Christ Church Chemistry Department

Redox Topic Test

Time allowed: 45 minutes
No reading time

Name: ANSWERS

Marks: _____ / 43

Teacher: CEM DGM JPT NMO
(circle your teacher)

Section 1: Multiple Choice **10 marks**

1. Which one of the following is not an oxidation-reduction reaction?

✓ A. $Mg(s) + 2\,H^+(aq) \rightarrow Mg^{2+}(aq) + H_2(g)$

✓ B. $2\,Ag^+(aq) + Zn(s) \rightarrow 2\,Ag(s) + Zn^{2+}(aq)$

(C.) $Ag^+(aq) + I^-(aq) \rightarrow AgI(s)$

✓ D. $C\ell_2(g) + 2\,I^-(aq) \rightarrow 2\,C\ell^-(aq) + I_2(s)$

2. Consider the following unbalanced equation.

$$\overset{-1}{I^-}(aq) + \overset{+5}{IO_3^-}(aq) + H^+(aq) \rightarrow \overset{0}{I_2}(s) + H_2O(\ell)$$

Which one of the following statements is true?

F A. H^+ is reduced.

F B. IO_3^- is not the oxidising agent. I reduced

F C. The oxidising agent is I_2.

T (D.) I^- is the reducing agent. I⁻ oxidised.

$$\overset{+3}{As}\overset{+3}{H_3}\overset{-6}{O_3} \rightarrow \overset{+5}{As}\overset{+5}{H_3}\overset{-8}{O_4}$$

3. When arsenious acid, H_3AsO_3, is oxidized to arsenic acid, H_3AsO_4, the number of moles of electrons released per mole of arsenious acid is:

A. 1

(B.) 2

C. 3

D. 4

4. An electrochemical cell based on the following reaction has an $E^O = 1.50V$.

$$2MnO_2 + Zn + 2\,H^+ \Leftrightarrow Mn_2O_3 + H_2O + Zn^{2+}$$ Zn → Zn^{2+} + 0.76

What is the standard reduction potential for the reduction of MnO_2 (2e) to Mn_2O_3?

1.5 − 0.76

A. - 0.74 V

(B.) + 0.74 V

C. +2.26 V

D. - 2.26 V

5. Which of the following are redox reactions?

I. $O^{2-} + H_2O \rightarrow 2OH^-$

II. $H^- + H_2O \rightarrow OH^- + H_2$

III. $2H_2O_2 \rightarrow 2H_2O + O_2$

IV. $2H_2 + O_2 \rightarrow 2H_2O$

A. II and IV

B. III and IV

C. II, III and IV

D. all of them

6. In which of the following is vanadium exhibiting the highest oxidation number?

A. VO^{2+}

B. NH_4VO_3

C. $V_2(SO_4)_3$

D. VBr_4

7. A cell with an EMF of 0.40 V has the cell reaction

$2H^+(aq) + 2X^{2+}(aq) \Leftrightarrow 2X^{3+}(aq) + H_2(g)$ where X is a metal.

If the concentrations of the ions were 1.00 mol L^{-1} and the pressure of H_2 was 101.3 kPa, then the Reduction Potential (E°) for the half reaction

$X^{3+}(aq) + e^- \rightarrow X^{2+}(aq)$ would be

A. – 0.40 V

B. – 0.80 V

C. +0.40V

D. +0.80 V

8. During the electrolysis of molten sodium bromide which one of the following equations best represents the reaction at the negative electrode?

A. $Na \rightarrow Na^+ + e^-$

B. $Na^+ + e^- \rightarrow Na$

C. $2Br^- \rightarrow Br_2 + 2e^-$

D. $Br_2 + 2e^- \rightarrow 2Br^-$

9. For the reaction $H_2SO_3 + H_2O_2 \Leftrightarrow H_2SO_4 + H_2O$ the true statement is:

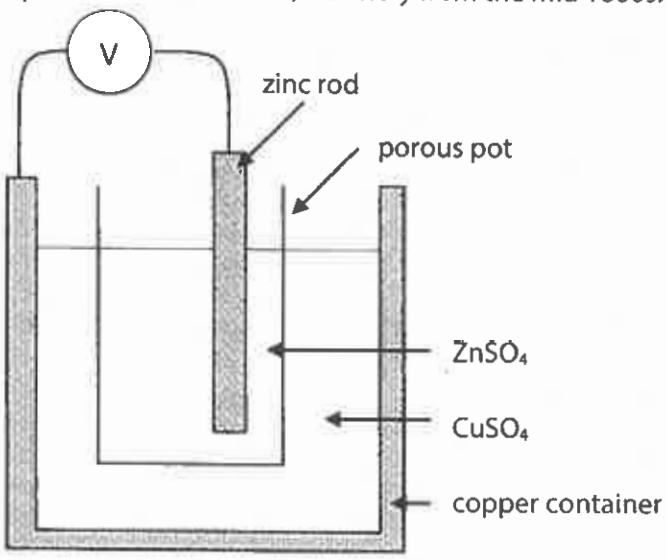
A. hydrogen peroxide is acting an an oxidant and as a reductant

B. hydrogen peroxide is acting as a reductant

C. the oxidation number of sulfur has decreased

D. the oxidation number of oxygen has decreased

10. The diagram below represents a Daniell Cell, a battery from the mid 1800s.



When the zinc rod and the copper container are connected as part of a completed electrical circuit, a current flows in this circuit. When the cell is operating, which one of the following statements is true?

A. The copper container gradually dissolves.

B. Electrons flows from the copper to the zinc through the external circuit.

C. Zinc is deposited around the zinc rod.

D. Sulfate ions migrate through the porous pot from the copper compartment to the zinc compartment.

Section 2: Short Answer **33 marks**

11. Write fully balanced, ionic equations (where possible) for any reactions that occur in the following procedures. If no reaction occurs, write 'no reaction'.

(a) Excess acidified potassium dichromate is added to propan-1-ol

Reduction half equation:

$(Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O) \times 2$

Oxidation half equation: ✓✓

$(CH_3CH_2CH_2OH + H_2O \rightarrow CH_3CH_2COOH + 4H^+ + 4e^-) \times 3$

$3CH_3CH_2CH_2OH + 3H_2O + 2Cr_2O_7^{2-} + 16H^+ + 12e^- \rightarrow 3CH_3CH_2COOH + 12H^+ + 12e^- + 4Cr^{3+} + 11H_2O$

Overall Equation:

$3CH_3CH_2CH_2OH + 2Cr_2O_7^{2-} + 16H^+ \rightarrow 3CH_3CH_2COOH + 4Cr^{3+} + 11H_2O$ ✓✓

Observation: Orange to deep green. ✓

(5 marks)

(b) Bromine water is added to potassium iodide solution.

Equation: $Br_2 + 2I^- \rightarrow 2Br^- + I_2$ ✓✓

Observation: Orange to brown ✓

(3 marks)

12. Consider the reactions below and complete the table accordingly:

Reaction 1 $+5 \quad -4 \quad +6 \quad +4 \quad +6$

$$2\,NaClO_3 + SO_2 + H_2SO_4 \rightarrow 2\,ClO_2 + 2\,NaHSO_4$$

Reaction 2 $0 \quad +5 \quad +5 \quad +4$

$$8H^+ + I_2 + 10NO_3^- \text{ ---> } 2IO_3^- + 10NO_2 + 4H_2O$$

	Redox reaction? (circle correct answer)	Explanation using oxidation number
Reaction 1	(Yes) / No	Oxidation Number of Cl in $NaClO_3$ from +5 to +4 ∴ reduced Oxidation Number of S in SO_2 to $NaHSO_4$ from +4 to +6 so oxidised
Reaction 2	(Yes) / No	O.N I_2 from 0 to +5 ∴ oxidised. O.N of N from +5 to +4 ∴ reduced.

(6 marks)

13. When chromium is added to periodic acid, H_5IO_6, the iodate ion, IO_3^-, is formed and the resulting solution turns deep green.

a) Determine the oxidation number of the iodine in:

H_5IO_6: +7 and IO_3^-: +5

(2 marks)

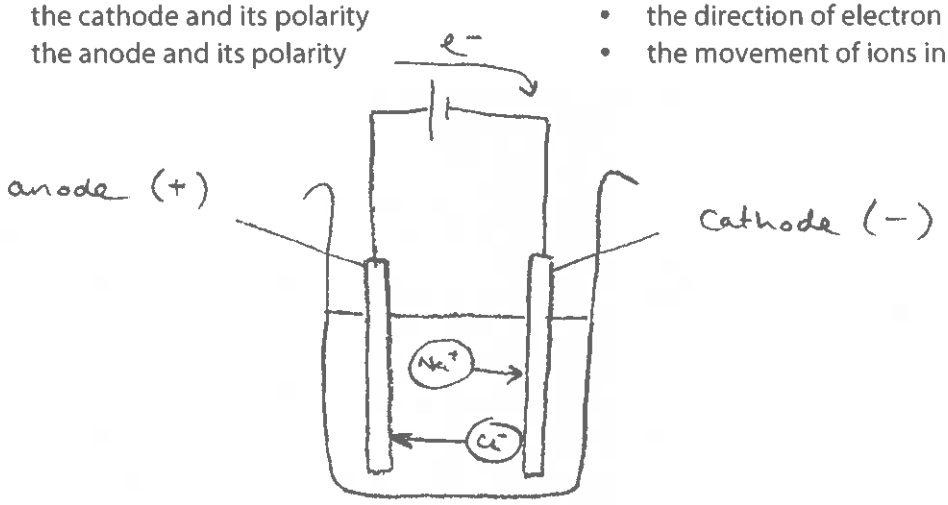
b) Using this information construct suitable fully balanced, half and overall equations.

Oxidation half-equation $Cr \longrightarrow Cr^{3+} + 3e^-$ ×2
Reduction half equation $H_5IO_6 + H^+ + 2e^- \longrightarrow IO_3^- + 3H_2O$ ×3
Overall $2Cr + 3H_5IO_6 + 3H^+ \longrightarrow 2Cr^{3+} + 3IO_3^- + 9H_2O$

(4 marks)

14. Draw a simple diagram of a suitable cell for the electrolysis of molten sodium chloride in the space below. On your diagram include the following.

- the cathode and its polarity
- the anode and its polarity
- the direction of electron flow in the wire
- the movement of ions in the cell



(4 marks)

a) Provide the oxidation and reduction reactions occurring at the electrodes

Oxidation half-equation

$2Cl^- \longrightarrow Cl_2 + 2e^-$

(1 mark)

Reduction half-equation

$Na^+ + e^- \longrightarrow Na$

(1 mark)

15. The most common type of corrosion is the redox process by which metals are oxidized by oxygen in the presence of moisture. The steel hull of a ship may be protected by having blocks of titanium attached to it. Use the standard potential table and that given below to explain this protection.

$Ti^{2+} + 2e^- \rightarrow Ti(s)$ $\quad E°=-1.60V$

$Fe \longrightarrow Fe^{2+} + 2e^- \quad E^\circ = +0.44\,V$

$O_2 + 2H_2O + 4e^- \longrightarrow 4OH^- \quad E^\circ = +0.4$ ✓

~~Oxidation of Ti happens more readily ($E^\circ = +1.6V$)~~ ✓ (or stronger reductant)

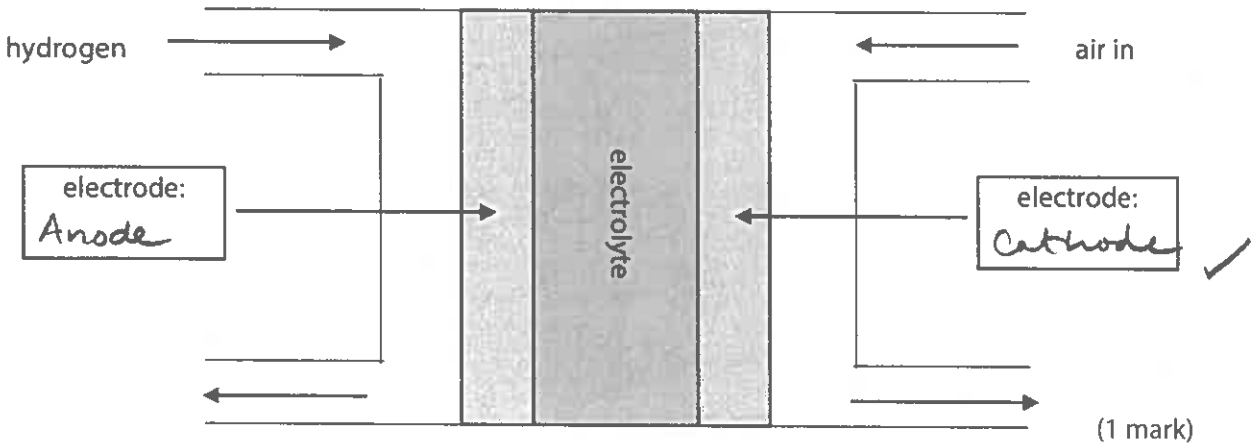
than iron ∴ Ti acts as anode ✓. Fe acts as

cathode for reduction of O_2 ✓

(3 marks)

16. The hydrogen fuel cell is shown in diagrammatic form below. The electrolyte used in this cell has a pH less than 7 and the external circuit is not shown.

a) Label the anode and cathode in the correct box.



(1 mark)

b) Complete the equations for:

the anode:

$H_2 \longrightarrow 2H^+ + 2e^-$ ($E^\circ = 0$)

(1 mark)

the cathode:

$O_2 + 4H^+ + 4e^- \longrightarrow 2H_2O$ ($E^\circ = +1.23$)

(1 mark)

c) What would the cell voltage generated by this cell be assuming standard conditions?

+ 1·23 ✓

(1 mark)

END OF TEST