91166

911660

NZQA
NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

2

SUPERVISOR'S USE ONLY

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.

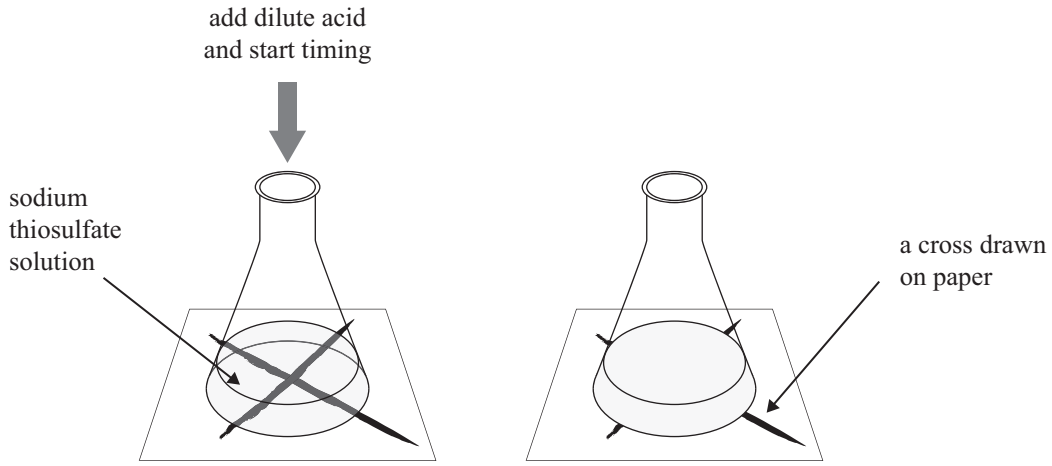
ASSESSOR'S USE ONLY

QUESTION ONE

When dilute hydrochloric acid, HCl(*aq*), is added to sodium thiosulfate, $Na_2S_2O_3(aq)$, in a conical flask, the following reaction occurs:

$$2HCl(aq) + Na_2S_2O_3(aq) \rightarrow 2NaCl(aq) + SO_2(g) + S(s) + H_2O(\ell)$$

A pale yellow solid of sulfur, 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.

(b) The following experiments were carried out, and the times taken for the cross to disappear recorded. The HCl(*aq*) was in excess in all of the experiments.

Experiment	Concentration of 50.0 mL $Na_2S_2O_3$ / mol L^{-1}	Concentration of 10.0 mL HCl / mol L^{-1}	Temperature / °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

ASSESSOR'S USE ONLY

Analyse how the results of **Experiment 2** and **Experiment 3** compare to **Experiment 1**.

In your answer you should:

- identify the factor being changed and the effect it has on the reaction rate
- explain how the rate of reaction was affected, with reference to the collision of particles, and activation energy where appropriate.

Experiment 2 compared to **Experiment 1**:

Experiment 3 compared to **Experiment 1**:

QUESTION TWO

ASSESSOR'S USE ONLY

Phosphorus pentachloride gas, $PCl_5(g)$, decomposes to form phosphorus trichloride gas, $PCl_3(g)$, and chlorine gas, $Cl_2(g)$. The equilibrium can be represented as:

$$PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$$

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

$K_c =$

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

Temperature/°C	**Value of K_c**
200	8.00×10^{-3}
350	0.612

(i) Circle the species that will be in the highest concentration at **200°C**.

$PCl_5(g)$ **$PCl_3(g)$**

(ii) Explain your answer.

(iii) Calculate the concentration of PCl_5 at equilibrium at 350°C, if the concentrations of PCl_3 and Cl_2 are both 0.352 mol L^{-1}.

ASSESSOR'S USE ONLY

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

(i) State if the amount of **chlorine gas, $Cl_2(g)$,** would increase or decrease.

(ii) Justify your answers using equilibrium principles.

$PCl_3(g)$ is removed.

Amount of $Cl_2(g)$ _____

Reason:

The pressure is decreased.

Amount of $Cl_2(g)$ _____

Reason:

ASSESSOR'S USE ONLY

(d) When the temperature of the equilibrium system is increased from 200°C to 350°C (at constant pressure), the value of K_c increases, as shown in the table in (b) on page 4.

Use this information to determine whether the decomposition of PCl_5 is endothermic or exothermic.

Justify your reasoning using equilibrium principles.

QUESTION THREE

ASSESSOR'S USE ONLY

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

Conjugate acid	Conjugate base
HCO_3^-	
H_2O	
	CN^-

(ii) $HPO_4^{2-}(aq)$ is a species that can act as an acid or a base.

Write equations for the reactions of HPO_4^{2-} with water: one where it acts as an acid, and one where it acts as a base.

HPO_4^{2-} acting as	**Equation**
an acid	$HPO_4^{2-} + H_2O \rightleftharpoons$
a base	$HPO_4^{2-} + H_2O \rightleftharpoons$

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

(i) Calculate the concentration of hydronium ions, H_3O^+.

(ii) Is this solution acidic, basic or neutral at 25°C?

Circle one answer.

acidic **basic** **neutral**

Explain your answer.

ASSESSOR'S USE ONLY

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

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

(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 $NH_3(aq)$, $HCl(aq)$ and $NH_4Cl(aq)$.

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 ($NH_3(aq)$, $HCl(aq)$, or $NH_4Cl(aq)$)			

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.

ASSESSOR'S USE ONLY

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

QUESTION NUMBER

ASSESSOR'S USE ONLY

91166