CHRIST CHURCH GRAMMAR SCHOOL

MULTIPLE CHOICE ANSWER SHEET

Year 12 Chemistry   Trial Exam 2008

NAME : _____   TEACHER: _____

Answer all multiple choice questions on this sheet by crossing out one of the letters

e.g. [A]   [B]   [C]   [D]

1	*[A]*	[B]	[C]	[D]
2	[A]	[B]	*[C]*	[D]
3	*[A]*	[B]	[C]	[D]
4	[A]	[B]	*[C]*	[D]
5	*[A]*	[B]	[C]	[D]
6	[A]	[B]	*[C]*	[D]
7	[A]	[B]	*[C]*	[D]
8	*[A]*	[B]	[C]	[D]
9	[A]	[B]	[C]	*[D]*
10	[A]	*[B]*	[C]	[D]
11	[A]	*[B]*	[C]	[D]
12	[A]	[B]	[C]	*[D]*
13	[A]	[B]	*[C]*	[D]
14	*[A]*	[B]	[C]	[D]
15	[A]	[B]	*[C]*	[D]

16	[A]	[B]	*[C]*	[D]
17	*[A]*	[B]	[C]	[D]
18	[A]	*[B]*	[C]	[D]
19	[A]	[B]	*[C]*	[D]
20	[A]	[B]	*[C]*	[D]
21	*[A]*	[B]	[C]	[D]
22	[A]	*[B]*	[C]	[D]
23	[A]	[B]	[C]	*[D]*
24	[A]	[B]	*[C]*	[D]
25	*[A]*	[B]	[C]	[D]
26	*[A]*	[B]	[C]	[D]
27	*[A]*	[B]	[C]	[D]
28	*[A]*	[B]	[C]	[D]
29	[A]	[B]	*[C]*	[D]
30	[A]	[B]	[C]	*[D]*

PART 2 **(70 marks = 35% of paper)**

Answer ALL questions in Part 2 in the spaces provided below.
_____

1.   Write equations for any reactions that occur in the following procedures. If no
        reaction occurs write 'no reaction'.

        In each case describe in full what you would observe, including any colours, odours,
        precipitates (give the colour) and gases evolved (give the colour or describe as
        colourless). If no change is observed you should state this.

(a)   Chlorine gas is bubbled through a solution of iron (II) nitrate.

Equation $Cl_2(g) + 2 Fe^{2+}(aq) \rightarrow 2 Fe^{3+}(aq) + 2 Cl^-(aq)$ ✓✓

Observation   **pale green solution turns brown**   ✓

(b)   Dilute sulfuric acid is mixed with a solution of lead (II) nitrate.

Equation $SO_4{}^{2-}(aq) + Pb^{2+}(aq) \rightarrow PbSO_4(s)$ ✓✓

Observation   **white ppt formed**   ✓

c)   Potassium metal is placed is water.

Equation $2 K(s) + 2 H_2O(l) \rightarrow H_2(g) + 2 K^+(aq) + 2 OH^-(aq)$ ✓✓

Observation   **silver solid dissolves rapidly, c/o gas evolves**   ✓

d)   An excess of 6 mol L^{-1} ammonia solution is added silver oxide.

Equation $4 NH_3(aq) + Ag_2O(s) + H_2O(l) \rightarrow 2 [Ag(NH_3)_2]^+(aq) + 2 OH^-(aq)$ ✓✓

Observation   **brown (white) solid dissolves**   ✓

                                                                        [4 x 3 = 12 marks]

2.   Atom A can be bonded covalently to a number of atoms of X and may also have some valence electrons left over as lone pairs.
For each situation specified in the table below, use electron pair repulsion theory to predict the shape of the molecule.

In each case give an example of a molecule that possesses your predicted shape. (A and X may be different for each case)

The first row is an example

Description	Shape of Molecule (name or sketch)	Example
AX	Linear	HF
AX_3 with one lone pair on atom A	**Pyramidal**	**NH_3**
AX_3 with no lone pairs on atom A	**Trigonal Planar**	**BF_3, SO_3**
AX_2 with one lone pair on atom A	**V-shape**	**SO_2**
AX_2 with no lone pairs on atom A	**Linear**	**CO_2**

                                          1 mark each   [8 marks]

3.   Give the name or formula of a substance that matches the following descriptions:

      (a)   the substance used to galvanise iron objects   **Zinc**   ✓

      (b)   a metal which does not react with dilute HCl(aq)   **Cu, Ag, Au, Pt**   ✓

      (c)   the Group 4 hydride which has the lowest melting point   **CH_4**   ✓

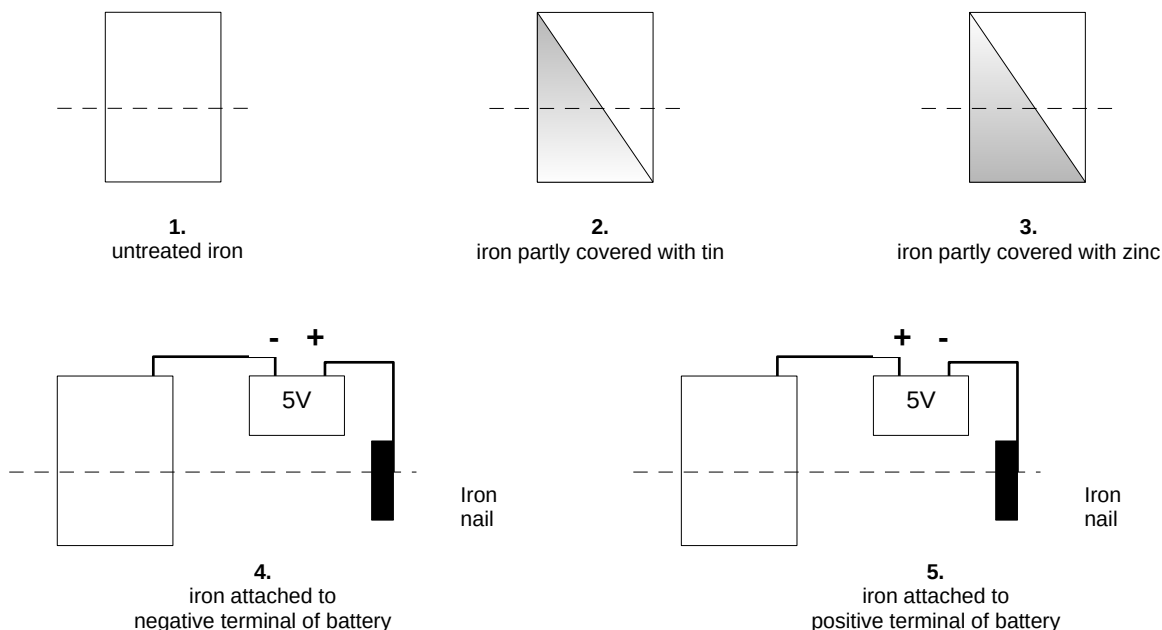   [3 marks]

4.   An electric current is passed through a 1 mol L^{-1} sulfuric acid solution using carbon electrodes. Write a half-equation for the reaction occurring at each electrode:

      Negative electrode   **$2\ H^+(aq)\ +\ 2\ e^-\ \rightarrow\ H_2(g)$**   ✓

      Positive Electrode   **$2\ H_2O(l)\ \rightarrow\ O_2(g)\ +\ 4\ H^+(aq)\ +\ 4\ e^-$**   ✓
                                                                    [2 marks]

5. A group of students decided to conduct a mini-research project on **methods of preventing corrosion** of iron structures in a salt water environment. A number of iron plates, numbered 1 to 5, were placed in sea water as shown below.

1.
untreated iron

2.
iron partly covered with tin

3.
iron partly covered with zinc

4.
iron attached to
negative terminal of battery

5.
iron attached to
positive terminal of battery

(a) Which two plates showed the least degree of corrosion? Give reasons.

Plates 3 and 4 show the least corrosion.

Plate 3 is protected by zinc which acts as a sacrificial anode. The zinc has a greater tendency to lose electrons (stronger reducing agent, more active metal) than iron, therefore it will become the anode of an electrochemical cell and corrodes instead of the iron which becomes the cathode, site of reduction and does not corrode until all zinc has corroded   ✓✓

Plate 4 cannot corrode (lose electrons) because it is continually being supplied with electrons from the battery, so it becomes the cathode of an electrolytic cell. The iron nail (scrap iron) becomes the anode and it loses electrons and corrodes (sacrificial anode).   ✓✓

(b) Which two plates showed the **greatest** degree of corrosion? Give reasons.

Plates 2 and 5 show the most corrosion.

In Plate 2 the iron acts as a sacrificial anode as it has a greater tendency to lose electrons (stronger reducing agent, more active metal) than tin, therefore the iron is oxidized in preference to the tin.   ✓✓

Plate 5 has accelerated corrosion due to electrons being removed from the iron plate by the positive terminal of the battery. Thus the reaction $Fe_{(s)} \rightarrow Fe^{2+}_{(aq)} + 2e^-$ is most likely to occur and corrosion results. ✓✓

[4,4 marks]

6.   Hydrazoic acid (hydrogen azide), HN_3, is a weak electrolyte.

   (a)   Write an equation for the ionisation of hydrazoic acid in water.

           $HN_3(aq) + H_2O(l) \rightleftharpoons H_3O^+(aq) \ N_3^-(aq)$ ✓ [1 mark]

   (b)   How would the pH of 0.1 mol L^{-1} hydrazoic acid compare to the pH of
           0.1 mol L^{-1} HCl and why?

           Comparison (higher, lower, same)   **Higher**   ✓

           Explanation

           **Since HCl is a strong acid and hydrolyses 100%, $[H^+] = 0.1$ and $pH = -\log[H^+]$,
           then pH of HCl = 1** ✓
           Since HN_3 is a weak electrolyte then $[H^+] << 0.1$, hence $pH > 1$ ✓   [3 marks]

   (c)   What will happen to the pH of a hydrazoic acid solution if a small quantity of solid
           sodium azide (NaN_3) is added to the acid? Give an explanation for your answer.

   Effect on pH   **increase**   ✓

           Explanation

           **The solid will dissolve producing $N_3^-(aq)$ which will cause the above
           equilibrium to shift left,** ✓ **therefore decreasing the $[H^+]$** ✓ **and hence
           increasing the pH**   [3 marks]

   (d)   Name a suitable indicator for the titration of 0.1 mol L^{-1} hydroazoic acid against
           0.1 mol L^{-1} sodium hydroxide solution. Give an explanation for your choice.

           Indicator used   **phenolphthalein**   ✓
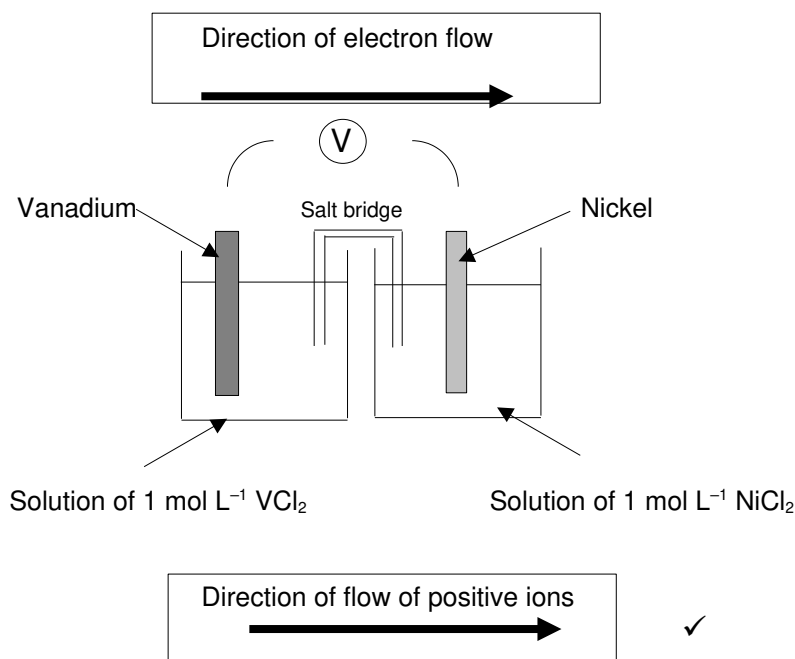
           Explanation

           The reaction between hydrazoic acid and sodium hydroxide is:

              $HN_3(aq) + OH^-(aq) \rightleftharpoons H_2O(aq) + N_3^-(aq)$ ✓
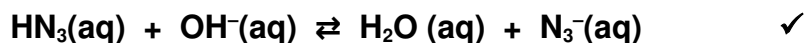
           **The $N_3^-(aq)$ will hydrolyse accepting a proton from water forming hydroxide
           ions, the equivalence point will be basic and phenolphthalein changes colour
           in the basic range.**   ✓   [3 marks]

                                                                        [total 10 marks]

7.   An electrochemical cell was set up as shown below:

The cell was allowed to operate for about 15 minutes and, during this time, it was noticed that a dark coloured solid was deposited on the nickel electrode, and the green colour of the nickel chloride solution faded.

(a)   Give the half-equation for the reaction occurring in the nickel half-cell.

$Ni^{2+}(aq) + 2e^-(aq) \rightarrow Ni(s)$ ✓

(b)   Which electrode in the anode?   **Vanadium**   ✓

(c)   Which is the stronger oxidant, V^{2+} or Ni^{2+} ?   **Ni^{2+}**   ✓

(d)   In the box provided on the diagram, mark the direction of electron flow in the external circuit.

(e)   In the box provided on the diagram, mark the direction of the positive ion flow in the cell.

(f)   At the beginning of the experiment the E.M.F generated by the cell was 0.92 volts. Use this information to determine the standard reduction potential (E^0) for the reaction: $V^{2+}(aq) + 2e^- \rightarrow V(s)$

0.92   = $E°_{red} - E°_{ox}$
**   = $-0.26 - E°_{ox}$**
$E°_{ox}$ = $-0.26 - 0.92$
**   = -1.18 V**   ✓

[1 each = 6 marks]

8. Phosgene is prepared from the reaction of carbon monoxide and chlorine in the presence of an activated carbon catalyst.

$$CO_{(g)} \; + \; Cl_{2(g)} \; \rightleftharpoons \; COCl_{2(g)}$$
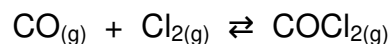
The following graph shows what happens when all three gases are mixed in the presence of the catalyst:
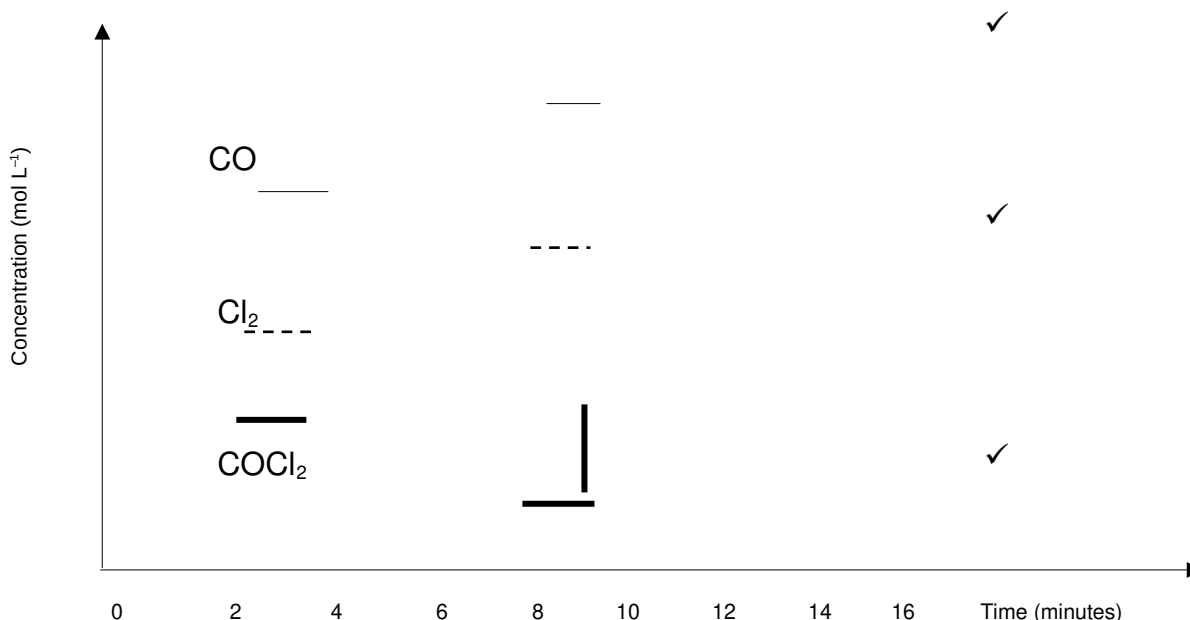
(a) How would you describe the system 3 minutes after mixing?

At equilibrium   ✓   [1 mark]

(b) At 4 minutes after mixing the temperature is decreased to a constant value. From the system's response as shown above deduce whether the reaction, as written, is endothermic or exothermic. Briefly explain your reasoning.

From the graph more reactants are formed therefore the equilibrium has

shifted left. ✓

A temperature decrease favours the exothermic reaction hence the reverse

**reaction is exothermic ✓ and so the forward is ENDOTHERMIC✓**

[3 marks]

(c) At 10 minutes after mixing, extra phosgene ($COCl_2$) was rapidly introduced in the system at constant temperature and volume. Show on the graph the effect of this change, on the concentration of the three gases. Assume that he system reaches equilibrium at about 14 minutes.

[3 marks]

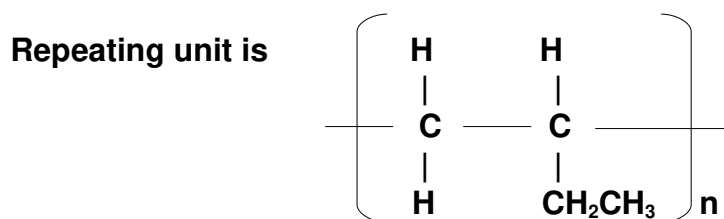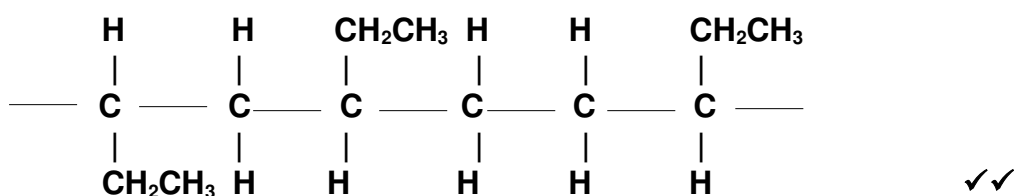9.   (a)   Give the I.U.P.A.C name of the following organic molecules:

CH$_3$–CH$_2$–CH–CH=C–CH$_3$ CH$_3$–CH–CHO
             | | |
            CH$_3$ CH$_2$CH$_3$ F
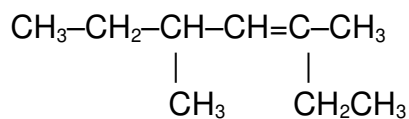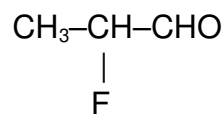
3,5–dimethyl–3–heptene ✓   **2–fluoropropanal** ✓

[2 marks]

(b)   Draw the structure of the polymer formed from 1-butene. At least three
monomer units are required.   [2 marks]

Repeating unit is

(b)   Name the organic reactant and the reagent required to make propanone.

Reactant   **2-propanol**   ✓

Reagent   **acidified KMnO$_4$ or acidified K$_2$Cr$_2$O$_7$**   ✓

(c)   Draw the structure of and name the organic product of reacting methanoic
acid and 2-butanol in the presence of an acid catalyst.
[2 marks]

Name   **2–butylmethanoate**   ✓

Structure   **O   CH$_3$**
                                       || |
                       H – C – O – CH – CH$_2$ – CH$_3$ ✓

[total 8 marks]

10.   Consider the following substances and their melting points:

carbon tetraiodide 171°C ;   hydrogen iodide –51°C ;   iodine 114°C.

Explain the difference in their melting points.

All three are covalent molecular solids. For melting to occur the

intermolecular bonds must be disrupted and so melting point depends on the

strength of the IMF. ✓

$CI_4 > I_2$

Both CI_4 and I_2 are non-polar molecules with only weak dispersion forces

between molecules. ✓ **The strength of dispersion forces increase as the**

number of electrons in the molecule increases (hence molar mass) and so CI_4

(M_r = 519.61) has a higher melting point than I_2 (Mr = 253.8) ✓

$I_2 > HI$

HI is a polar molecule with both dipole-dipole and dispersion forces acting

between molecules. ✓ **For molecules of similar molar mass dipole-dipole**

interactions are stronger than dispersion forces ✓ **but since the M_r of I_2 is**

approximately 2 x M_r HI, I_2 has much stronger dispersion forces and in this

case outweigh the dipole-dipole + dispersion force in HI. ✓

[6 marks]

End of Part 2

PART 3   **(50 marks = 25% of paper)**

1. $m(FeS_2) = 1250 \times 92.4/100 = 1155$ kg $= 1\ 155\ 000$ g   ✓

        $n(FeS_2) = m/M = 1\ 155\ 000\ /\ 119.97 = 9627$ mol   ✓

        $n(Na_2S_2O_7) = n\ (FeS_2) = 9627$ mol   ✓✓

        $m(Na_2S_2O_7) = n.M = 9627 \times 222.1 = 2138$ kg   ✓

        % efficiency $= 1620\ /\ 2138 \times 100 = \underline{75.8\%}$ ✓

           or

        $m(FeS_2) = 1250 \times 92.4/100 = 1155$ kg   ✓

        $n(Na_2S_2O_7) = m/M = 1620\ /\ 222.1 = 7294$ mol   ✓

        $n(FeS_2) = n(Na_2S_2O_7) = 7294$ mol   ✓✓

        $m(FeS_2) = n.M = 7294 \times 119.97 = 875$ kg   ✓

        % efficiency $= 875\ /\ 1155 \times 100 = \underline{75.8\%}$ ✓

2.   (a) $n(C) = n(CO_2) = V/22.41 = 4.21 / 22.41 = 0.188$ mol   ✓

              $m(C) = n.M = 0.188 \times 12.01 = 2.26$ g

              $n(H) = 2 \times n(H_2O) = 2 \times m/M = 2 \times 3.39 / 18.016 = 0.376$ mol   ✓

              $m(H) = n.M = 0.376 \times 1.008 = 0.379$ g

              $m(O) = 4.14 - m(C) - m(H) = 1.50$ g

              $n(O) = m/M = 1.50 / 16 = 0.0938$ mol   ✓✓

	C	:	H	:	O
	0.188	:	0.376	:	0.0938
			0.0938		
	2	:	4	:	1

                                                          ✓

              $EF = C_2H_4O$ ✓
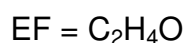
     (b) $n = PV/RT = (102 \times 1.12) / (8.315 \times 443.1) = 0.0310$ mol   ✓

              $M = m/n = 2.73 / 0.0310 = 88.06$ g mol^{-1} ✓

              $M/EFM = 88 / 44 = 2$

              $MF = 2 \times EF = C_4H_8O_2$ ✓

     (c) $MF \Rightarrow$ carboxylic acid or ester
              No reaction with Na_2CO_3 ∴ ester

              One of:

                                               O
                                               ‖
              methyl propanoate $CH_3CH_2C–O–CH_3$

                                            O
                                            ‖
              ethyl ethanoate $CH_3C–O–CH_2CH_3$

                                            O
                                            ‖
              propyl methanoate $H_2C–O–CH_2CH_2CH_3$

                                            O
                                            ‖
              propyl methanoate $H_2C–O–CH(CH_3)_2$

                     ✓   ✓

3.   (a) $Cu \rightarrow Cu^{2+} + 2e^-$
              $m(Cu) = m/M = 2.53 /63.55 = 0.0398$ mol   ✓

$n(e^-) = 2 \times n(Cu) = 0.0796$ mol   ✓

$Q = n(e^-) \times 96490 = 7683$ C   ✓

$I = Q/t = 7683 / 2400 = \underline{3.20\ A}$ ✓

(b) $n(In) = m/M = 3.05 / 114.8 = 0.0266$ mol   ✓

$n(e^-) / n(In) = 0.0796 / 0.0266 = 3$ ✓

$\therefore \quad In^{3+} / +3$ ✓

(c)   Cell 1 $2\ H_2O + 2\ e^- \rightarrow H_2 + 2\ OH^-$

$n(H_2) = 1/2\ n(e^-) = 0.0398$ mol   ✓

Cell 2 $2\ Cl^- \rightarrow Cl_2 + 2\ e^-$

$n(Cl_2) = 1/2\ n(e^-) = 0.0398$ mol   ✓
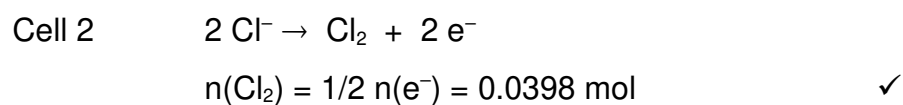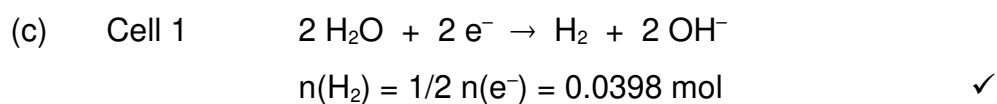
$n(gas) = n(H_2) + n(Cl_2) = 0.0796$ mol   ✓

$V(gas) = nRT/P = (0.0796 \times 8.315 \times 297.1)/100.9$

$= \underline{1.95\ L}$ ✓✓

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4. $V(S_2O_3^{2-})_{average}$ = (15.30 + 15.25)/2 = 15.27 mL   ✓

        $n(S_2O_3^{2-})$ = c.V = 0.00120 x 0.01527 = 1.833×10^{-5} mol   ✓

        $n(I_3^-)_{20mL}$ = 1/2 $n(S_2O_3^{2-})$ = 9.165×10^{-6} mol   ✓

        $n(I_3^-)_{total}$ = 9.165×10^{-6} x 150/20 = 6.874×10^{-5} mol   ✓

        $n(Mn^{3+})$ = 2 x $n(I_3^-)$ = 1.375×10^{-4} mol   ✓

        $n(Mn(OH)_3)$ = $n(Mn^{3+})$ = 1.375×10^{-4} mol   ✓

        $n(O_2)$ = 1/4 $n(Mn(OH)_3)$ = 3.437×10^{-5} mol   ✓

        $m(O_2)$ = n.M = 3.437×10^{-5} x 32 = 1.10×10^{-3} g   ✓

        1.10 mg / 0.1 kg = 11.0 ppm   ✓✓

5. $6\ Fe^{2+}\ +\ Cr_2O_7^{2-}\ +\ 14\ H^+\ \rightarrow\ 6\ Fe^{3+}\ +\ 2\ Cr^{3+}\ +\ 7\ H_2O$

        $n(Cr_2O_7^{2-})$ = c.V = 0.0168 x 0.01831 = 3.08×10^{-4} mol   ✓

        $n(Fe^{2+})$ = 6 x $n(Cr_2O_7^{2-})$ = 1.85×10^{-3} mol   ✓✓

        $m(Fe)$ = n.M = 1.85×10^{-3} x 55.85 = 0.103 g   ✓

        %(Fe) = 0.103 / 2.401 x 100 = <u>4.29%</u>   ✓

        $n(MnO_4^-)$ = c.V = 0.1097 x 0.02596 = 2.85×10^{-3} mol   ✓

        $n(C_2O_4^{2-})_{50mL}$ = 5/2 x $n(MnO_4^-)$ = 7.12×10^{-3} mol   ✓

        $n(C_2O_4^{2-})_{total}$ = 7.12×10^{-3} x 250/50 = 0.0356 mol   ✓

        $n(Ca)$ = $n(C_2O_4^{2-})$ = 0.0356 mol   ✓

        $m(Ca)$ = n.M = 0.0356 x 40.08 = 1.43 g   ✓

        %(Ca) = 1.43 / 7.00 x 100 = <u>20.4%</u>   ✓

End of Part 3

PART 4 **(20 marks = 10% of paper)**

Answer the following extended answer question. Where applicable use equations, diagrams and illustrative examples of the chemistry you are describing.

Marks are awarded for the relevant chemical content of your answer, but you will lose marks if what you write is unclear or lacks coherence.

Give an account of the chemistry of water.

You may discuss all aspects of the chemistry of water that you have studied, making particular reference to the points and data below.

- Structure, bonding and intermolecular forces in water

substance	molar mass (g mol^{-1})	melting point (K)
methane, CH_4	16	91
ammonia, NH_3	17	195
water, H_2O	18	273
hydrogen fluoride, HF	20	190

- Chemical equilibrium and the effect of changes of conditions upon it

temperature (^{0}C)	K_w
0	2.0×10^{-15}
25	1.2×10^{-14}
50	5.5×10^{-14}

- Acid/base chemistry, pH and the role of water in it

End of Examination