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90311

NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

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

Level 2 Chemistry, 2003

90311 Describe oxidation–reduction reactions

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 2–10 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.

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Achievement Criteria		
Achievement	**Achievement with Merit**	**Achievement with Excellence**
Describe oxidation–reduction reactions. ☐	Apply oxidation–reduction principles. ☐	Interpret information from oxidation–reduction processes. ☐
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 40 minutes answering the questions in this booklet.

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QUESTION ONE: Redox Reactions in the Laboratory

When acidified potassium permanganate solution is added to freshly prepared iron(II) nitrate solution, a reaction occurs. The unbalanced equation is shown below:

$$MnO_4^- + Fe^{2+} \rightarrow Fe^{3+} + Mn^{2+}$$

(a) Is the MnO_4^- ion oxidised or reduced? Use oxidation numbers to justify your answer.

_____

_____

(b) Identify the oxidant and reductant in the reaction above.

Oxidant: _____

Reductant: _____

(c) Write balanced equations for the oxidation and reduction half reactions.

Oxidation:

Reduction:

(d) Combine the half equations in (c) to give the balanced equation for this oxidation–reduction reaction.

(e) Clearly describe what would be observed when this reaction is carried out, linking the observations to the species involved in the reaction.

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(f) Complete the table below for EACH combination of species.

Species to be mixed	Does a reaction occur? (yes or no)	**If a reaction occurs,** describe what would be observed.	**If a reaction occurs,** write a balanced equation for the reaction.
(i) $Cl_2(aq) + Br^-(aq)$			
(ii) $Cl^-(aq) + I_2(aq)$			

QUESTION TWO: Oxidation of Wine

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Wines often contain a small amount of sulfur dioxide that is added as a preservative. If too little is added, the wine is oxidised to vinegar. If too much is added, it affects the taste of the wine.

The sulfur dioxide content of wine can be determined using a reaction with iodine, I_2, to produce sulfate and iodide ions.

(a) What is the oxidation number of sulfur in EACH of the following?

(i) SO_2 _____

(ii) SO_4^{2-} _____

(b) Write ion–electron half equations for the oxidation and reduction reactions occurring between SO_2 and I_2.

(c) Combine the half equations in (b) above to form a balanced equation.

(d) The alcohol content of the wine can be determined by a reaction with acidified potassium dichromate.

What colour change would be observed if excess wine is added to acidified potassium dichromate solution? Link the colour change observed to the species responsible for the observed colour. (Neither the alcohol nor its oxidation product is coloured.)

_____

_____

_____

QUESTION THREE: Electrolysis of Aluminium Oxide

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Aluminium is produced by the electrolysis of aluminium oxide that has been extracted from bauxite ore. A typical electrolysis cell is shown in the diagram below. The oxygen gas produced reacts with the carbon (graphite) electrodes, so that the electrodes have to be replaced from time to time.

[For copyright reasons, this resource cannot be reproduced here. See below.]

Adapted from *Chemistry*, Ann and Patrick Fullick, Heinemann, 1994.

(a) On the diagram above:

(i) clearly label the anode and the cathode

(ii) show the direction of movement of ions in the electrolyte.

(b) Write balanced half equations for the reactions occurring at:

(i) the positive electrode

(ii) the negative electrode.

(c) Write an equation for the reaction that occurs between the oxygen gas and the carbon electrode, and hence explain why the electrode must be replaced from time to time.

Equation:

Explanation: _____

_____

_____

QUESTION FOUR: Chlorine

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Sodium hypochlorite, NaOCl, reacts with hydrochloric acid to give sodium chloride, NaCl, and chlorine gas, Cl_2. It is the reaction between the Cl^- and OCl^- ions that produces the chlorine gas.

(a) What are the oxidation states of the chlorine in EACH of the following species?

(i) OCl^- _____

(ii) Cl^- _____

(iii) Cl_2 _____

(b) Write balanced ion–electron half equations for the formation of chlorine, Cl_2, from:

(i) chloride ion (Cl^-)

(ii) hypochlorite ion (OCl^-)

(c) Identify the reaction in part (b) above that is an oxidation reaction, and give reasons for your answer.

_____

_____

_____

_____

(d) If warmed, or left to stand, a solution of sodium hypochlorite decomposes as follows:

$$2NaOCl \rightarrow 2NaCl + O_2$$

Clearly identify the element that is being oxidised and the one being reduced.
Justify your decision.

_____

_____

_____

_____

(e) A bottle of bleach contains sodium hypochlorite. The following information is written on the bottle's label:

'This bleach decays into common salt and water after it has killed germs.
Do not use with lavatory cleaners containing acid.'

Discuss the validity of the claims made on this label.

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

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