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90310

NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

National Certificate of Educational Achievement
TAUMATA MĀTAURANGA Ā-MOTU KUA TAEA

Level 2 Chemistry, 2003

90310 Describe principles of chemical reactivity

Credits: Four
2.00 pm Monday 24 November 2003

Check that the National Student Number (NSN) on your admission slip is the same as the number at the top of this page.

A Periodic Table is printed on page 2 of this booklet.

You should answer ALL the questions in this booklet.

If you need more space for any answer, use the pages provided at the back of this booklet and clearly number the question.

Check that this booklet has pages 2–11 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.

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Achievement Criteria		
Achievement	**Achievement with Merit**	**Achievement with Excellence**
Describe and use thermochemical and equilibrium information. ☐	Interpret information about thermochemical and equilibrium systems. ☐	Evaluate and explain information about thermochemical and equilibrium systems. ☐
Overall Level of Performance ☐		

PERIODIC TABLE OF THE ELEMENTS

Atomic Number 1 **H** 1.0 Atomic Mass

1	2											13	14	15	16	17	18
																	2 **He** 4.0
3 **Li** 6.9	4 **Be** 9.0											5 **B** 10.8	6 **C** 12.0	7 **N** 14.0	8 **O** 16.0	9 **F** 19.0	10 **Ne** 20.2
11 **Na** 23.0	12 **Mg** 24.3	3	4	5	6	7	8	9	10	11	12	13 **Al** 27.0	14 **Si** 28.1	15 **P** 31.0	16 **S** 32.1	17 **Cl** 35.5	18 **Ar** 40.0
19 **K** 39.1	20 **Ca** 40.1	21 **Sc** 45.0	22 **Ti** 47.9	23 **V** 50.9	24 **Cr** 52.0	25 **Mn** 54.9	26 **Fe** 55.9	27 **Co** 58.9	28 **Ni** 58.7	29 **Cu** 63.5	30 **Zn** 65.4	31 **Ga** 69.7	32 **Ge** 72.6	33 **As** 74.9	34 **Se** 79.0	35 **Br** 79.9	36 **Kr** 83.8
37 **Rb** 85.5	38 **Sr** 87.6	39 **Y** 88.9	40 **Zr** 91.2	41 **Nb** 92.9	42 **Mo** 95.9	43 **Tc** 98.9	44 **Ru** 101	45 **Rh** 103	46 **Pd** 106	47 **Ag** 108	48 **Cd** 112	49 **In** 115	50 **Sn** 119	51 **Sb** 122	52 **Te** 128	53 **I** 127	54 **Xe** 131
55 **Cs** 133	56 **Ba** 137	71 **Lu** 175	72 **Hf** 179	73 **Ta** 181	74 **W** 184	75 **Re** 186	76 **Os** 190	77 **Ir** 192	78 **Pt** 195	79 **Au** 197	80 **Hg** 201	81 **Tl** 204	82 **Pb** 207	83 **Bi** 209	84 **Po** 210	85 **At** 210	86 **Rn** 222
87 **Fr** 223	88 **Ra** 226	103 **Lr** 262	104 **Rf**	105 **Db**	106 **Sg**	107 **Bh**	108 **Hs**	109 **Mt**									

Lanthanide Series	57 **La** 139	58 **Ce** 140	59 **Pr** 141	60 **Nd** 144	61 **Pm** 147	62 **Sm** 150	63 **Eu** 152	64 **Gd** 157	65 **Tb** 159	66 **Dy** 163	67 **Ho** 165	68 **Er** 167	69 **Tm** 169	70 **Yb** 173
Actinide Series	89 **Ac** 227	90 **Th** 232	91 **Pa** 231	92 **U** 238	93 **Np** 237	94 **Pu** 239	95 **Am** 241	96 **Cm** 247	97 **Bk** 249	98 **Cf** 251	99 **Es** 254	100 **Fm** 257	101 **Md** 258	102 **No** 255

You are advised to spend 45 minutes answering the questions in this booklet.

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QUESTION ONE

A 1 g lump of calcium carbonate was added to a 250 mL beaker containing 100 mL of 1.0 mol L^{-1} hydrochloric acid solution, at room temperature (25°C). Bubbles of carbon dioxide were produced.

The experiment was repeated under different conditions, as given below.

(a) For EACH change, describe how the **reaction rate** would be affected.
Use the words 'increase', 'decrease' or 'remain the same' in each answer.

Change 1
The temperature of the reaction mixture was increased to 40°C.

Effect: _____

Change 2
100 mL of water was added to the acid. 100 mL of this diluted acid solution was added to a 1 g lump of calcium carbonate.

Effect: _____

Change 3
The 1 g lump of calcium carbonate was ground to form a powder, and then 100 mL of the 1.0 mol L^{-1} hydrochloric acid was added.

Effect: _____

Change 4
A 500 mL beaker was used instead of the 250 mL beaker, but the same amounts of reactants were used.

Effect: _____

(b) Explain the effect on the reaction rate for **Change 1** and **Change 2** above by referring to the collisions of particles.

Change 1: _____

_____

_____

_____

Change 2: _____

_____

_____

_____

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QUESTION TWO

Classify EACH of the following processes as **either** endothermic **or** exothermic.

	Process	endothermic or exothermic
(a)	$H_2(g) + \frac{1}{2}O_2(g) \longrightarrow H_2O(g) \quad \Delta_f H = -286$ kJ mol^{-1}	
(b)	Photosynthesis – food-making process in plants	
(c)	Freezing of water	
(d)	Dissolving sodium hydroxide in water (the temperature increases)	
(e)	Sublimation of solid carbon dioxide to carbon dioxide gas	

QUESTION THREE

Hydrogen peroxide, a common bleaching agent, decomposes as follows:

$$H_2O_2(l) \longrightarrow H_2O(l) + \tfrac{1}{2}O_2(g) \quad \Delta_f H = -98.2 \text{ kJ mol}^{-1}$$

(a) Calculate how much energy is released when 5 moles of hydrogen peroxide decompose.

(b) Calculate how much energy is released when 1.0 g of oxygen is formed by the decomposition of hydrogen peroxide.

(c) Calculate the mass of hydrogen peroxide that must decompose to produce 600 kJ of energy.

QUESTION FOUR

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Write the equilibrium constant expression for EACH of the following reactions:

(a) $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$ $K_c =$

(b) $4NH_3(g) + 5O_2(g) \rightleftharpoons 4NO(g) + 6H_2O(g)$ $K_c =$

(c) $CH_3COOH(aq) \rightleftharpoons H^+(aq) + CH_3COO^-(aq)$ $K_c =$

QUESTION FIVE

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Two oxides of nitrogen exist in the following equilibrium system:

$2NO_2(g) \rightleftharpoons N_2O_4(g)$ $\quad \Delta_r H = -57$ kJ mol^{-1} and $K_c = 6.3 \times 10^{-5}$ at 227°C

(a) Which oxide would you expect to be present in the greater concentration at equilibrium?

(Circle your answer.) **NO_2** *or* **N_2O_4**

(b) Justify your answer to (a) above.

(c) NO_2 is a brown gas and N_2O_4 is a colourless gas.

What would you expect to observe when the following changes are applied to the equilibrium system? In EACH case, justify your observation.

(i) The temperature is increased to 500°C (without changing the pressure).

Observation:

Explanation:

(ii) More NO_2 gas is added to the system.

Observation:

Explanation:

QUESTION SIX

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The pH of a 0.10 mol L^{-1} solution of acid **HX** and the pH of a 0.10 mol L^{-1} solution of acid **HY** are measured. The pH of acid **HX** is 3 and the pH of acid **HY** is 1.

(a) Which of the two acids, **HX** or **HY**, is the stronger acid?

(Circle your answer.) **HX** *or* **HY**

(b) Justify your answer to (a) in terms of the measured pH.

(c) Describe **another** test that could be carried out to confirm that the acid you selected in (a) above is the stronger of the two.
Describe what you would do and what you would expect to observe.

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QUESTION SEVEN

$HCO_3^-(aq)$ is a species that may act as an acid or a base. Consider the equilibrium system:

$$HCO_3^-(aq) + H_2O(l) \rightleftharpoons H_2CO_3(aq) + OH^-(aq)$$

(a) Is $HCO_3^-(aq)$ acting as an acid or a base?

(Circle your answer.) **ACID** *or* **BASE**

(b) Justify your answer to (a) above.

QUESTION EIGHT

A sample of solid ammonium chloride, NH_4Cl, is dissolved in water. The solution formed is tested and is found to be acidic.

Explain why the solution is acidic. Include appropriate equation(s) in your answer.

QUESTION NINE

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Complete the following table by showing the:

- hydronium ion concentration for both solution **A** and solution **B**
- hydroxide ion concentration for solution **B**
- pH of solution **A**.

$K_w = [H_3O^+]\,[OH^-] = 1.00 \times 10^{-14}$

Solution	$[H_3O^+]$ / mol L^{-1}	$[OH^-]$ / mol L^{-1}	pH
A		0.0288	
B			5.24

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

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