Christ Church Grammar School

Year 12 Chemistry

Redox test
2018

Time allowed: **45 minutes**

Name: Answers

Mark = .../45

Teacher:

KLW   CEM   JPT   NMO

Section 1   Multiple Choice   **10 marks**

1.   In which of the following is sulfur in the highest oxidation state (oxidation number)?

   A. $S_2O_6^{2-}$ 7 5
   B. $S_2O_4^{2-}$ × 3
   C. $S_2O_8^{2-}$ +8 7
   D. $S_4O_6^{2-}$ +2½

2.   Which of the following contains nitrogen with an oxidation number of +5?

   A. N_2H_4 −2
   B. $(NH_4)_3PO_4$ −3
   C. $Ba(\underline{N}O_3)_2$ +5
   D. $Al(NO_2)_3$ +3

3.   Which of the following are redox reactions?

   I.   ✓ $Ca + 2HCl \rightarrow CaCl_2 + H_2$
   II. × $CaO + 2HCl \rightarrow CaCl_2 + H_2O$
   III. × $Ca(OH)_2 + 2HCl \rightarrow CaCl_2 + 2H_2O$
   IV. × $CaCO_3 + 2HCl \rightarrow CaCl_2 + CO_2 + H_2O$

   A.   I only
   B.   II, III and IV only
   C.   I and IV only
   D.   all of them

   The following 3 questions refer to a galvanic cell comprising a Ag(s)/Ag$^+$(aq) half-cell and a Co(s)/Co^{2+}(aq) half-cell under standard conditions

4.   What will be the voltage of the galvanic cell?

   A.   0.52V
   B.   0.80V
   C.   -0.28V
   D.   1.08V

5.   During the operation of the cell, which of the following will occur?

   A. × The mass of the cathode will decrease
   B. × The concentration of Ag$^+$(aq) will increase
   C. × Electrons will flow from the Ag electrode to the Co electrode
   D. ✓ Anions flow to the Co(s)/Co^{2+}(aq) half-cell through the salt bridge.

6.   If a student used aqueous sodium carbonate for his salt bridge, which of the following would you be most likely to observe?

   A.   The voltage of the cell would drop and a yellow precipitate would form in one of the half cells.
   B.   The voltage of the cell would drop and a pink precipitate would form in one of the half cells.
   C.   The voltage of the cell would be unchanged and a yellow precipitate would form in one of the half cells.
   D.   The voltage of the cell would be unchanged and a ~~yellow~~ pink precipitate would form in one of the half cells.

※ B + D allowed
(actually voltage will increase !!)

7. Which of the following is true of galvanic cells?

    A. ✗ The overall reaction is an endothermic process.
    B. ✗ Electrical energy is converted into chemical potential energy.
    C. ✗ Electrical energy is required to overcome the activation energy.
    Ⓓ The enthalpy of the products is lower than that of the reactants.

8. How many electrons are transferred when 2 moles of thiosulfate ions ($S_2O_3^{2-}$) are converted into sulfate ions (SO_4^{2-})

    Ⓐ   ⑯ $S_2O_3^{2-} + 5H_2O \rightarrow \big[SO_4^{2-} + 10H^+ + 8e^-$
    B.   8.
    C.   4.
    D.   2.
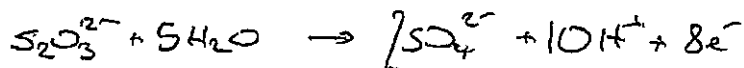
9. Which of the following is true for electrolytic cells?

    A. ✗ Cations in the electrolyte flow towards the anode.
    B. ✗ Oxidation occurs at the negative electrode.
    Ⓒ ✓ Electrons flow from the anode to the cathode through the external circuit.
    D. ✗ A salt bridge is not used because of the high temperatures.

10. Which of the following is true about $1.0\,molL^{-1}$ hydrogen peroxide solution

    I.   ✓ It can decompose into water and $O_2(g)$
    II. ✓ It can be reduced by $Mn^{2+}(aq)$.
    III. ✓ It can oxidise $Mn^{2+}(aq)$.
    IV. ✓ It can be reduced by Mn.

    A.   I and II
    B.   III and IV
    C.   II, III and IV
    Ⓓ   all of them

Question 11   **(10 marks)**

Write balanced half-equations and a full equation that account for the following observations.

(a)   A colourless solution reacts with a pale pink solution and the solution turns purple.

Oxidation half equation	$Mn^{2+} + 4H_2O \longrightarrow MnO_4^- + 8H^+ + 5e^-$ (x4) ✓
Reduction half equation	$H_2O_2 + 2H^+ + 2e^- \longrightarrow 2H_2O$ (x5) ✓
Full redox equation	$2Mn^{2+} + 5H_2O_2 \longrightarrow 2MnO_4^- + 6H^+ + 2H_2O$ ✓

(4)

(b)   When nitrate ions are added to dithionate ($S_2O_4^{2-}$) ions, sulfate ions are formed and a brown gas is given off.

Oxidation half equation	$S_2O_4^{2-} + 4H_2O \longrightarrow 2SO_4^{2-} + 8H^+ + 6e^-$ (x1) ✓
Reduction half equation	$NO_3^- + 2H^+ + e^- \longrightarrow NO_2 + H_2O$ (x6) ✓
Full redox equation	$S_2O_4^{2-} + 6NO_3^- + 4H^+ \longrightarrow 2SO_4^{2-} + 6NO_2 + 2H_2O$ ✓

(6)

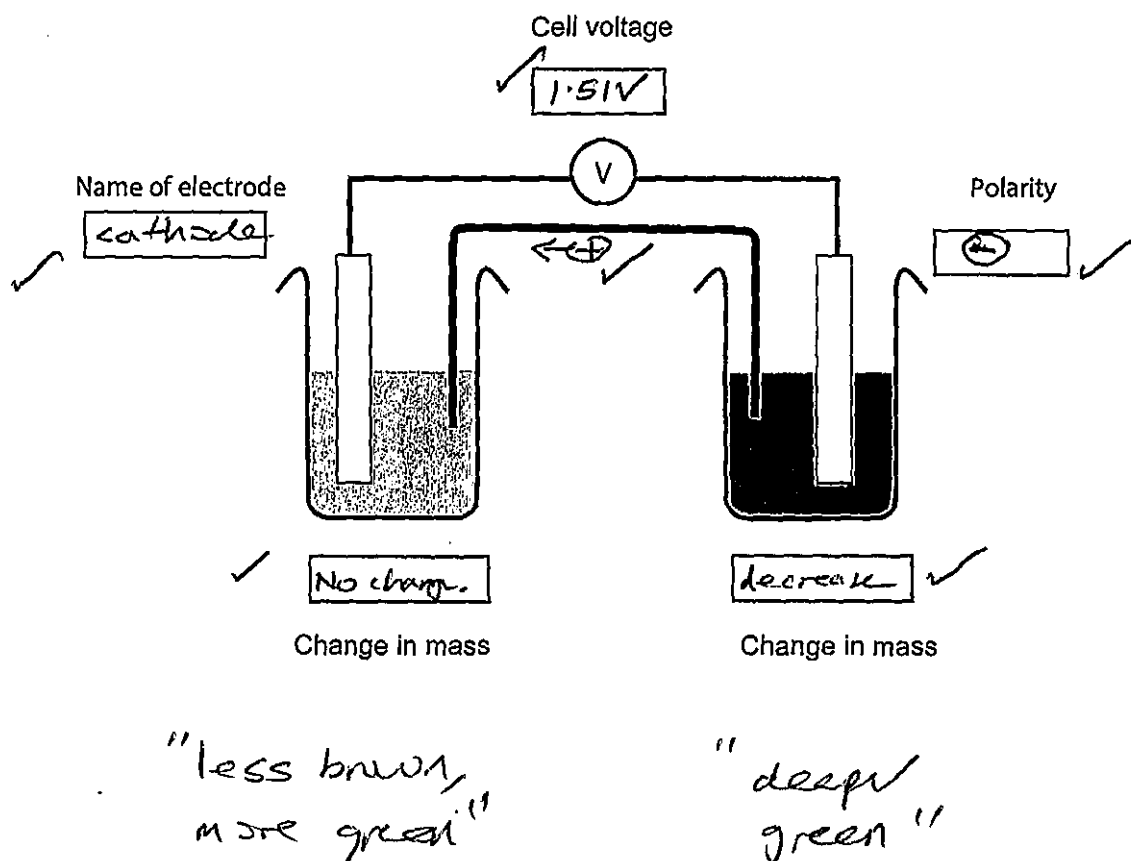**Question 12**   (6 marks)

An galvanic cell is constructed as follows. In the half-cell on the left, a platinum electrode is placed into a solution that contains both $1.00molL^{-1}$ $Fe^{2+}(aq)$ and $1.00molL^{-1}$ $Fe^{3+}(aq)$. In the half-cell on the right, a chromium electrode is placed in a solution of $1.00molL^{-1}$ $Cr^{3+}(aq)$. Complete the diagram below, indicating the following in the relevant spaces provided.

- Name of the left-hand electrode (anode or cathode).
- Polarity of the right-hand electrode (+ or -).
- Direction of flow of cations in the external circuit.
- Observation at each electrode
- Change in mass of each electrode (increase, decrease, no change)
- Cell voltage

Cell voltage

✓ $\boxed{1·51V}$

Name of electrode   Polarity

✓ $\boxed{cathode}$ $\boxed{\ominus}$ ✓

✓ $\boxed{No\ change.}$ $\boxed{decrease}$ ✓

Change in mass   Change in mass

"less brown,
more green"

"deep
green"
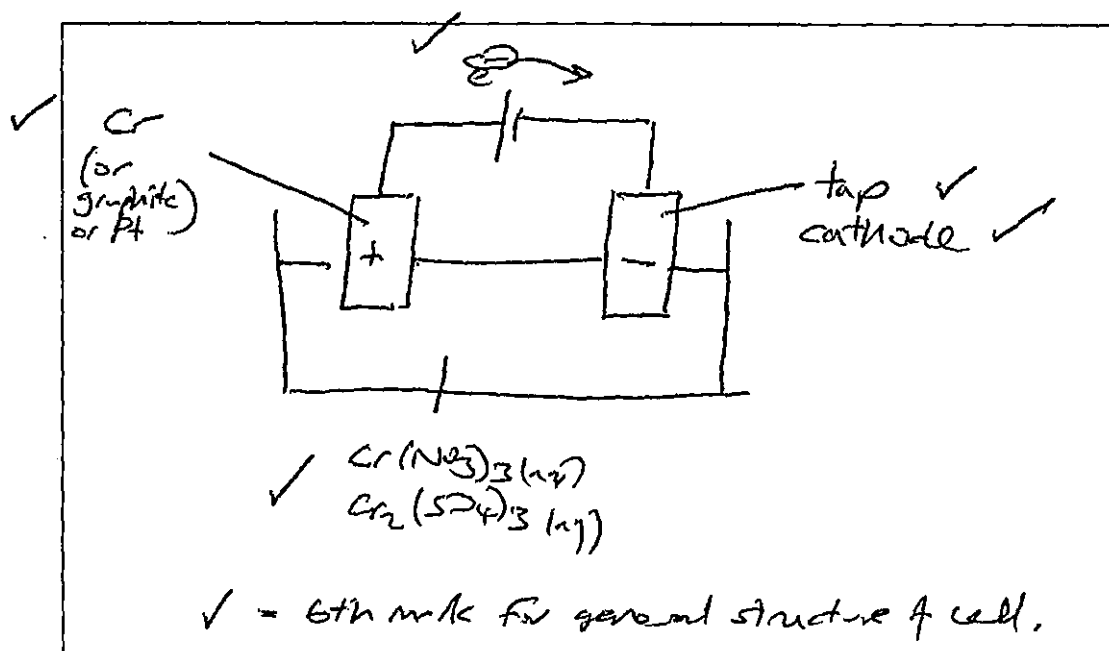
Question 13   **(6 marks)**

Chromium is a corrosion resistant metal and chrome plating is a method of coating iron objects with chromium. It is similar to the silver plating of cutlery.

Draw a diagram below to show a cell that would be suitable for conducting this process on a kitchen tap fitting. In addition to the general layout of the cell, clearly indicate the following
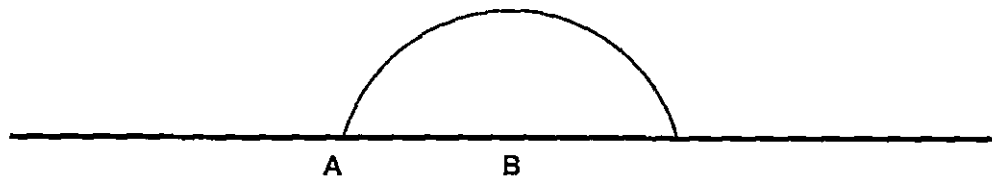
- The electrode that is the tap
- The most suitable material for the other electrode
- The anode and cathode
- The direction of flow of electrons
- A suitable solution for the electrolyte

Question 14   **(5 marks)**

Below is a simplified diagram of a drop of water on an iron surface.

A   B

Write 'true' or 'false' in the boxes below alongside the following statements

Statement	True or False
Loss of iron metal will most likely be seen at location A	False
B is a cathodic area	False
Electrons will flow through the iron from B to A	True
During the corrosion process, Fe(s) is oxidised to Fe^{2+}(aq) and O_2(g) is reduced to OH^-(aq)	True
The red/brown colour of the rust is due $Fe(OH)_2$(s)	False

7

Question 15 (8 marks)
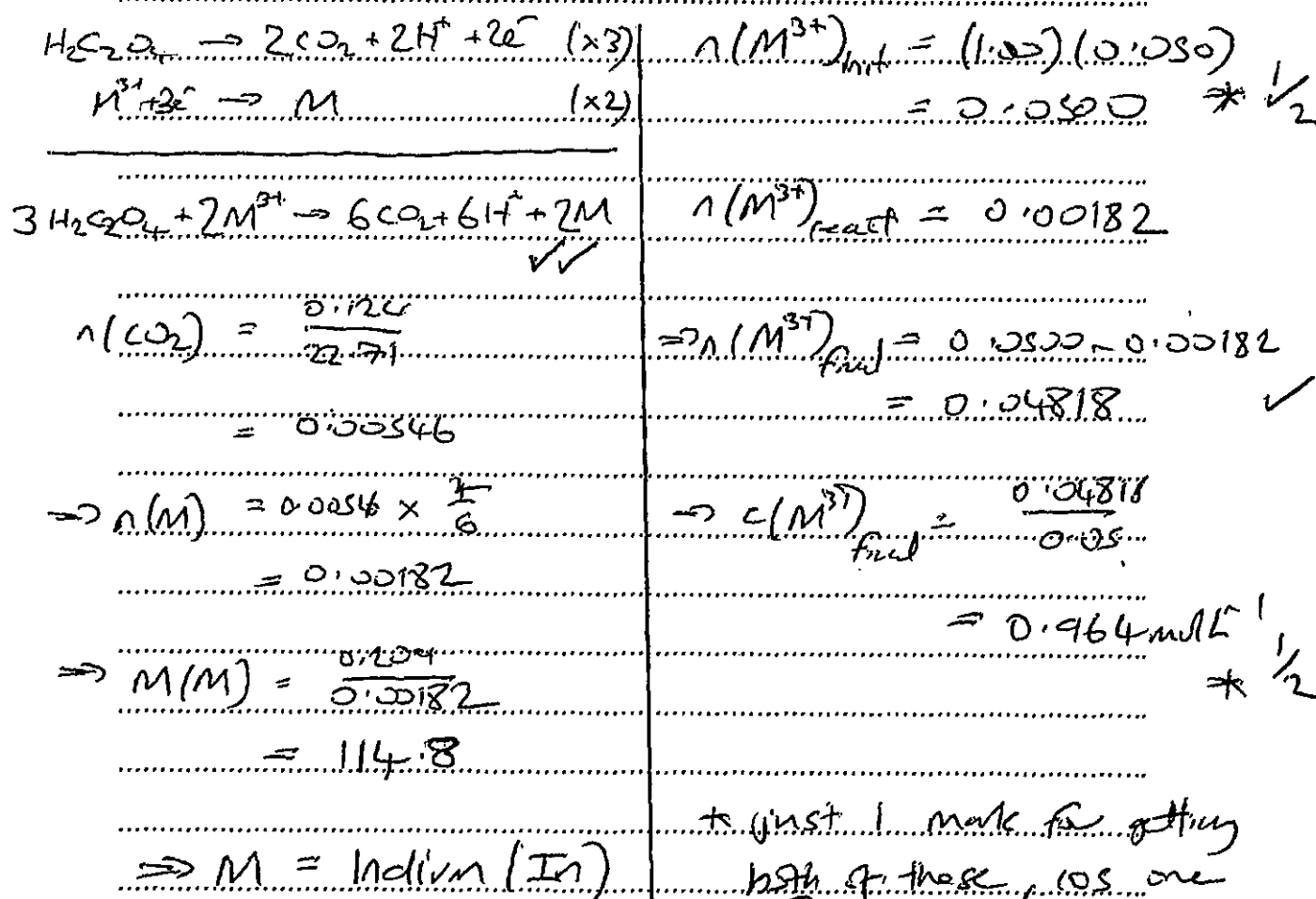
A galvanic cell is set up as follows. One half cell consists of a 50.0mL solution of 1.00molL^{-1} oxalic acid ($H_2C_2O_4$) and a platinum electrode. The other half cell consists of an electrode made of unknown metal (M) and 50.0mL of a solution of its 1.00molL^{-1} M^{3+}(aq) ions.

During operation of the cell, 124mL (measured at STP) of a colourless gas was given off at the anode and the mass of the M electrode increased by 0.209g.

Identify metal M and calculate the final concentration of M^{3+}(aq) ions in the M^{3+}(aq)/M(s) half cell after the cell had operated. Put your answers in the boxes below, showing your working in full underneath.

Metal M	Indium (In)
Final concentration of M^{3+}(aq)	0.964 molL^{-1}

$H_2C_2O_4 \rightarrow 2CO_2 + 2H^+ + 2e^-$ (×3)

$M^{3+} + 3e^- \rightarrow M$ (×2)

$3H_2C_2O_4 + 2M^{3+} \rightarrow 6CO_2 + 6H^+ + 2M$ ✓✓

$n(CO_2) = \dfrac{0.124}{22.71}$

$= 0.00546$

$\Rightarrow n(M) = 0.00546 \times \dfrac{2}{6}$

$= 0.00182$

$\Rightarrow M(M) = \dfrac{0.209}{0.00182}$

$= 114.8$

$\Rightarrow M = $ Indium (In)

$n(M^{3+})_{init} = (1.00)(0.0050)$

$= 0.0500$ ✱ ½

$n(M^{3+})_{react} = 0.00182$

$\Rightarrow n(M^{3+})_{final} = 0.0500 - 0.00182$

$= 0.04818$ ✓

$\Rightarrow c(M^{3+})_{final} = \dfrac{0.04818}{0.05}$

$= 0.964$ molL^{-1} ½

✱ just 1 mark for getting both of these, cos one operation is +V, the other is just the reverse, × V.

END OF TEST