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NZQA

NEW ZEALAND QUALIFICATIONS AUTHORITY
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For Supervisor's use only

Level 2 Chemistry, 2008

90310 Describe thermochemical and equilibrium principles

Credits: Five
2.00 pm Friday 28 November 2008

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 answer 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.

For Assessor's use only	**Achievement Criteria**	
Achievement	**Achievement with Merit**	**Achievement with Excellence**
Describe thermochemical and equilibrium principles. ☐	Interpret information about thermochemical and equilibrium systems. ☐	Discuss information about thermochemical and equilibrium systems. ☐
Overall Level of Performance ☐		

You are advised to spend 55 minutes answering the questions in this booklet.

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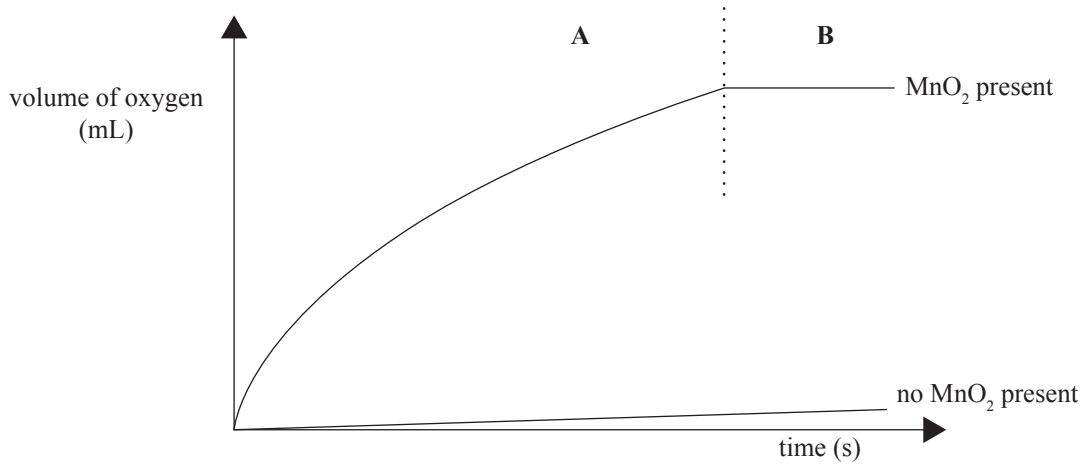
QUESTION ONE

Hydrogen peroxide decomposes to form water and oxygen gas.

$$2H_2O_2(aq) \rightarrow 2H_2O(\ell) + O_2(g)$$

The rate of decomposition is changed with the addition of manganese dioxide, MnO_2.
The rate of the reaction can be followed by recording the volume of oxygen produced. The graph below shows the volume of oxygen produced with, and without, manganese dioxide.



(a) Describe what happens to the rate of decomposition of hydrogen peroxide when manganese dioxide is added.

(b) A student suggested that manganese dioxide is a catalyst for the decomposition reaction.

Explain the role of a catalyst in changing the rate of a reaction.

Your answer must include reference to:

- particle collision
- Activation Energy.

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(c) One line on the graph on the opposite page is divided into two time periods, **A** and **B**.

Discuss the change in reaction rate in terms of particle collisions during these two time periods, **A** and **B**.

Time period **A**:

Time period **B**:

QUESTION TWO

Complete the equilibrium constant expressions for the following equations.

(a) $N_2(g) + O_2(g) \rightleftharpoons 2NO(g)$

$K_c =$

(b) $2O_3(g) \rightleftharpoons 3O_2(g)$

$K_c =$

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QUESTION THREE

Complete the equations below to show how each species will react with water to form an acidic solution.

(a) $NH_4^+(aq) + H_2O \rightleftharpoons$

(b) $HF(aq) + H_2O \rightleftharpoons$

QUESTION FOUR

Determine the $[H_3O^+]$, $[OH^-]$ and pH in each of the following solutions.

(a) 0.00112 mol L^{-1} HCl solution.

$[H_3O^+]$ (mol L^{-1})	$[OH^-]$ (mol L^{-1})	pH

(b) 3.68×10^{-2} mol L^{-1} NaOH solution.

$[H_3O^+]$ (mol L^{-1})	$[OH^-]$ (mol L^{-1})	pH

QUESTION FIVE

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When an 18.4 g sample of ethanol is burned, 546 kJ of energy is released.

Determine the enthalpy change, $\Delta_r H$, for the reaction when one mole of ethanol is burned.

$$C_2H_5OH(\ell) + 3O_2(g) \rightarrow 2CO_2(g) + 3H_2O(\ell)$$

$M(C_2H_5OH) = 46.0 \text{ g mol}^{-1}$

QUESTION SIX

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One step in the production of sulfuric acid involves forming sulfur trioxide from sulfur dioxide. The equilibrium reaction can be represented by

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g) \qquad \Delta_r H = -196 \text{ kJ mol}^{-1}$$

(a) (i) Explain why a low temperature favours the formation of $SO_3(g)$.

(ii) The temperature that is actually used is approximately 450°C. However, this is not considered to be a low temperature.

Discuss why this temperature is used.

(b) (i) Describe another way of increasing the amount of $SO_3(g)$ present at equilibrium without adding any more reactants.

(ii) Explain why this will increase the amount of $SO_3(g)$ present at equilibrium.

QUESTION SEVEN

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Carbon dioxide is added to drinks to make them **fizzy**. The following equilibria are involved:

$CO_2(g) \rightleftharpoons CO_2(aq)$ **Equation One**

$CO_2(aq) + 2H_2O(\ell) \rightleftharpoons H_3O^+(aq) + HCO_3^-(aq)$ **Equation Two**

The drink is **fizzy** when there is dissolved carbon dioxide, $CO_2(aq)$. The drink stops being fizzy when the carbon dioxide escapes from the drink as a gas.

Using equilibrium principles, discuss the changes that occur as a bottle containing fizzy drink is opened.

Your answer must include reference to:

- equilibrium shift in **Equation One** and **Equation Two**
- changes in the fizziness of the drink
- any change in pH.

Question Eight is on the following page.

QUESTION EIGHT

Assessor's use only

Aqueous solutions of acids **HA** and **HB** both have the same concentration of 0.100 mol L^{-1}. The pH of the solution of acid **HA** is 3.5 and the pH of the solution of acid **HB** is 1.8.

(a) (i) Identify which one of these acids is stronger and circle your choice below.

HA **HB**

(ii) Discuss the reasons for your choice.
You should include relevant equations in your answer, as well as reference to what is meant by the strength of an acid.

(b) Describe what is observed when the following two tests are carried out on 5 mL samples of the acids **HA** and **HB**.

(i) Identical small pieces of magnesium ribbon are placed in each acid.

(ii) Sodium hydroxide solution is slowly added to each acid. The volume of sodium hydroxide solution required to completely react with the acid is measured.

(c) Discuss the observations in (b) (i) and (ii).

Your answer must include reference to:

- similarities and / or differences in the observations of the tests on each acid
- equations for reactions.

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Extra paper for continuation of answers if required.
Clearly number the question.

Assessor's use only

Question number