fit.(5 marks)

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1. At what mass fraction of citric acid did you see the largest change in temperature?(1 mark)

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1. Calculate the mole for each reagent in your answer to question 5. Hence, determine the limiting reagent.(3 marks)

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1. Use the following equation to determine the change in enthalpy for this reaction:

Where,

Make sure that the mole and change in temperature are from the same reaction.(1 mark)

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1. Rewrite the equation between citric acid and sodium bicarbonate as a thermochemical equation.(2 marks)

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1. In the space below, draw an energy profile diagram for this reaction. Make sure to label the axes, reactants and products, activation energy, and change in enthalpy. A scale is not required.(4 marks)