

91166



NEW ZEALAND QUALIFICATIONS AUTHORITY  
MANA TOHU MĀTAURANGA O AOTEAROA

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## Level 2 Chemistry, 2012

### 91166 Demonstrate understanding of chemical reactivity

9.30 am Tuesday 20 November 2012

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

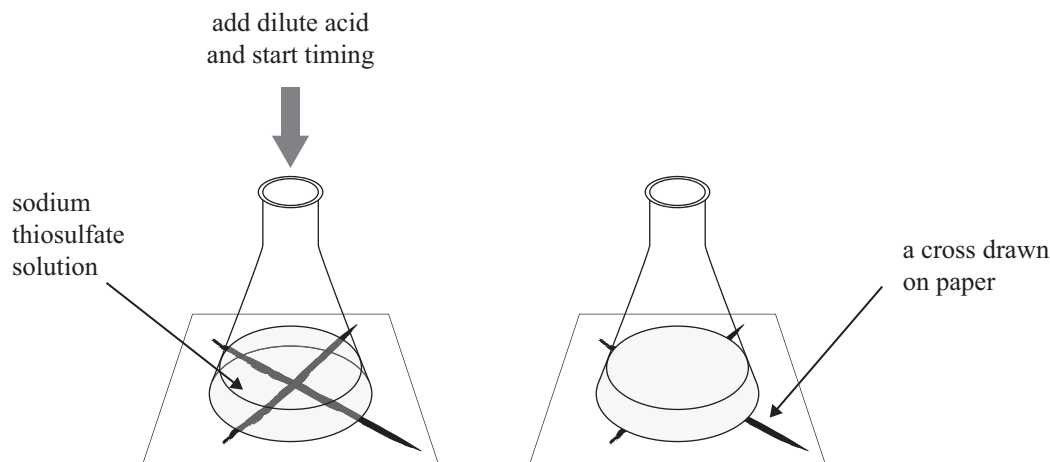
You are advised to spend 60 minutes answering the questions in this booklet.

### QUESTION ONE

When dilute hydrochloric acid,  $\text{HCl}(aq)$ , is added to sodium thiosulfate,  $\text{Na}_2\text{S}_2\text{O}_3(aq)$ , in a conical flask, the following reaction occurs:



A pale yellow solid of sulfur,  $\text{S}(s)$ , forms during the reaction. Over time, a cross on a piece of paper under the conical flask gradually disappears when viewed from above.



- (a) List TWO ways that the rate of this reaction could be decreased.

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- (b) The following experiments were carried out, and the times taken for the cross to disappear recorded. The  $\text{HCl}(aq)$  was in excess in all of the experiments.

Experiment	Concentration of 50.0 mL $\text{Na}_2\text{S}_2\text{O}_3$ / $\text{mol L}^{-1}$	Concentration of 10.0 mL $\text{HCl}$ / $\text{mol L}^{-1}$	Temperature / $^{\circ}\text{C}$	Time taken for cross to disappear/s
1	0.0500	1.00	25	127
2	0.0250	1.00	25	206
3	0.0500	1.00	45	34



## QUESTION TWO

Phosphorus pentachloride gas,  $\text{PCl}_5(\text{g})$ , decomposes to form phosphorus trichloride gas,  $\text{PCl}_3(\text{g})$ , and chlorine gas,  $\text{Cl}_2(\text{g})$ . The equilibrium can be represented as:



- (a) Complete the equilibrium constant expression for this reaction.

$K_c =$
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- (b) The table below shows the value of the equilibrium constant,  $K_c$  at two different temperatures.

Temperature/ $^{\circ}\text{C}$	Value of $K_c$
200	$8.00 \times 10^{-3}$
350	0.612

- (i) Circle the species that will be in the highest concentration at **200 $^{\circ}\text{C}$** .



- (ii) Explain your answer.

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- (iii) Calculate the concentration of  $\text{PCl}_5$  at equilibrium at  $350^{\circ}\text{C}$ , if the concentrations of  $\text{PCl}_3$  and  $\text{Cl}_2$  are both  $0.352 \text{ mol L}^{-1}$ .

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(c) For each of the following changes applied to this system:

- (i) State if the amount of **chlorine gas,  $\text{Cl}_2(g)$** , would increase or decrease.
- (ii) Justify your answers using equilibrium principles.

**$\text{PCl}_3(g)$  is removed.**

Amount of  $\text{Cl}_2(g)$  \_\_\_\_\_

Reason:

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**The pressure is decreased.**

Amount of  $\text{Cl}_2(g)$  \_\_\_\_\_

Reason:

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## QUESTION THREE

- (a) (i) Complete the table below to show the conjugate acid-base pairs.

Conjugate acid	Conjugate base
$\text{HCO}_3^-$	
$\text{H}_2\text{O}$	
	$\text{CN}^-$

- (ii)
- $\text{HPO}_4^{2-}(\text{aq})$
- is a species that can act as an acid or a base.

Write equations for the reactions of  $\text{HPO}_4^{2-}$  with water: one where it acts as an acid, and one where it acts as a base.

$\text{HPO}_4^{2-}$ acting as	Equation
an acid	$\text{HPO}_4^{2-} + \text{H}_2\text{O} \rightleftharpoons$
a base	$\text{HPO}_4^{2-} + \text{H}_2\text{O} \rightleftharpoons$

- (b) A solution contains
- $9.56 \times 10^{-5} \text{ mol L}^{-1}$
- of hydroxide ions.

- (i) Calculate the concentration of hydronium ions,
- $\text{H}_3\text{O}^+$
- .

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- (ii) Is this solution acidic, basic or neutral at
- $25^\circ\text{C}$
- ?

Circle one answer.

**acidic**

**basic**

**neutral**

Explain your answer.

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- (c) (i) Calculate the pH of a  $0.133 \text{ mol L}^{-1}$  solution of hydrochloric acid.

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- (ii) Calculate the hydroxide ion concentration,  $[\text{OH}^-]$ , of a solution of sodium hydroxide with a pH of 12.8.

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- (d) Some properties of three aqueous solutions A, B and C, of equal concentration are shown in the table below.

Solution	A	B	C
pH	5.15	11.6	1.05
Electrical conductivity	good	poor	good

The labels of the three solutions have been removed.

It is known that the solutions are  $\text{NH}_3(\text{aq})$ ,  $\text{HCl}(\text{aq})$  and  $\text{NH}_4\text{Cl}(\text{aq})$ .

Use the information in the table above to identify each of the three solutions and complete the table below.

Solution	A	B	C
Identity of solution ( $\text{NH}_3(\text{aq})$ , $\text{HCl}(\text{aq})$ , or $\text{NH}_4\text{Cl}(\text{aq})$ )			

Justify the identification of all three solutions.

In your answer you should:

- refer to both pH and electrical conductivity of the solutions
- link your answers to appropriate chemical equations.

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