91166

911660

NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

QUALIFY FOR THE FUTURE WORLD
KIA NOHO TAKATŪ KI TŌ ĀMUA AO!

2

SUPERVISOR'S USE ONLY

Level 2 Chemistry, 2019

91166 Demonstrate understanding of chemical reactivity

2.00 p.m. Monday 11 November 2019
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 is 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 and clearly number the question.

Check that this booklet has pages 2–11 in the correct order and that none of these pages is blank.

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

TOTAL

ASSESSOR'S USE ONLY

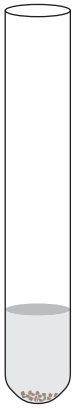
QUESTION ONE

ASSESSOR'S USE ONLY

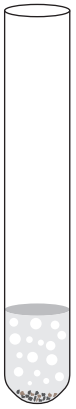
The same volume and concentration of hydrochloric acid, HCl(*aq*), was added to each of three test tubes. Metal samples were added, according to the table and diagram below.

Test tube 1
zinc and acid

Test tube 2
copper and acid



Test tube 3
zinc, copper and acid



Test tube	Contents	Observations
1	20 mL hydrochloric acid, HCl(*aq*), and 1 g zinc granules, Zn(*s*)	slow rate of bubbles
2	20 mL hydrochloric acid, HCl(*aq*), and 1 g copper granules, Cu(*s*)	no observable reaction
3	20 mL hydrochloric acid, HCl(*aq*), 1 g zinc granules, Zn(*s*), and 1 g copper granules, Cu(*s*)	fast rate of bubbles

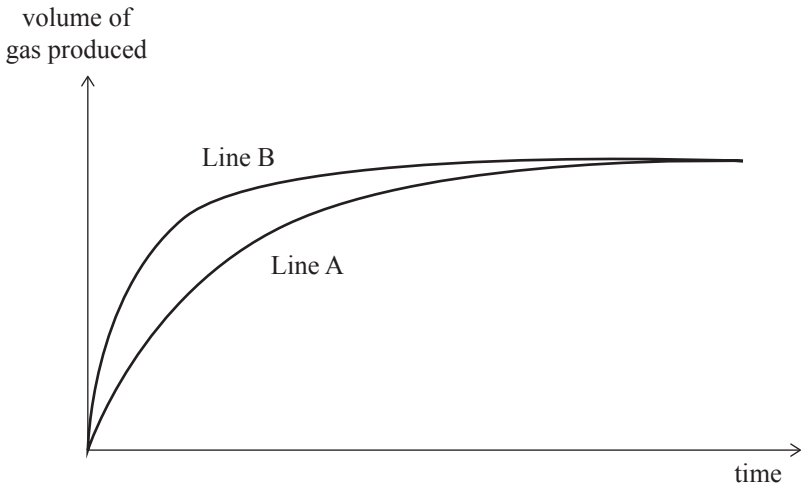
(a) (i) Identify the role of the copper granules, Cu(*s*), in test tube 3.

(ii) Explain the role of copper, Cu(*s*), in this reaction.

You should refer to activation energy and collision theory in your answer.

ASSESSOR'S USE ONLY

(b) In a second investigation, two 20 mL samples of 0.2 mol L^{-1} sulfuric acid, $H_2SO_4(aq)$, were placed in separate conical flasks. One of the flasks was placed in a water bath at 40°C and the other was placed in a water bath at 20°C. To each conical flask, 5.0 g of zinc granules, Zn(*s*), were added. The gas produced was collected and measured over time and the following graph was produced.



(i) Identify which line on the graph represents the reaction at 40°C, and explain why the two lines still finish in the same position.

(ii) Elaborate on the effect of increasing temperature on the rate of reaction.

Refer to collision theory and activation energy in your answer.

QUESTION TWO

ASSESSOR'S USE ONLY

The Haber process combines nitrogen, $N_2(g)$, from the air with hydrogen, $H_2(g)$, to form ammonia, $NH_3(g)$, which is then used in the manufacture of fertiliser.

The equation for this process is $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

(a) (i) Write the equilibrium constant expression for this reaction.

$K_c =$

(ii) Using equilibrium principles, explain why carrying out the Haber process at high pressure is an advantage to the manufacturer.

ASSESSOR'S USE ONLY

(iii) In another part of the process, the ammonia, $NH_3(g)$, is removed as it is produced.

Justify this step using equilibrium principles to explain why this would be an advantage to a manufacturer.

(b) $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ $\Delta_r H = -92$ kJ mol^{-1}

Explain, using equilibrium principles, whether the value of K_c would increase or decrease if the temperature of the reaction is increased.

ASSESSOR'S USE ONLY

(c) (i) Nitrogen, $N_2(g)$, can also be reacted with oxygen, $O_2(g)$, to give nitrogen dioxide, $NO_2(g)$, and the following K_c expression would apply.

$$K_c = \frac{[NO_2]^2}{[N_2][O_2]^2}$$

The K_c for the reaction at 25°C is 8.30×10^{-10}.

Calculate the concentration of nitrogen dioxide, NO_2, if the concentration of oxygen, O_2, is 0.230 mol L^{-1} and the concentration of nitrogen, N_2, is 0.110 mol L^{-1}.

Give your answer to appropriate significant figures.

(ii) Explain the effect on K_c if the concentration of nitrogen, $N_2(g)$, is increased to 0.200 mol L^{-1} at 25°C (no calculations are necessary).

$$N_2(g) + 2O_2(g) \rightleftharpoons 2NO_2(g)$$

QUESTION THREE

ASSESSOR'S USE ONLY

(a) Nitric acid, $HNO_3(aq)$, and ethanoic acid, $CH_3COOH(aq)$, are both acids.

(i) Write equations to show their reactions with water, $H_2O(\ell)$.

$HNO_3(aq) + H_2O(\ell)$

$CH_3COOH(aq) + H_2O(\ell)$

(ii) Use these equations to explain why they are classified as acids.

(b) (i) A solution of hydrochloric acid, $HCl(aq)$, has a hydronium ion concentration, $[H_3O^+]$, of 0.0164 mol L^{-1}.

Calculate the pH and hydroxide ion concentration, $[OH^-]$, of the solution.

pH:

$[OH^-]$:

(ii) Calculate the hydroxide ion concentration, $[OH^-]$, of a solution of potassium hydroxide, $KOH(aq)$, with a pH of 9.4.

ASSESSOR'S USE ONLY

(c) The table below provides information about solutions **A** to **D**.

Solution	**A**	**B**	**C**	**D**
Concentration (mol L^{-1})	0.100	0.100	0.100	0.100
pH	5.62	1	7	13

The solutions are known to be hydrochloric acid, HCl(*aq*), ammonium chloride, $NH_4Cl(aq)$, sodium hydroxide, NaOH(*aq*) and sodium chloride, NaCl(*aq*).

(i) Identify solutions **A** to **D**.

A: _____ **B**: _____

C: _____ **D**: _____

(ii) Justify your choices by comparing relative amounts of hydronium ion concentrations, $[H_3O^+]$, in the solutions.

Include relevant equations in your answer.

(iii) Elaborate on the electrical conductivity of the four solutions.

ASSESSOR'S USE ONLY

Extra paper if required.
Write the question number(s) if applicable.

QUESTION NUMBER

ASSESSOR'S USE ONLY

Extra paper if required.
Write the question number(s) if applicable.

QUESTION NUMBER

ASSESSOR'S USE ONLY

91166