

SUPERVISOR'S USE ONLY

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91166



Draw a cross through the box (☒) if you have NOT written in this booklet

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Mana Tohu Mātauranga o Aotearoa
New Zealand Qualifications Authority

Level 2 Chemistry 2023

91166 Demonstrate understanding of chemical reactivity

Credits: Four

Achievement	Achievement with Merit	Achievement with Excellence
Demonstrate understanding of chemical reactivity.	Demonstrate in-depth understanding of chemical reactivity.	Demonstrate comprehensive understanding of chemical reactivity.

Check that the National Student Number (NSN) on your admission slip is the same as the number at the top of this page.

You should attempt ALL the questions in this booklet.

A periodic table and other reference material are provided in the Resource Booklet L2-CHEMR.

If you need more room for any answer, use the extra space provided at the back of this booklet.

Check that this booklet has pages 2–12 in the correct order and that none of these pages is blank.

Do not write in any cross-hatched area (⊘). This area will be cut off when the booklet is marked.

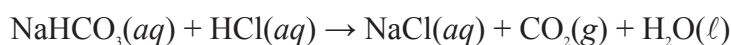
YOU MUST HAND THIS BOOKLET TO THE SUPERVISOR AT THE END OF THE EXAMINATION.

QUESTION ONE

- (a) The acid found in human stomachs is primarily hydrochloric acid, $\text{HCl}(aq)$, and has a pH value of approximately 1.5.

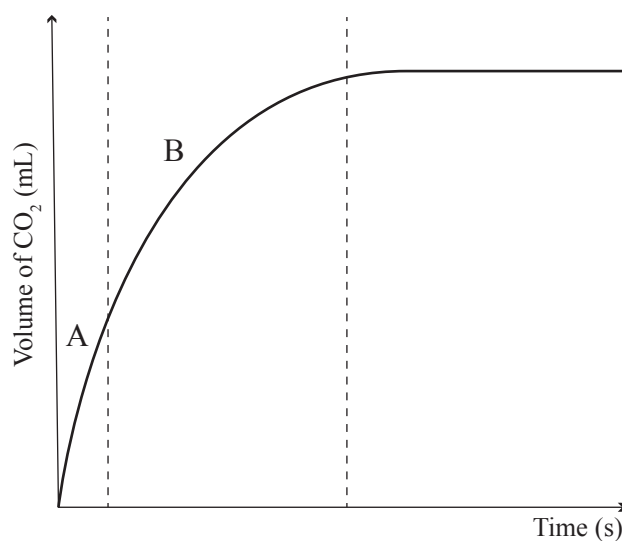
Calculate the concentration of hydronium ions, $\text{H}_3\text{O}^+(aq)$, present in a hydrochloric acid solution of pH 1.5.

- (b) Fast-acting paracetamol tablets contain sodium hydrogen carbonate, NaHCO_3 , which reacts with stomach acid, $\text{HCl}(aq)$. The equation is shown below.



Some students wanted to investigate how long it takes for all the NaHCO_3 in a paracetamol tablet to react in a human stomach. They conducted an experiment where a 0.25 g tablet of NaHCO_3 was reacted with an excess of hydrochloric acid at room temperature, approximately 20°C .

The volume of CO_2 produced during the reaction was recorded and graphed below.



- (i) With reference to collision theory, explain why the steepness of the line changes as the reaction proceeds.

Refer to sections A and B in your answer.

- (ii) The internal temperature of a human stomach is approximately 37 °C.

Explain why the students' experiment would not give a good indication of how long the NaHCO_3 in the tablet takes to react in a human stomach.

Refer to collision theory in your answer.

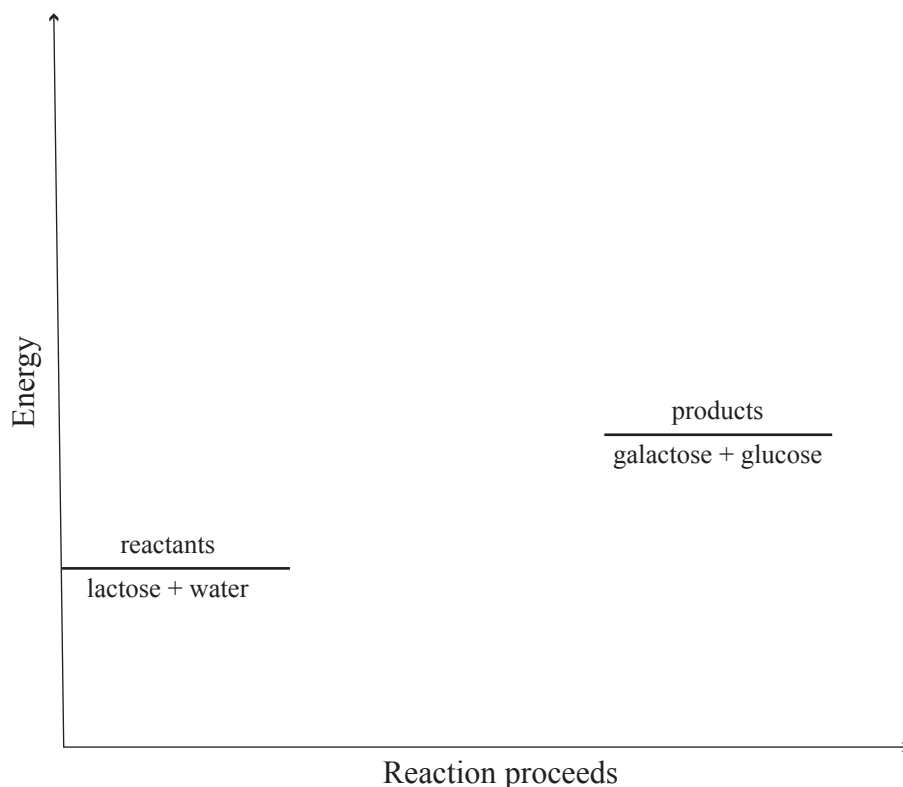
QUESTION TWO

- (a) The molecule lactose, which is found in milk, is slowly broken down in the stomach by water into the sugars galactose and glucose. The rate of this reaction is significantly increased by the presence of an enzyme called lactase. The lactase is not used up in the reaction.

- (i) Identify the role of lactase in the reaction.

- (ii) Complete the energy diagram below by **drawing two lines** to show the reaction with and without the addition of lactase.

Be sure to label your lines.



*If you
need to
redraw your
response, use
the diagram
on page 11.*

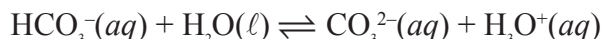
- (ii) Explain, using equilibrium principles, why removing hydrogen gas, H₂(g), as it forms, is advantageous in the production of hydrogen gas.

- (iii) At higher temperatures, the value of K_c increases.

Explain, using equilibrium principles, whether the forwards reaction is endothermic or exothermic.

QUESTION THREE

- (a) Both water, $\text{H}_2\text{O}(\ell)$, and hydrogen carbonate, $\text{HCO}_3^-(aq)$, are amphiprotic, meaning they can act as either an acid or a base. The reaction of hydrogen carbonate with water is shown below.



Identify the two acid/base conjugate pairs in the reaction of hydrogen carbonate with water.

Pair 1: _____

Pair 2: _____

- (b) A 0.1 mol L^{-1} solution of the weakly basic salt sodium ethanoate, $\text{CH}_3\text{COONa}(aq)$, has a pH of 8.88.

Write equations below to show:

- (i) The dissolving of sodium ethanoate in water:

- (ii) The reaction that follows, which results in a basic solution:

A solution of potassium hydroxide, $\text{KOH}(aq)$, of equal concentration has a significantly higher pH than the sodium ethanoate solution, $\text{CH}_3\text{COONa}(aq)$.

- (iii) Calculate the pH of a 0.1 mol L^{-1} solution of potassium hydroxide, $\text{KOH}(aq)$.

- (iii) Explain what effect, if any, increasing the pressure of the system would have on the position of equilibrium.

SPARE DIAGRAMS

If you need to redraw your response to Question Two (a)(ii), use the diagram below. Make sure it is clear which answer you want marked.

