**Unit 3: Test 3 Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Redox chemistry/galvanic cells Mark: \_\_\_\_\_\_/50**

**SECTION A – Multiple-choice questions**

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| **Instructions for Section A**  Answer **all** questions.  Choose the response that is **correct** for the question.  A correct answer scores 1, an incorrect answer scores 0.  Marks are **not** deducted for incorrect answers.  If more than one answer is completed for any question, no mark will be given. |

**Question 1**

Vanadium is an example of a transition metal that has more than one oxidation state.

The following ions or compounds containing vanadium are known to exist;

V2O5 VO2+ VO2+ VCl3  VCl2

The oxidation number(s) of vanadium in the above compounds is

**A**. -1 and -2

**B**. +2 and +3 only

**C**. +3 and +5 only

**D**. +2, +3, +4 and +5

*Use the following information to answer questions 2 and 3*

The equation for the reaction occurring in zinc, silver oxide button cells is

Zn(s) + Ag2O(s) + H2O(l) 🡪 2Ag(s) + Zn(OH)2(s)

**Question 2**

In this cell

**A**. electrons will flow from the silver oxide to the zinc.

**B**. zinc metal is reduced and silver oxide oxidised.

**C**. zinc metal is the reductant and silver ions are the oxidant.

**D**. the zinc metal will be the positive electrode and silver the negative.

**Question 3**

In this cell, the reaction

**A**. will produce twice the mass of silver as zinc.

**B**. will see the same number of zinc atoms react as silver ions.

**C**. will cause the mass of the cell to drop steadily as zinc metals corrodes away.

**D**. will produce silver atoms at twice the rate zinc atoms react.

**Question 4**

The half equation Sn4+(aq) + 2e ⇄ Sn2+(aq) is listed on your electrochemical series. The half-cell required for this reaction could have a

**A**. Sn(NO3)2 solution and a platinum electrode

**B**. Sn(NO3)4 solution, a Sn(NO3)2 solution and a platinum electrode

**C**. Sn(NO3)4 solution, a Sn(NO3)2 solution and a Sn electrode

**D**. Sn(NO3)4 solution with a Sn electrode

**Question 5**

If a cell is constructed with the overall equation

2Cr(s) + 3CoCl2(aq) 🡪 2CrCl3(aq) + 3Co(s)

**A**. the mass of chromium reacting will be 2/3 times the mass of cobalt forming

**B**. the mass of chromium reacting will be 3/2 times the mass of cobalt forming

**C**. the number of mole of chromium reacting will be 3/2 times the mole of cobalt forming

**D**. the number of mole of chromium reacting will be 2/3 times the mole of cobalt forming

*Use the following table of half equations and potentials to answer questions 6 and 7*

Au3+(aq) + 3e- ⇄ Au(s) 1.50 V

Ce4+(aq) + e- ⇄ Ce3+(aq) 1.74 V

Pb2+(aq) + 2e- ⇄ Pb(s) -0.13 V

Ti2+(aq) + 2e- ⇄ Ti(s) -1.63

**Question 6**

The strongest oxidant and strongest reductant on this list are, respectively

**A**. Ce4+ and Ti

**B**. Ce3+ and Ti2+

**C**. Au3+ and Ti

**D**. Au and Ti2+

**Question 7**

A spontaneous reaction will occur when

**A**. Gold is dropped into Pb(NO3)2 solution

**B**. Gold is dropped into Ce(NO3)4 solution

**C**. Lead is dropped into Ti(NO3)2 solution

**D**. Cerium is dropped into Ce(NO3)4 solution

**Question 8**

A balanced half-equation for the reaction of silver ions in basic conditions is

**A**. Ag+(aq) + e 🡪 Ag(s)

**B**. Ag(s) + e 🡪 Ag(s)

**C**. AgOH(s) + e 🡪 Ag(s) + OH-(aq)

**D**. 2AgOH(s) + e 🡪 Ag2O(s) + 2H+(aq)

*Use the following information to answer questions 9 and 10*

Ethanol can be used as a reactant in a fuel cell. The reaction is conducted in acidic conditions. The overall reaction is

CH3CH2OH(l) + 3O2(g) 🡪 2CO2(g) + 3H2O(g)

**Question 9**

The reaction occurring at the anode will be

**A**. CH3CH2OH(l) + 3O2(g) 🡪 2CO2(g) + 3H2O(g)

**B**. CH3CH2OH(l) + 3H2O(l) 🡪 2CO2(g) + 12H+(aq) + 12e-

**C**. O2(g) + 4H+(aq) + 4e- 🡪 2H2O(g)

**D**. O2(g) + 2H2O(g) + 4e- 🡪 4OH-(aq)

**Question 10**

Select the correct statement about this cell.

**A**. The overall reaction will differ according to whether the conditions are acidic or alkaline.

**B**. This cell can be recharged easily after it has completely discharged.

**C**. The nature of the electrodes will ensure this cell is relatively expensive.

**D**. This cell will be cheap and efficient

**SECTION B- Short-answer questions**

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| **Instructions for Section B**  Questions must be answered in the spaces provided in this book.  To obtain full marks for your responses you should   * Give simplified answers with an appropriate number of significant figures to all numerical questions; unsimplified answers will not be given full marks. * Show all workings in your answers to numerical questions. No credit will be given for an incorrect answer unless it is accompanied by details of the working.   Make sure chemical equations are balanced and that the formulas for individual substances include an indication of state; for example, H2(g); NaCl(s) |

**Question 1** (10 marks)

a. Determine the oxidation number of chlorine in each of the following 3 marks

**i**. HClO \_\_\_\_\_\_ **ii**. NaClO4 **\_\_\_\_\_\_\_\_iii**. ClO3-  \_\_\_\_\_\_\_\_\_\_\_\_\_\_

**b**. Complete and balance the following half equations.

**i**. H2S(g) 🡪S(s) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ 1 mark

**ii**. NO3-(aq) + H+(aq) 🡪 NO(g) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ 1 mark

**iii**. Label each of the above reactions as oxidation or reduction 2 marks

**c**. The following reaction is a redox reaction:

2LiI(aq) + F2(g) 🡪 2LiF(aq) + I2(l)

**i**. Write equations for the two half equations occurring. 2 marks

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**ii**. Identify the oxidant \_\_\_\_\_\_\_\_\_\_\_\_\_\_ and the reductant \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ 1 mark

**Question 2** (10 marks)

The following half-equations can be found on a detailed electrochemical series

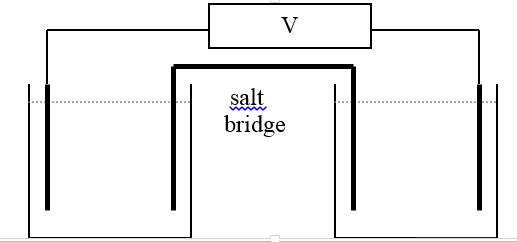
PbO2(s) + 4H+(aq) + 2e- ⇄ Pb2+(aq) + 2H2O(l) 1.46

Cd2+(aq) + 2e ⇄ Cd(s) -0.40 V

An electrochemical cell is to be designed based on these half-equations.

Complete the template below to show the half-reactions occurring in this cell. Show

* the polarity of the electrodes
* possible solutions in each cell
* the material the electrode is made from
* direction of electron flow
* ion movement on salt bridge



Oxidation half equation Reduction half-equation

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Overall equation \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Theoretical cell voltage \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

10 marks

**Question 3** (5 marks)

Oxalic acid has a structure

Oxalic acid can be oxidised to carbon dioxide. An acidic solution is also produced.

**a. i**. Write a balanced half-equation for the oxidation of oxalic acid to carbon dioxide and acid. 1 mark

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**ii**. This half-equation is listed on the electrochemical series with a potential of -0.48 V

Write this half-equation as it will appear on the electrochemical series. 1 mark

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**b**. Oxalic acid can undergo a spontaneous redox reaction with iodine.

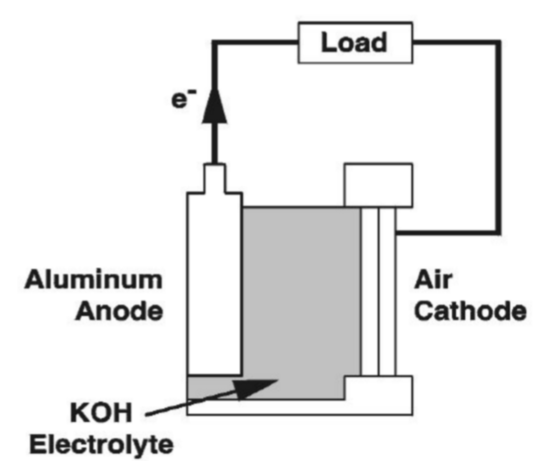
**i**. Write a balanced half-equation for the reduction of iodine. 1 mark

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**ii**. Write a balanced overall equation for the reaction between iodine and oxalic acid. 1 mark

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**iii**. What will the theoretical voltage of this cell be? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ 1 mark

**Question 4** (8 marks)

A cell that utilizes the reaction between aluminium and oxygen is commercially available. The cell has a voltage of 2.72 Volts.

The half-equation for the reaction of alumimium is

Al(s) + 3OH-(aq) 🡪 Al(OH)3(aq) + 3e-

**a. i**. What is the polarity of this electrode? 1 mark

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**ii**. How will this electrode change with time as the cell discharges? 1 mark

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**b. i**. What is half-equation for the reaction of the oxygen? 1 mark

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**ii**. Write a balanced equation for the overall reaction in this cell. 1 mark

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**c**. 1.35 g of aluminium is consumed in this cell. What mass of oxygen will have been

consumed? 3 marks

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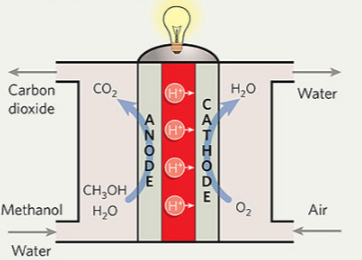
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**d**. This cell is a primary cell but it can have a longer life than most cells if the aluminium

electrode is periodically replaced. Explain why this is done. 1 mark

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**Question 5** (7 marks)

A fuel cell using methanol and oxygen is a common experimental cell. The cell operates in acidic conditions.

**a**. Use the template below to show the half equations and overall equation for this cell. 3 marks

Anode reaction : \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Cathode reaction: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Overall equation: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**b**. Determine the maximum amount of energy that could be formed from the reaction of 4.0 g of

methanol. 2 marks

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**c**. The use of this cell on a large scale will have environmental impacts. List two likely impacts. 2 marks

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**END OF KEY TOPIC TEST**