91166

911660

NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

2

SUPERVISOR'S USE ONLY

Level 2 Chemistry, 2014

91166 Demonstrate understanding of chemical reactivity

2.00 pm Tuesday 11 November 2014
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 space for any answer, use the page(s) provided at the back of this booklet and clearly number the question.

Check that this booklet has pages 2–10 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) Ammonia, NH_3, is dissolved in water and the resulting solution has a pH of 11.3.

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

$$NH_3(aq) + H_2O(\ell) \rightleftharpoons \_\_\_\_\_ + \_\_\_\_\_$$

(ii) Explain what is occurring during this reaction.

In your answer you should:

- identify the acid and its conjugate base
- identify the base and its conjugate acid
- describe the proton transfer that occurs.

(b) (i) In a solution of potassium hydroxide, KOH, the pH is found to be 12.8.

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

$[H_3O^+]$ =

$[OH^-]$ =

ASSESSOR'S USE ONLY

(ii) Calculate the pH of a 2.25×10^{-4} mol L^{-1} sodium hydroxide, NaOH, solution.

pH = _____

(c) The table below shows the relative electrical conductivity of five solutions of the **same concentration**, and the colour of pieces of litmus paper which have been dipped into each solution.

Solution	**A**	**B**	**C**	**D**	**E**
Electrical conductivity	poor	good	good	poor	good
Red litmus paper	turns blue	stays red	stays red	stays red	turns blue
Blue litmus paper	stays blue	turns red	stays blue	turns red	stays blue

Identify a strong base and a neutral salt, using the information in the table above.

In your answer you should justify your choices by referring to the properties of the identified solutions.

QUESTION TWO

ASSESSOR'S USE ONLY

Hydrogen can be produced industrially by reacting methane with water. An equation for this reaction can be represented by:

$$CH_4(g) + H_2O(g) \rightleftharpoons CO(g) + 3H_2(g)$$

$K_c = 4.7$ at 1127°C

(a) (i) Complete the equilibrium constant expression for this reaction:

$K_c =$

(ii) The concentrations of the four gases in a reaction mixture at 1127°C are found to be:

Gas	CH_4	H_2O	CO	H_2
Concentration / mol L^{-1}	0.0300	0.0500	0.200	0.300

Use these values to carry out a calculation to determine if the reaction is at equilibrium.

Mixture at equilibrium? **Yes** **No** (circle correct option)

Calculation:

ASSESSOR'S USE ONLY

(b) The reaction shown in the equation below is at equilibrium.

$$CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g)$$

Describe the effect of each of the following changes on the equilibrium concentration of methanol (increase, decrease, stay the same).

Justify your answers using equilibrium principles.

A copper oxide, CuO, catalyst is added.

Amount of $CH_3OH(g)$ would: **increase** OR **decrease** OR **stay the same** (circle correct answer)

Reason:

H_2(g) is removed.

Amount of $CH_3OH(g)$ would: **increase** OR **decrease** OR **stay the same** (circle correct answer)

Reason:

ASSESSOR'S USE ONLY

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

The equation for this reaction is represented by:

$$\underset{\text{brown gas}}{2NO_2(g)} \rightleftharpoons \underset{\text{colourless gas}}{N_2O_4(g)}$$

The table below shows the observations when changes were made to the system.

Change		**Observations**
Pressure	increased (by decreasing the volume of the container)	Colour faded
	decreased (by increasing the volume of the container)	Colour darkened
Temperature	container with reaction mixture put into hot water	Colour darkened
	container with reaction mixture put into ice water	Colour faded

Analyse these experimental observations.

In your answer you should:

- link all of the observations to equilibrium principles
- justify whether the formation of dinitrogen tetroxide from nitrogen dioxide is endothermic or exothermic.

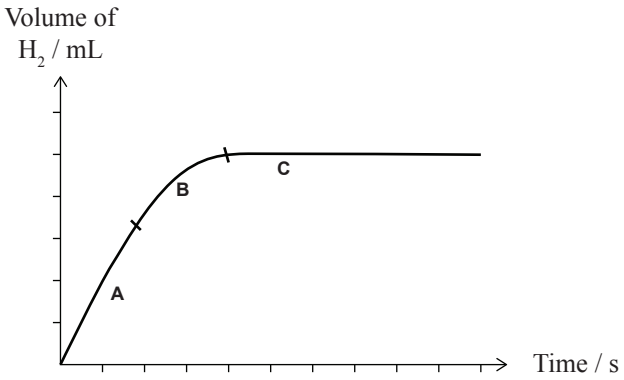
QUESTION THREE

ASSESSOR'S USE ONLY

(a) The equation for the reaction between zinc granules (lumps), Zn(*s*), and sulfuric acid, $H_2SO_4(aq)$, is represented by:

$$Zn(s) + H_2SO_4(aq) \rightarrow ZnSO_4(aq) + H_2(g)$$

The graph below shows how the volume of hydrogen gas produced changes with time, when zinc is reacted with excess sulfuric acid at 20°C.



Explain the changes in the reaction rate during the periods **A**, **B** and **C**.

In your answer you should refer to collision theory.

A: _____

B: _____

C: _____

ASSESSOR'S USE ONLY

(b) The rate of the reaction between zinc and sulfuric acid can be changed by the addition of small pieces of copper, Cu(*s*), as a catalyst.

Explain the role of the copper catalyst in the reaction between zinc and sulfuric acid.

In your answer you should refer to collision theory.

(c) The pH values of 0.100 mol L^{-1} solutions of two acids, HA and HB, are given in the table below.

Solution	**pH**
0.100 mol L^{-1} HA(*aq*)	1.0
0.100 mol L^{-1} HB(*aq*)	2.2

(i) Compare the relative strengths of the two acids, HA(*aq*) and HB(*aq*), using the information given above.

Your answer should include equations and calculations.

(ii) Predict and compare, with reasons, what would be observed when two 5 g samples of calcium carbonate chips, $CaCO_3(s)$, are reacted, separately, with excess HA and HB.

ASSESSOR'S USE ONLY

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

QUESTION NUMBER

ASSESSOR'S USE ONLY

91166