91166

911660

NZQA

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, 2017

91166 Demonstrate understanding of chemical reactivity

2.00 p.m. Thursday 16 November 2017
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 on the Resource Sheet 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 2–12 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

(a) Propanoic acid, C_2H_5COOH, is dissolved in water and the resulting solution has a pH of 4.2.

(i) Complete the equation by writing the formulae of the two products.

$$C_2H_5COOH(aq) + H_2O(\ell) \rightleftharpoons \_\_\_\_\_ + \_\_\_\_\_$$

(ii) Explain the proton, H^+, transfer in this reaction, and identify the two conjugate acid-base pairs.

(b) Sodium ethanoate, $CH_3COONa(s)$, is a salt. When dissolved in water, it dissociates into ions.

Explain, including TWO relevant equations, whether a solution of sodium ethanoate is acidic or basic.

ASSESSOR'S USE ONLY

(c) (i) A solution of sodium hydroxide, NaOH(*aq*), has a pH of 11.6.

Calculate the hydronium ion concentration $[H_3O^+]$, and the hydroxide ion concentration, $[OH^-]$, in the solution.

$K_w = 1 \times 10^{-14}$

$[H_3O^+]$ =

$[OH^-]$ =

(ii) Calculate the pH of a 2.96×10^{-4} mol L^{-1} solution of potassium hydroxide, KOH(*aq*).

pH =

(d) Solutions of ammonia, $NH_3(aq)$, and sodium carbonate, $Na_2CO_3(aq)$, are both basic.

Compare and contrast the electrical conductivity of these two solutions.

QUESTION TWO

ASSESSOR'S USE ONLY

The addition of a small amount of iron to a mixture of nitrogen and hydrogen gases helps to speed up the production of ammonia gas.

$$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$$

(a) Identify and explain the role of iron in this reaction.

In your answer, you should refer to activation energy and collision theory.

You may include a diagram or diagrams in your answer.

The reaction described above is an equilibrium reaction, as represented by the following equation:

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

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

$K_c =$

ASSESSOR'S USE ONLY

(ii) The value of the equilibrium constant, K_c, is 640 at 25ºC.

Show, by calculation, using the concentrations of the gases given in the table below, whether or not the reaction is at equilibrium.

Explain your answer.

Gas	N_2	H_2	NH_3
Concentration (mol L^{-1})	0.0821	0.0583	0.105

Is the mixture at equilibrium?

(Circle) **Yes** **No**

Calculation and explanation:

(c) As the temperature increases, the value of the equilibrium constant, K_c, decreases from 640 at 25ºC to 0.440 at 200ºC.

Justify whether the formation of ammonia, $NH_3(g)$, is an endothermic or exothermic reaction.

ASSESSOR'S USE ONLY

QUESTION THREE

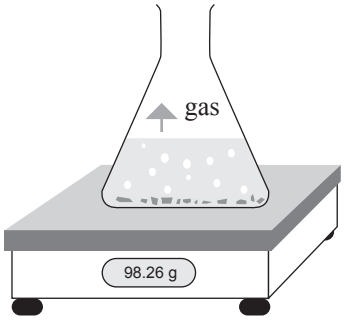
ASSESSOR'S USE ONLY

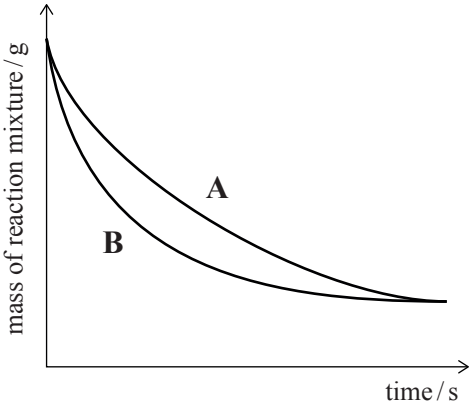
(a) Consider the reaction between calcium carbonate powder, $CaCO_3(s)$, and a solution of hydrochloric acid, $HCl(aq)$.

As the reaction proceeds, the mass of the reaction mixture decreases as carbon dioxide gas, $CO_2(g)$, escapes.

This is represented on the graph below.

Line A represents the reaction occurring at 20°C and line B represents the reaction occurring at 40°C.





Compare and contrast the reaction between calcium carbonate powder, $CaCO_3(s)$, and a solution of hydrochloric acid, $HCl(aq)$ at two temperatures: 20°C and 40°C, assuming all other conditions are kept the same.

Your answer should refer to collision theory and rates of reaction.

There is more space for your answer to this question on the following page.

ASSESSOR'S USE ONLY

(b) Two different cobalt(II) complex ions, $[Co(H_2O)_6]^{2+}$ and $[CoCl_4]^{2-}$, exist together in a solution in equilibrium with chloride ions, $Cl^-(aq)$.

The forward reaction is endothermic; ΔH is positive. The equation for this equilibrium is shown below.

$$[Co(H_2O)_6]^{2+}(aq) + 4Cl^-(aq) \rightleftharpoons [CoCl_4]^{2-}(aq) + 6H_2O(\ell)$$

pink blue

Explain using equilibrium principles, the effect on the colour of the solution if:

(i) more water is added to the reaction mixture

(ii) a test tube containing the reaction mixture is placed in a beaker of ice-cold water.

(c) Brown nitrogen dioxide gas, $NO_2(g)$, exists in equilibrium with the colourless gas, dinitrogen tetroxide, $N_2O_4(g)$.

$$2NO_2(g) \rightleftharpoons N_2O_4(g)$$
brown colourless

Explain using equilibrium principles, the effect of decreasing the volume of the container (therefore increasing the pressure) on the observations of this equilibrium mixture.

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

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

QUESTION NUMBER

ASSESSOR'S USE ONLY

91166