

Chemistry

Unit 3

Area of Study 3 Test:

Oxidation and reduction

This sample test paper has been prepared as part of the Pearson suite of resources for the Year 12, Unit 3, ATAR Chemistry Course prescribed by the Western Australian School Curriculum and Standards Authority.

Time allowed

Reading time: 5 minutes

Working time: 45 minutes

Materials required

An approved non-programmable calculator.

Chemistry Data Booklet. This may be downloaded from the SCSA website.

Structure of this paper

Section	Number of questions available	Number of questions to be answered	Suggested working time (minutes)	Marks available	Percentage of total test
Section 1: Multiple choice	8	8	12	16	27
Section 2: Short answer	4	4	16	21	35
Section 3: Extended answer	2	2	17	23	38
Total			45	60	100

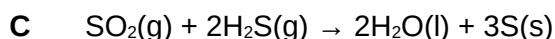
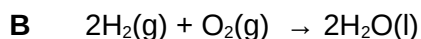
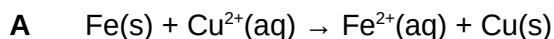
Section 1: Multiple choice

27% (16 marks)

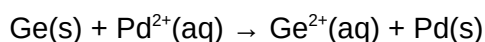
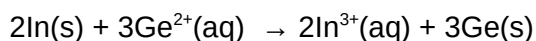
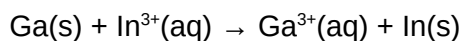
This section has **8** questions. Answer **all** questions by circling the correct option. Marks will not be deducted for incorrect answers. No marks will be given if more than one answer is completed for any question.

Suggested working time: 12 minutes

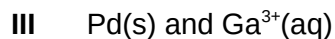
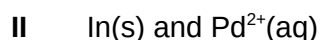
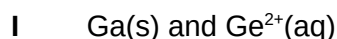
1 Which one of the following is *not* a redox reaction?



2 The following redox reactions are spontaneous as written:



Therefore, which of the following pairs will also react spontaneously?



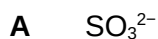
A I only

B II only

C III only

D I and II only

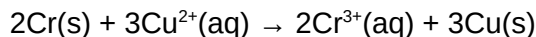
3 Which one of the following could be a product of the reduction of SO_2 ?



Questions 4 and 5 refer to the following information.

An electrochemical cell is set up under standard conditions. It is composed of a $\text{Cr}^{3+}(\text{aq})/\text{Cr}(\text{s})$ half-cell, a $\text{Cu}^{2+}(\text{aq})/\text{Cu}(\text{s})$ half-cell and a potassium nitrate salt bridge. The two half-cells are connected to a voltmeter in the external circuit.

The cell reaction is:



4 What is the predicted cell potential, in volts, under standard conditions?

- A 0.40
- B 1.08
- C 1.82
- D 2.50

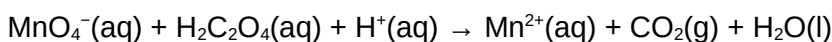
5 What is the cathode in this cell?

- A $\text{Cu}(\text{s})$
- B $\text{Cu}^{2+}(\text{aq})$
- C $\text{Cr}^{3+}(\text{aq})$
- D $\text{Cr}(\text{s})$

6 What do galvanic cells do, as opposed to electrolytic cells?

- A produce an electric current from a spontaneous reaction
- B produce an electric current from a non-spontaneous reaction
- C use an external potential difference to drive a spontaneous reaction
- D use an external potential difference to drive a non-spontaneous reaction

7 Consider the following unbalanced redox equation:



When the equation is correctly balanced, what are the whole number coefficients of $\text{H}_2\text{C}_2\text{O}_4(\text{aq})$ and $\text{H}^{+}(\text{aq})$?

	$\text{H}_2\text{C}_2\text{O}_4(\text{aq})$	$\text{H}^{+}(\text{aq})$
A	1	2
B	1	4
C	5	6
D	5	16

8 In which one of the following cases will a small piece of iron sheeting rust most quickly?

- A The iron sheet is coated with tin.
- B The iron sheet is given a thin coat of paint.
- C The iron sheet is made into the anode of an electrolytic cell.
- D A block of magnesium is attached to one end of the iron sheet.

End of section 1

Section 2: Short answer

35% (21 marks)

This section has **4** questions. Answer **all** questions. Write your answers in the space provided.

When calculating numerical answers, show your working or reasoning clearly. Express numerical answers to three significant figures and include appropriate units where applicable.

Do not use abbreviations, such as 'nr' for 'no reaction', without first defining them.

Suggested working time: 16 minutes

Question 9

(3 marks)

What is the oxidation number of nitrogen in each of the following compounds?

Compound	Oxidation number of N
NaNO_3	
HNO_2	
N_2O_4	

Question 10

(8 marks)

a Under standard conditions, hydrogen gas is bubbled through a solution of $1.0 \text{ mol L}^{-1} \text{ Fe}^{3+}(\text{aq})$ ions.

i Write an equation for the reaction you would predict to occur. (1 mark)

ii However, in practice, there is no visible reaction. Provide a reason for this observation. (1 mark)

b i Predict what you observe if some $\text{Br}_2(\text{aq})$ was added to a 1.0 mol L^{-1} solution of colourless $\text{NaI}(\text{aq})$. (1 mark)

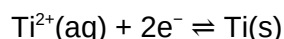
ii Predict what you would observe if some $\text{Br}_2(\text{aq})$ was added to a 1.0 mol L^{-1} solution of colourless $\text{NaCl}(\text{aq})$. (1 mark)

iii Explain your predictions in terms of the relative strength of the reducing

agents involved.

(2 marks)

- c** An electrochemical cell comprises a $\text{Ti}^{2+}(\text{aq})/\text{Ti}(\text{s})$ half-cell connected to a $\text{Cu}^{2+}(\text{aq})/\text{Cu}(\text{s})$ half-cell under standard conditions. Reduction occurs at the Cu electrode and the cell is predicted to produce a voltage of 1.97 V. Deduce the standard reduction potential of:



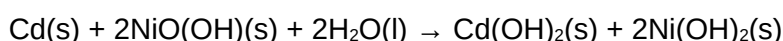
(2 marks)

Question 11

(6 marks)

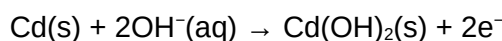
The rechargeable nickel–cadmium (Ni-Cad) cell can be used to power small appliances.

The electrolyte is alkaline and the overall cell reaction when this cell is providing electricity is:



- a** Consider what happens when this cell is providing electricity.

- i** One of the electrode reactions is:



Does this reaction occur at the anode or cathode of the cell?

(1 mark)

- ii** Deduce the other electrode reaction.

(1 mark)

- iii** What is the oxidation number of nickel in $\text{NiO}(\text{OH})(\text{s})$ and in $\text{Ni}(\text{OH})_2$?

(2 marks)

- b** Consider what happens when this cell is being recharged.

- i** Write the reaction at the cathode.

(1 mark)

- ii** What feature must a secondary cell have in order to allow it to be recharged?

(1 mark)

Question 12

(4 marks)

A fuel cell, based on the reaction between methanol ($\text{CH}_3\text{OH}(\text{g})$) and oxygen ($\text{O}_2(\text{g})$), has been developed for possible use in small electronic devices. The cell uses an acidic electrolyte and one of the products of the cell reaction is carbon dioxide ($\text{CO}_2(\text{g})$).

- a** Give the half-equation for the anode reaction. (1 mark)

- b** Give the half-equation for the cathode reaction. (1 mark)

- c** Write the overall cell equation. (1 mark)

- d** Identify one fundamental difference between a fuel cell and a galvanic cell such as the one that is used to power a torch. (1 mark)

End of section 2

Section 3: Extended answer

38% (23 marks)

This section has **2** questions. Answer **both** questions. Write your answers in the space provided.

When calculating numerical answers, show your working or reasoning clearly. Express numerical answers to three significant figures and include appropriate units where applicable.

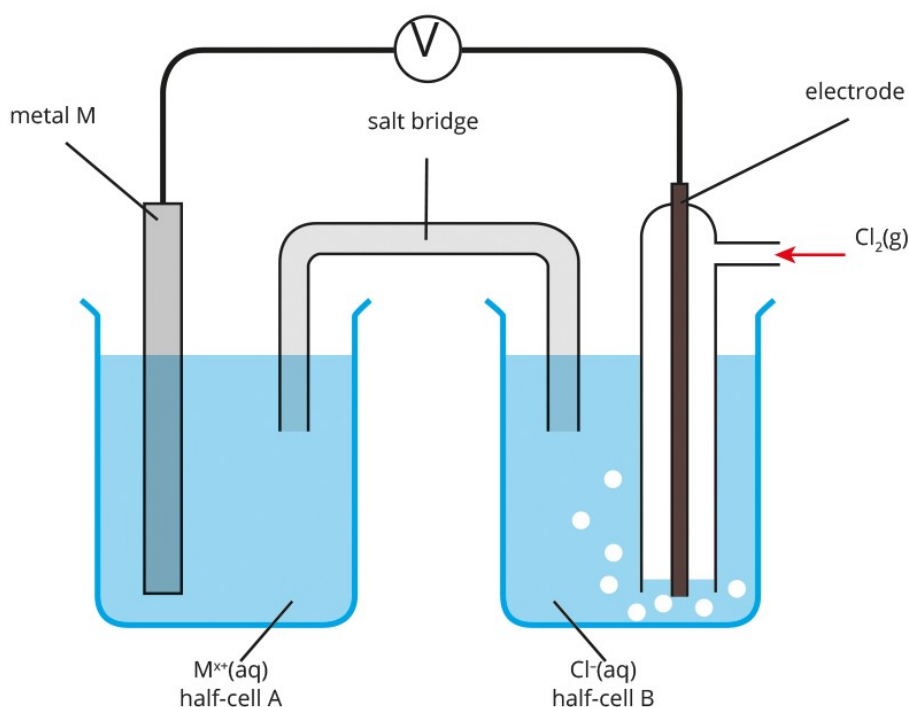
Do not use abbreviations, such as 'nr' for 'no reaction', without first defining them.

Suggested working time: 17 minutes

Question 13

(13 marks)

A galvanic cell, under standard conditions, is set up as shown in the following diagram.



- a** Identify a material that would be suitable for the electrode in the solution of chloride ions in half-cell B. (1 mark)

- b** The predicted potential difference that can be generated by this cell is 1.49 V. Deduce the identity of metal M and metal ions M^{x+} . (3 marks)

- c** State whether the electrode made of metal M in half-cell A is the anode or cathode in this cell. (1 mark)
-

- d** On the diagram itself, show the direction of electron flow in the external circuit. (1 mark)

- e i** Give the formula of an ionic compound that can be used in the salt bridge. (1 mark)
-

- ii** On the diagram itself, show the direction in which the cations and anions of your chosen compound move in the salt bridge. (1 mark)

- f** For this galvanic cell, write an equation for the:

- i** oxidation half-reaction (1 mark)
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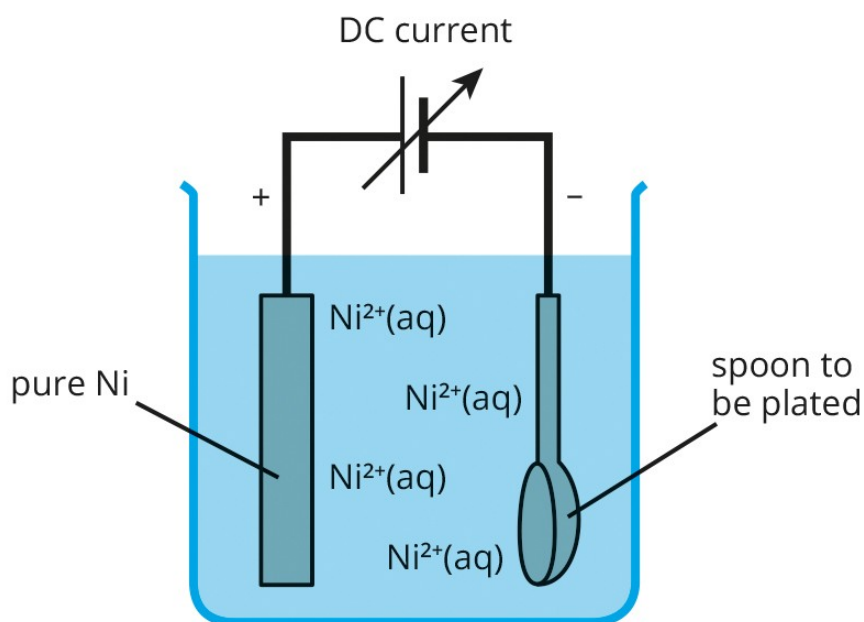
- ii** reduction half-reaction (1 mark)
-

- iii** overall cell reaction (1 mark)
-

- g** Explain how you can use this galvanic cell to determine whether an unknown metal is more or less reactive than metal M. (2 marks)
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Question 14**(10 marks)**

Electrolytic cells are used industrially for a number of applications. This diagram shows a cell that can be used to electroplate a thin layer of nickel on an iron spoon.



- a** **i** Write the half-equation for the reaction that causes the spoon to be nickel plated. (1 mark)
- _____
- ii** Does the spoon form the anode or cathode of the cell? Explain your choice. (2 marks)
- _____
- _____
- b** **i** Write the half-equation for the reaction at the Ni electrode. (1 mark)
- _____
- ii** What would you observe at the Ni electrode after some time? (1 mark)
- _____
- _____
- c** $\text{Ni}^{2+}(\text{aq})$ ions are green. What would you observe about the intensity of the green colour of the plating bath as the electroplating proceeds? (1 mark)
- _____
- _____

- d** Calculate the amount, in mol, of electrons that would be needed to deposit 0.935 g of nickel on the spoon. (2 marks)

- e** Explain why this method is also suitable for electroplating silver onto metal objects but is not suitable for electroplating magnesium onto metal objects. (2 marks)

End of questions