Name: .....

Teacher: .....

Strathfield Girls High School

2008

Trial Higher School Certificate Examination

Chemistry

General Instructions

- Reading time – 5 minutes
- Working time – 3 hours
- Board-approved calculators may be used
- Write using blue or black pen
- Draw diagrams using pencil
- A Data Sheet and Periodic Table are provided at the back of this paper
- The Multiple Choice answer sheet is attached at the back of this paper and should be detached.
- A separate booklet is available for answering the Option questions.
- All other questions should be answered on this paper.
- All papers should be handed in together at the end of the paper.

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Section I Pages 2 – 15

Total marks (**75**)

This section has two parts, Part A and Part B

Section II

Part A

Total marks (**15**)

- Attempt questions 1 – 15
- Allow about 30 minutes for this part

Part B

Total marks (**60**)

- Attempt questions 16 – 31
- Allow about 1 hour and 45 minutes for this part.

Pages 16 – 17

Total marks (**25**)

- Attempt all parts of this question
- Allow about 45 minutes for this section.

Section I
Total marks (75)

Part A
Total marks (15)
Attempt questions 1 – 15

Allow about 30 minutes for this part

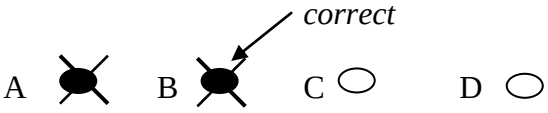
Use the multiple-choice answer sheet.
Select the alternative A, B, C or D that best answers the question. Fill in the response oval completely.

Sample 2 + 4 = (A) 2 (B) 6 (C) 8 (D) 9

A ⬭ B ⬬ C ⬭ D ⬭

If you think you have made a mistake, put a cross through the incorrect answer and fill in the new answer.

If you change your mind and have crossed out what you consider to be the correct answer, then indicate this by writing the word *correct* and drawing an arrow as follows:



1. The reaction between a particular hydrocarbon and bromine produces the following product:

$$\mathbf{CH_3CHBrCHBrCH_3}$$

Which of the following hydrocarbons was reacted with bromine to produce this product?

(A) 1-propene
(B) butane
(C) 2-butene
(D) propane

2. The heat of combustion of methanol is 22.7 kJg^{-1}.

Which of the following is the theoretical mass of water that could be heated from 25°C to 53°C using the heat produced by the complete combustion of 0.5 g of methanol?

(A) 0.097 g
(B) 0.194 g
(C) 97 g
(D) 194 g

3. An example of a condensation polymer is:

(A) cellulose
(B) polyethylene
(C) poly(ethenylbenzene)
(D) PVC

4. A piece of zinc is placed into copper (II) nitrate solution in a test tube.

Which one of the following changes would occur?

(A) The concentration of nitrate ions would decrease.
(B) The colour of the solution would darken.
(C) The concentration of nitrate ions would increase.
(D) The colour of the solution would fade.

5. A radioisotope is to be used to gauge the thickness of aluminium foil as it is formed.

Which of the following isotopes is suitable for this purpose?

(A) A beta source with a long half-life
(B) A beta source with a short half-life
(B) A gamma source with a long half-life
(D) A gamma source with a short half-life

6. A student was shown a demonstration in which a sample of an element was heated strongly in air, forming a powder, which was then added to water. When tested with a pH probe connected to a data logger, the resulting solution had a pH of 9.

Which one of the following elements could have been used?

(A) C
(B) Ca
(C) S
(D) Si

7. Which combination of solutes form a buffer solution in water?

(A) nitric acid and potassium nitrate
(B) citric acid and potassium citrate
(C) hydrochloric acid and sodium hydroxide
(D) ammonia and potassium nitrate

8. Which of the following is the characteristic which is present in the conjugate base of any Bronsted-Lowry acid?

(A) a negative charge
(B) a hydroxide ion
(C) a coordinate covalent bond
(D) an unshared electron pair

9. Consider the equilibrium reaction:

$$C_6H_5COOH\ (aq) + H_2O \leftrightarrows C_6H_5COO^-\ (aq) + H_3O^+(aq)$$

Which of the following would decrease the $C_6H_5COO^-$ ion concentration in solution?

(A) adding H_2
(B) adding HCl
(C) adding NaOH
(D) adding C_6H_5COOH

10. Nitric oxide is a colourless gas. It reacts with oxygen in an equilibrium in which dark brown nitrogen dioxide is formed.

$$NO_{(g)} + \tfrac{1}{2}O_{2(g)} \rightleftharpoons NO_{2(g)} \quad \Delta H = -56\ kJmol^{-1}$$

Which of the following combination of conditions results in the deepest brown colour for the equilibrium system?

	(colourless)	(dark brown)	
			$[O_2]$
(A)	Low	Low	Low
(B)	High	High	Low
(C)	High	Low	High
(D)	Low	High	High

11. Which of the following is a pair of isomers?

(A) 1-propanol and 2-propanol
(B) dichloromethane and difluoromethane
(C) dichloromethane and 1,1-dichloroethane
1,2-dichloroethane and 1,2-dichloroethene

12. An unknown solid was analysed by a number of tests, the results of which are described below.

- The solid did not react when HNO_3 (aq) was added to a sample.
- When $Ba(NO_3)_2$ (aq) was added to a solution of the solid, no observable change occurred.

- When $AgNO_3$ (aq) was added to a solution of the solid, a cream precipitate formed. The precipitate dissolved in excess nitric acid.
- When a small sample of the solid was placed into a Bunsen flame, a flash of red colour was observed.

Which of the following chemicals would behave in a similar way when analysed with the same set of tests?

(A) barium chloride
(B) barium phosphate
(C) calcium chloride
(D) calcium phosphate

13. In which layer of the atmosphere is ozone a pollutant?

(A) lower troposphere
(B) upper troposphere
(C) lower stratosphere
(D) upper stratosphere

14. For which of the following was the Haber process developed?
(A) plastics
(B) explosives
(C) fertilisers
(D) dyes

15. The following guidelines show the concentrations of calcium carbonate in different classes of water.

Concentration of $CaCO_3$ (mg/L)	Class of Water
< 60	Soft, but possibly corrosive.
60-200	Good quality.
200-500	Increasing scaling problems.
>500	Severe scaling.

The calcium ion concentration of tap water in one area in NSW was found to be 1.25×10^{-3} $molL^{-1}$.

Which class of water does this fall into according to the above guidelines?

(A) soft, but possibly corrosive water
(B) good quality water
(C) water with some scaling problems
(D) water with severe scaling problems (extremely hard water)

Chemistry

Section I

Part B – 60 marks

Attempt Questions 16–24 Allow about 1 hour and 45 minutes for this part

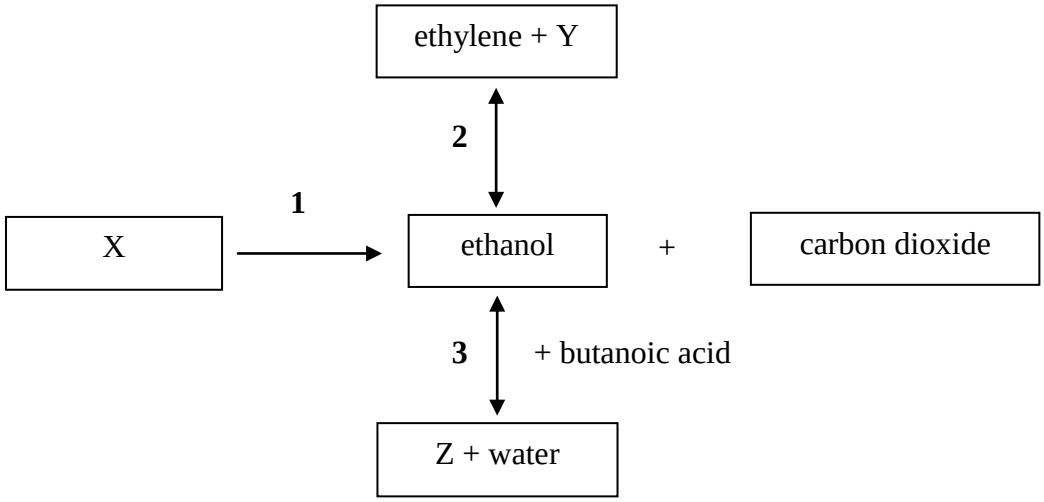
Answer the questions in the spaces provided.

Show all relevant working in questions involving calculations.

Marks

Question 16 (6 marks)

The flow chart below represents a series of reactions (1, 2, 3) starting with Compound X in reaction 1.



a) Name Compound X. **1**

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b) Draw the structural formula for Compound Z. **1**

c) Write a balanced chemical equation to represent reaction 2 and identify the catalyst used. **2**

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Question 16 continued

d) Describe the process to convert ethylene to polyethylene. **2**

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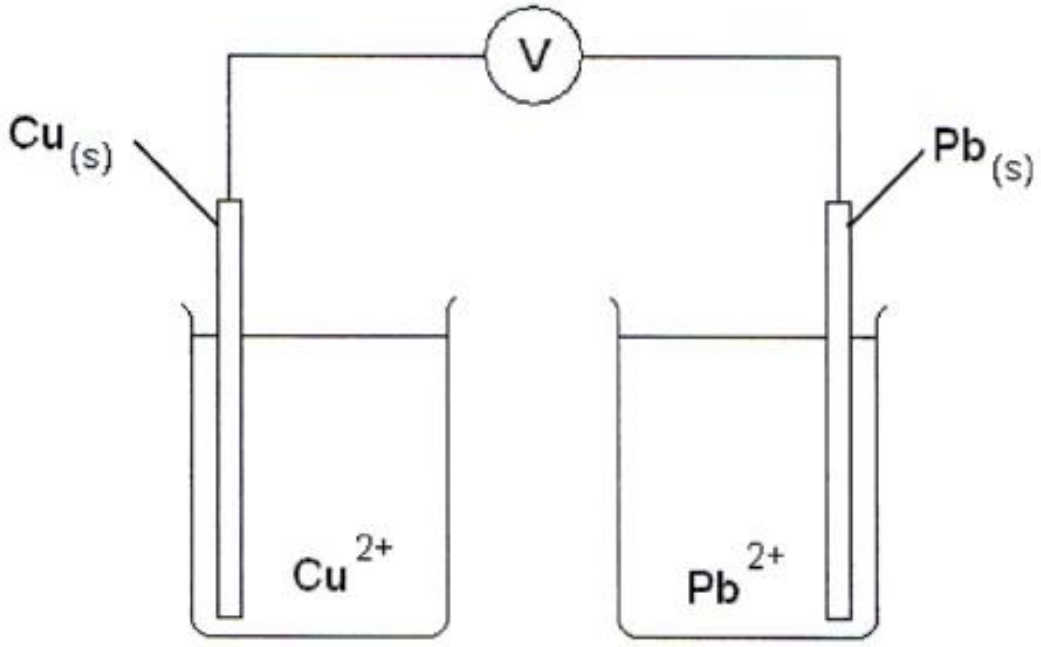
Question 17 (5 marks)

The diagram below shows a partially constructed galvanic cell.



a) On the above diagram:

(i) Draw and label any extra components that would be required to allow this galvanic cell to operate. **1**

(ii) Label the anode and cathode in this galvanic cell. **1**

(iii) Indicate the direction of the electron flow. **1**

b) Write an ionic equation to represent the overall reaction occurring in this galvanic cell. **1**

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c) Calculate the theoretical voltage generated by this cell under standard conditions. **1**

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Marks

Question 18 (5 marks)

Polyvinyl alcohol is a water-soluble addition polymer used in adhesives and paints. The monomer is vinyl alcohol (ethanol) with the structure:

$$CH_2 = CHOH$$

a) Construct a structural formula for a 3-unit segment of the polymer. **1**

b) Describe how bromine water can be used to distinguish between a solution of the monomer and a solution of the polymer. **1**

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c) Explain the interaction of the polymer with water. **1**

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d) Polyvinyl alcohol can be reacted with acetic acid to form polyvinyl acetate.

Describe the reaction conditions that you would use to produce polyvinyl acetate in this reaction. **2**

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Marks

Question 19 (4 marks)

Two radioisotopes produced by scientists are nitrogen-13 and neptunium-239.

a) The equation to describe the production of nitrogen-13 is shown below:

$$^{A}_{Z}X + ^{1}_{1}H \longrightarrow ^{13}_{7}N$$

Identify X in the equation above. Include the symbol of the element, its atomic umber (Z) and mass number (A). **1**

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b) Np-239 can be produced from the bombardment of U-238 with a neutron. This forms U-239 as shown.

$$^{238}_{92}U + ^{1}_{0}n \longrightarrow ^{239}_{92}U$$

The U-239 then decays into Np-239 via the equation:

$$^{239}_{92}U \longrightarrow ^{239}_{93}Np + Z$$

Identify Z in the equation above. **1**

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c) A student researching the production of the above radioisotopes reported that both could be produced in a nuclear reactor such as the one located in Lucas Heights, NSW. **2**

Assess the accuracy of this statement.

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Marks

Question 20 (6 marks)

Two unlabelled bottles contain different acids, both with a pH of 3.0.

25.0 mL of each acid solution is titrated with a standard solution of 0.12 mol L^{-1} sodium hydroxide. The titration results are:

Titration	**Volume of standard solution used (mL)**	
	Acid A	**Acid B**
1st titration	0.20	13.2
2nd titration	0.25	13.1
3rd titration	0.20	13.1

a) Calculate the acid concentration of acid A and acid B, assuming both acids are monoprotic. **2**

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b) Identify the instrument used to obtain 25 mL samples of the acids and describe the procedure followed when changing from one acid to other. **2**

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c) Identify a possible acid for both Acid A and Acid B and account for the difference in the titration results. **2**

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Marks

Question 21 (6 marks)

Discuss the factors that need to be monitored to maximise the yield of ammonia in the Haber process. **6**

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Question 22 (3 marks)

A teacher tripped in the laboratory whilst carrying a large glass flask of concentrated sulfuric acid. Although she avoided serious injury, the contents were spilt onto the floor. **3**

Outline an appropriate method to minimise the damage of this spill. Justify your choice.

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Marks

Question 23 (7 marks)

You carried out a first-hand investigation to determine the mass of $CO_{2(g)}$ dissolved in a can of soft drink.

a) Outline the procedure you used. **2**

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b) A group of students carried out this experiment and obtained the following results:

Time	Mass of can (g)
Initial	335.8
Final	327.2

Using the students' results, calculate the total volume of CO_2 dissolved in the soft drink can (at 25°C and 100 kPa). **2**

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c) Explain how the pH of the soft drink would have changed over the course of the student's experiments, including appropriate chemical equation(s). **3**

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Marks

Question 24 (7 marks)

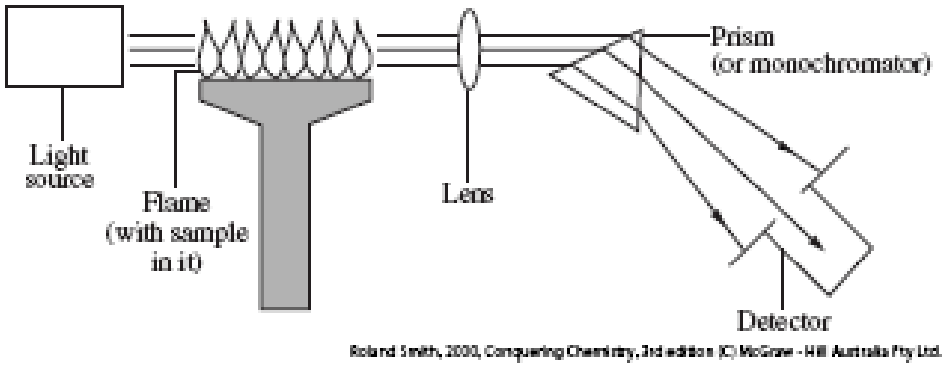
With reference to the information below, evaluate the role that human activity and technology have played in altering the concentration of ozone in the stratosphere and in monitoring this concentration. Include all relevant equations in your answer. **7**

1928	An industrial chemist named T. Midgley selected chlorofluorocarbons (CFCs) as non-flammable, non-toxic compounds to replace the hazardous compounds then used in home refrigerators.
1985	Atmospheric scientists in Antarctica reported a 50% reduction in ozone concentrations in the stratosphere over the previous decade. This result was supported by independent data measured spectroscopically from a satellite.
1987	An international treaty, the Montreal Protocol, agreed to halve the use of CFCs by 1999.
1990	The 80 Montreal Protocol countries met again and agreed to phase out the production and consumption of CFCs, halons and carbon tetrachloride by 2000.

Marks

Question 25 (9 marks)

The following diagram shows the apparatus that can be used to analyse lead levels in blood samples.



a) Explain how this apparatus can be used to analyse lead levels in blood. **3**

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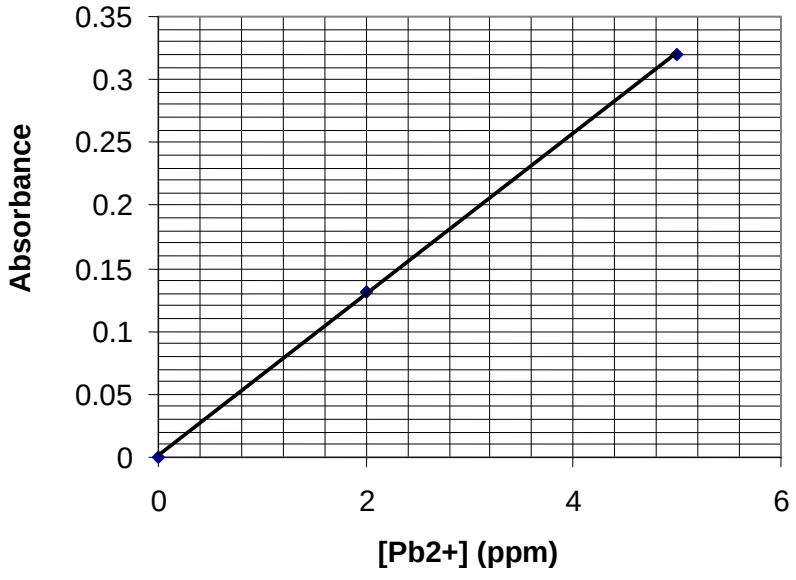
b) A group of students used standard solutions of Pb^{2+} to generate a calibration curve using an AAS machine. They then used the machine to measure the lead levels in a sample of blood. This was repeated five times. Their curve is shown below and the results are shown on the following page.



Question 25 continued

Measurement	Absorbance at 217 nm
1	0.149
2	0.152
3	0.148
4	0.119
5	0.147

The students calculated the average absorbance to be 0.143.

Using the average calculated by the students, calculate the level of lead in the sample. **1**

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c) Referring to the results in the table, assess the validity of the lead concentration determined using this procedure. **3**

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d) Identify a reagent that could be used in the laboratory to detect lead ions in solution and construct an ionic equation for this reaction. **2**

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Question 26 (2 marks)

Waterways that flow over rocks containing calcium carbonate often have a higher pH.
Explain this observation using an appropriate equation to support your argument. **2**

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Chemistry

Section II

25 marks
Allow about 45 minutes for this section

Answer the question in a writing booklet. Extra writing booklets are available. Show all relevant working in questions involving calculations.

Question 27 – Shipwrecks, Corrosion and Conservation (25 marks)

Marks

(a) In 1800, Volta developed his famous Voltaic Pile, consisting of vertical stacks of alternating metallic discs (eg zinc and silver). The discs were separated by cloth or paper that had been soaked in brine.

i. With the aid of suitable equations, outline the role that electron transfer and ion movement play in producing an electric current from the cell. **2**

ii. Analyse the impact of the work of Davy and Faraday on our current understanding of electron-transfer reactions and its applications. **4**

(b) During your studies you gathered and processed information about different types of steel.

i. Describe how you gathered and processed this information **4**

ii. Compare the composition, properties and uses of two (2) different steels. **4**

(c) Zincalum is a type of roofing consisting of steel sheets coated with a thin layer of an alloy of zinc and aluminium.

i. Describe and explain the protection given to steel by this layer. **4**

ii. The manufacturer warns that roofing sheets must not be marked with ordinary graphite pencils. **2**

Use your knowledge of electrochemical cells to justify this warning.

(d) Rusting experiment

Students set up the following experiment to investigate the conditions that affect the rusting of iron.

They placed 4 mild steel nails into individual test tubes.

Test tube 1 – water heated to remove dissolved air from the water
Test tube 2 – water heated to remove dissolved air from the water and oil added to prevent air re-entering.
Test tube 3 – water that hasn't been heated.
Test tube 4 – is stoppered and contains silica crystals to remove moisture from the air.

Test tube 1 Test tube 2 Test tube 3 Test tube 4

After leaving the test tubes for three days the following observations were made.

Test tube 1 Test tube 2 Test tube 3 Test tube 4

i. Analyse the results provided to discuss the conditions required for the rusting of iron. **3**

ii. Use appropriate equations to explain the process of rusting. **3**

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DATA SHEET

Avogadro constant, N_A ..... 6.022×10^{23} mol^{-1}

Volume of 1 mole ideal gas: at 100 kPa and

at 0°C (273.15 K) ..... 22.71 L

at 25°C (298.15 K) ..... 24.79 L

Ionisation constant for water at 25°C (298.15 K), K_w ..... 1.0×10^{-14}

Specific heat capacity of water ..... 4.18×10^3 J kg^{-1} K^{-1}

Some useful formulae

$$\mathrm{pH} = -\log_{10}[\mathrm{H}^+] \qquad \Delta H = -m\,C\,\Delta T$$

Some standard potentials

$K^+ + e^-$	$\rightleftharpoons$	$K(s)$	–2.94 V
$Ba^{2+} + 2e^-$	$\rightleftharpoons$	$Ba(s)$	–2.91 V
$Ca^{2+} + 2e^-$	$\rightleftharpoons$	$Ca(s)$	–2.87 V
$Na^+ + e^-$	$\rightleftharpoons$	$Na(s)$	–2.71 V
$Mg^{2+} + 2e^-$	$\rightleftharpoons$	$Mg(s)$	–2.36 V
$Al^{3+} + 3e^-$	$\rightleftharpoons$	$Al(s)$	–1.68 V
$Mn^{2+} + 2e^-$	$\rightleftharpoons$	$Mn(s)$	–1.18 V
$H_2O + e^-$	$\rightleftharpoons$	$\frac{1}{2}H_2(g) + OH^-$	–0.83 V
$Zn^{2+} + 2e^-$	$\rightleftharpoons$	$Zn(s)$	–0.76 V
$Fe^{2+} + 2e^-$	$\rightleftharpoons$	$Fe(s)$	–0.44 V
$Ni^{2+} + 2e^-$	$\rightleftharpoons$	$Ni(s)$	–0.24 V
$Sn^{2+} + 2e^-$	$\rightleftharpoons$	$Sn(s)$	–0.14 V
$Pb^{2+} + 2e^-$	$\rightleftharpoons$	$Pb(s)$	–0.13 V
$H^+ + e^-$	$\rightleftharpoons$	$\frac{1}{2}H_2(g)$	0.00 V
$SO_4^{2-} + 4H^+ + 2e^-$	$\rightleftharpoons$	$SO_2(aq) + 2H_2O$	0.16 V
$Cu^{2+} + 2e^-$	$\rightleftharpoons$	$Cu(s)$	0.34 V
$\frac{1}{2}O_2(g) + H_2O + 2e^-$	$\rightleftharpoons$	$2OH^-$	0.40 V
$Cu^+ + e^-$	$\rightleftharpoons$	$Cu(s)$	0.52 V
$\frac{1}{2}I_2(s) + e^-$	$\rightleftharpoons$	I^-	0.54 V
$\frac{1}{2}I_2(aq) + e^-$	$\rightleftharpoons$	I^-	0.62 V
$Fe^{3+} + e^-$	$\rightleftharpoons$	Fe^{2+}	0.77 V
$Ag^+ + e^-$	$\rightleftharpoons$	$Ag(s)$	0.80 V
$\frac{1}{2}Br_2(l) + e^-$	$\rightleftharpoons$	Br^-	1.08 V
$\frac{1}{2}Br_2(aq) + e^-$	$\rightleftharpoons$	Br^-	1.10 V
$\frac{1}{2}O_2(g) + 2H^+ + 2e^-$	$\rightleftharpoons$	H_2O	1.23 V
$\frac{1}{2}Cl_2(g) + e^-$	$\rightleftharpoons$	Cl^-	1.36 V
$\frac{1}{2}Cr_2O_7^{2-} + 7H^+ + 3e^-$	$\rightleftharpoons$	$Cr^{3+} + \frac{7}{2}H_2O$	1.36 V
$\frac{1}{2}Cl_2(aq) + e^-$	$\rightleftharpoons$	Cl^-	1.40 V
$MnO_4^- + 8H^+ + 5e^-$	$\rightleftharpoons$	$Mn^{2+} + 4H_2O$	1.51 V
$\frac{1}{2}F_2(g) + e^-$	$\rightleftharpoons$	F^-	2.89 V

Aylward and Findlay, *SI Chemical Data* (5th Edition) is the principal source of data for this examination paper. Some data may have been modified for examination purposes.

PERIODIC TABLE OF THE ELEMENTS

KEY

Atomic Number	Symbol of element	Name of element
79	Au	Gold
	197.0	
Atomic Weight		

1 H 1.008 Hydrogen																	2 He 4.003 Helium
3 Li 6.941 Lithium	4 Be 9.012 Beryllium											5 B 10.81 Boron	6 C 12.01 Carbon	7 N 14.01 Nitrogen	8 O 16.00 Oxygen	9 F 19.00 Fluorine	10 Ne 20.18 Neon
11 Na 22.99 Sodium	12 Mg 24.31 Magnesium											13 Al 26.98 Aluminium	14 Si 28.09 Silicon	15 P 30.97 Phosphorus	16 S 32.07 Sulfur	17 Cl 35.45 Chlorine	18 Ar 39.95 Argon
19 K 39.10 Potassium	20 Ca 40.08 Calcium	21 Sc 44.96 Scandium	22 Ti 47.87 Titanium	23 V 50.94 Vanadium	24 Cr 52.00 Chromium	25 Mn 54.94 Manganese	26 Fe 55.85 Iron	27 Co 58.93 Cobalt	28 Ni 58.69 Nickel	29 Cu 63.55 Copper	30 Zn 65.41 Zinc	31 Ga 69.72 Gallium	32 Ge 72.64 Germanium	33 As 74.92 Arsenic	34 Se 78.96 Selenium	35 Br 79.90 Bromine	36 Kr 83.80 Krypton
37 Rb 85.47 Rubidium	38 Sr 87.62 Strontium	39 Y 88.91 Yttrium	40 Zr 91.22 Zirconium	41 Nb 92.91 Niobium	42 Mo 95.94 Molybdenum	43 Tc [97.91] Technetium	44 Ru 101.1 Ruthenium	45 Rh 102.9 Rhodium	46 Pd 106.4 Palladium	47 Ag 107.9 Silver	48 Cd 112.4 Cadmium	49 In 114.8 Indium	50 Sn 118.7 Tin	51 Sb 121.8 Antimony	52 Te 127.6 Tellurium	53 I 126.9 Iodine	54 Xe 131.3 Xenon
55 Cs 132.9 Caesium	56 Ba 137.3 Barium	57–71 Lanthanides	72 Hf 178.5 Hafnium	73 Ta 180.9 Tantalum	74 W 183.8 Tungsten	75 Re 186.2 Rhenium	76 Os 190.2 Osmium	77 Ir 192.2 Iridium	78 Pt 195.1 Platinum	79 Au 197.0 Gold	80 Hg 200.6 Mercury	81 Tl 204.4 Thallium	82 Pb 207.2 Lead	83 Bi 209.0 Bismuth	84 Po [209.0] Polonium	85 At [210.0] Astatine	86 Rn [222.0] Radon
87 Fr [223.0] Francium	88 Ra [226.0] Radium	89–103 Actinides	104 Rf [261.1] Rutherfordium	105 Db [262.1] Dubnium	106 Sg [266.1] Seaborgium	107 Bh [264.1] Bohrium	108 Hs [277] Hassium	109 Mt [268] Meitnerium	110 Ds [271] Darmstadtium	111 Rg [272] Roentgenium							

Lanthanides

57 La 138.9 Lanthanum	58 Ce 140.1 Cerium	59 Pr 140.9 Praseodymium	60 Nd 144.2 Neodymium	61 Pm [144.9] Promethium	62 Sm 150.4 Samarium	63 Eu 152.0 Europium	64 Gd 157.3 Gadolinium	65 Tb 158.9 Terbium	66 Dy 162.5 Dysprosium	67 Ho 164.9 Holmium	68 Er 167.3 Erbium	69 Tm 168.9 Thulium	70 Yb 173.0 Ytterbium	71 Lu 175.0 Lutetium

Actinides

89 Ac [227.0] Actinium	90 Th 232.0 Thorium	91 Pa 231.0 Protactinium	92 U 238.0 Uranium	93 Np [237.0] Neptunium	94 Pu [244.1] Plutonium	95 Am [243.1] Americium	96 Cm [247.1] Curium	97 Bk [247.1] Berkelium	98 Cf [251.1] Californium	99 Es [252.1] Einsteinium	100 Fm [257.1] Fermium	101 Md [258.1] Mendelevium	102 No [259.1] Nobelium	103 Lr [262.1] Lawrencium

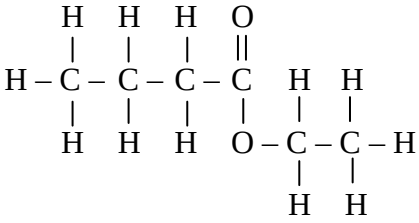
Where the atomic weight is not known, the relative atomic mass of the most common radioactive isotope is shown in brackets.
The atomic weights of Np and Tc are given for the isotopes ^{237}Np and ^{99}Tc.

Chemistry Trial 08 Marking Criteria

1. C. 2. A 3. A 4. D 5. A,C 6. B 7. B 8. D 9. B 10. D
11. A 12. D 13. A 14. B,C 15. B

16. (a) Glucose (or sucrose) **1**

(b)



1

(c)

Balanced equation plus name of catalyst	**2**
Balanced equation OR name of catalyst	**1**

Sample answer:

$C_2H_5OH \rightarrow C_2H_4 + H_2O$. Catalyst = dilute H_2SO_4

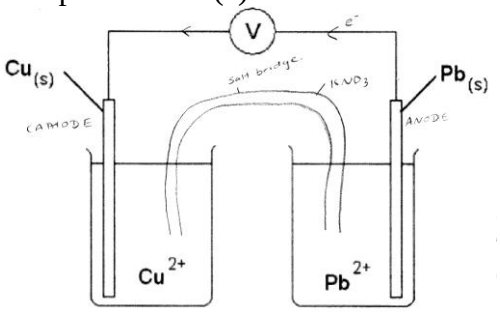
(d) Describes the process

Describes the process for producing polyethylene fully.	**2**
Describes the process for producing polyethylene partially OR Describes the reaction conditions.	**1**

17. (a)

Correctly draws and labels salt bridge, labels anode and cathode and indicates the direction of electron flow.	**3**
Does some of the above	**1-2**

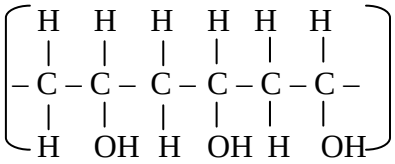
Sample answer: (a)



(b) $Pb\ (s) + Cu^{2+}\ (aq) \rightarrow Pb^{2+}\ (aq) + Cu\ (s)$ **1**

(c) 0.13 + 0.34 = 0.47 V **1**

18. (a) **1**



(b) The monomer, having a double bond, will decolourise bromine water very quickly. The polymer, having no double bond, will not decolourise bromine water.

(c) The OH groups in the polymer are polar and form hydrogen bonds with the polar bonds in water, making the polymer soluble. **1**

(d)

Describes the reaction conditions fully.	**2**
Describes the reaction conditions partially.	**1**

Sample answer:
Polyvinyl alcohol and acetic acid would be refluxed together by heating them in a pear-shaped flask under a condenser. Concentrated sulfuric acid and boiling chips would be added.

19. (a) $^{12}_{6}C$ **1**

(b) $^{0}_{-1}e$ (beta particle) **1**

(c)

Explains why the statement is correct for Np-239 but not for N-13	**2**
Explains one of the above	**1**

Sample answer: The statement is not completely accurate because C-12 must be bombarded with a charged particle to form N-13. To do this a particle accelerator is required to accelerate a proton to high velocities to overcome repulsion between positive charges. Np-239 can be produced in a nuclear reactor by bombarding U-238 with neutrons.

20. (a)

Correctly calculates the concentration of both Acid A and Acid B	**2**
Correctly calculates the concentration of one Acid or completes part of the calculation.	**1**

Acid A
Number of moles of NaOH = CV = 0.12 $molL^{-1}$ x 0.2 x 10^{-3}L = 2.556x10^{-5} moles
Concentration of Acid A = n/V = 2.556x10^{-5} / 0.025 = 1.0 x 10^{-3} $molL^{-1}$

Acid B
Number of moles of NaOH = CV = 0.12 $molL^{-1}$ x 0.013 = 1.56 x 10^{-3} moles
Concentration of Acid B = n/V = 1.56 x 10^{-3}/0.025 = 0.063 $molL^{-1}$

(b)

Identify pipette as the instrument and describes the correct procedure.	**2**
Either identifies pipette or describes the correct procedure.	**1**

Sample answer: A pipette is used to obtain a 25mL aliquot of a solution. To change to another solution, the pipette must first be rinsed several times with water and then rinsed several times with the new solution to avoid contamination.

(c)

Correctly identified possible acids and stated a correct reason based upon their results for (a)	**2**
Does some of the above.	**1**

Sample answer: Both acids had the same pH, or $[H^+]$, however, the amount of NaOH required for neutralisation was very different. Acid A only required a very small amount of NaOH and must therefore be a strong acid that was fully ionised. For example, HCl. Acid B required a large volume of NaOH indicating that it was only partially ionised in solution and so must be a weak acid. For example, acetic acid.

21

Comprehensively discuss 3 or more factors that need to be monitored.	**5-6**
Comprehensively discuss 2 factors, or Comprehensively discuss one factor and outline several others.	**3-4**
Outline several factors that need to be monitored.	**1-2**

Sample answer: There are many factors that need to be monitored during the Haber process to ensure a maximum yield. As it is an equilibrium reaction carried out in the gaseous state, an increased pressure in the reaction vessel will promote the formation of ammonia as the number of moles are less. ($N_{2(g)} + 3H_{2(g)} \rightarrow 2NH_{3(g)}$) For this reason the reaction is carried out at high pressures exceeding 250 atm. Thus the high pressures will increase the yield and the rate of the reaction as the particles are closer together. However, there are increased safety problems as explosions are more likely. This means increased monitoring and expense is required.

The temperature of the reaction vessel must also be monitored to maintain optimum conditions of 500°C that are high enough to promote a fast reaction rate and yet not produce too low a yield as the production of ammonia is exothermic. The temperature after the reaction must also be monitored so that it is less than 33°C which will remove the ammonia that has been produced by liquefaction.

Other factors to be monitored include the catalyst which may be poisoned by contaminants and so will have a reduced efficiency, negatively affecting the rate of the reaction. It will then take longer to produce the same amount of ammonia. The ratio of the reactants, N_2 and H_2, should also be kept in a 3:1 ratio according to the equation to have a maximum yield. Monitoring for contaminants throughout the process should also be carried out, this will avoid either poisoning of the catalyst or, in the case of O_2, explosions.

22.

Outlines a correct method and provides a thorough justification	**3**
Outlines a correct method and provides a brief justification	**2**
Either names a correct method or provides a correct justification	**1**

Sample answer: An appropriate method is to sprinkle a powdered, weak base (such as $NaHCO_3$) in excess over the spill. This will neutralise the acid without a dangerous exothermic reaction, or the dangers of a concentrated alkaline solution. Being a powder, it will also serve to contain the spill area, and is cheap and safe to store.

23 (a)

A detailed outline of the procedure	**2**
A brief outline, or missing a crucial step (e.g. not opening the can)	**1**

Sample answer:

1. Weigh the mass of a soda water can using an electronic balance and record the weight.
2. Carefully open the can so that none of the contents spill.
3. Gently heat the can in a water bath so that it doesn't boil over long period of time.
4. Reweigh the can.
5. Repeat steps 3-4 until the mass is constant.

(b)

Correctly calculates the volume of CO_2	**2**
Completes some of the calculation	**1**

Sample:
Mass of CO_2: 335.8 – 327.2 = 8.6g
Moles of CO_2: mass/molar mass = 8.6/44.01 = 0.1954
Volume at 25°C = moles x 24.79L = 4.844L

(c)

Correctly explain how the pH increases using correct equations.	**3**
Identifies that the pH increases and either includes an appropriate equation or explanation.	**1-2**

Sample answer: During the experiment CO_2 came out of solution into the atmosphere. As there was less in solution, less carbonic acid formed, according to the equilibrium equation.

$$CO_{2(aq)} + H_2O_{(l)} \leftrightarrow H_2CO_{3(aq)} \leftrightarrow HCO_3^-{}_{(aq)} + H^+{}_{(aq)}$$

Less carbonic acid will then mean less H^+ ions in solution and so the pH will increase.

Question 24 (7 marks)

Marking Criteria	Marks
Evaluates the effect that the use of CFCs has had on ozone concentration in the stratosphere, explaining the destruction of ozone by CFCs, including two correct equations. Evaluates the effectiveness of technology used in monitoring ozone concentration by describing a method used (TOMS or Dobson spectrometer). Evaluates the role of international agreements and the development of replacement chemicals for CFCs and their impact on ozone depletion in the stratosphere.	7
Evaluates the contribution that CFCs have had on ozone concentration in the stratosphere by explaining the destruction of ozone by CFCs, including at least one correct equation. Evaluates the use of technology in monitoring ozone concentration by describing a method used (TOMS or Dobson spectrometer). Evaluates the role of international agreements and the development of replacement chemicals for CFCs and their impact on ozone depletion in the stratosphere.	5 - 6
Evaluates the contribution that CFCs have had on ozone concentration in the stratosphere by explaining the destruction of ozone by CFCs. Identifies a form of technology used in monitoring ozone concentration (TOMS or Dobson spectrometer). Identifies a replacement chemical for CFCs.	3 – 4
Outlines the destruction of ozone by CFCs.	1 - 2

Sample Answer

The development and use of CFCs had a devastating effect on the concentration of ozone in the stratosphere. As stated in the information, CFCs were first used in home refrigerators. As they were non-flammable and non-toxic, they were later used as propellants in aerosol cans, as solvents and in blowing plastic foams. Because CFCs are very unreactive they are not broken down in the troposphere and diffuse to the stratosphere.

Here they are decomposed by ultraviolet radiation releasing chlorine free radicals.

$CCl_3F_{(g)} + UV \rightarrow CCl_2F_{(g)} + \bullet Cl_{(g)}$

The chlorine free radicals attack ozone molecules and form another free radical which reacts with an oxygen free radical again releasing the chlorine free radical, as shown in the equations below.

$$O_{3(g)} + \bullet Cl_{(g)} \rightarrow ClO\bullet + O_{2(g)}$$

$$ClO\bullet + O\bullet_{(g)} \rightarrow O_{2(g)} + \bullet Cl_{(g)}$$

Thus one CFC molecule can destroy thousands of ozone molecules.

Different forms of technology were being used to monitor the ozone concentration and each was effective in determining the thinning of ozone by 1985. One method used was the Dobson spectrophotometer, an Earth-based station in Antarctica, that measured total ozone levels at that location by comparing the intensity of a UV wavelength strongly absorbed by ozone with the intensity of a wavelength that is only weakly absorbed by ozone. The readings reported a significant decrease in ozone levels over Antarctica for the ten years prior to 1985, as stated in the information. Another method is TOMS, the Total Ozone Measuring Spectrometer which is satellite-based and measured the total amount of ozone between the Earth's surface and the top of the atmosphere. All data indicated a significant depletion of ozone.

This powerful evidence led to a series of international agreements to reduce CFC production and use around the world, such as the Montreal Protocol referred to in the information. Scientists looked for replacement compounds to reduce the use of CFCs, the first of which was HCFCs, however these compounds still contained chlorine and although they could be broken down in the troposphere they could still destroy ozone if they reached the stratosphere. More recently HFCs have been used as they contain no chlorine and should not promote ozone destruction even if they reach the stratosphere. Thus human activity has played a significant role in the depletion of ozone and in trying to find a solution to the problem.

Question 25 (9 marks)

(a)

Marking Criteria	Marks
Explains the principle of AAS and the purpose of the light source and the flame in the apparatus.	3
Explains the purpose of the light source and the flame.	1 - 2

Sample Answer

The apparatus works on the principle that the metal ions to be analysed will absorb a specific wavelength of light that is unique to the metal atoms being analysed. The lamp provides this specific wavelength of light. The flame vapourises the sample and converts the molecules and ions into atoms. By measuring the intensity of light at that wavelength that is absorbed by the sample compared to the intensity of the light without the sample the concentration of the element can be determined.

(b)

Marking Criteria	Marks
Correctly states the lead level from the calibration graph.	1

Sample Answer

2.2 ppm

(c)

Marking Criteria	Marks
Assesses the validity of the results in terms of the suitability of AAS for measuring lead levels in blood, the number of readings taken and the effect of including an inconsistent reading (reading 4) in the calculation of the average and hence the determination of the lead ion concentration.	3
Assesses the validity of the results in terms of the suitability of AAS for measuring lead levels in blood and the reliability of the readings taken by identifying measurement 4 as being inconsistent with the other readings.	1 - 2

Sample Answer

AAS is very sensitive for determining concentrations of metal ions in a sample in the range of ppm and so is considered a valid method of analysis of lead levels in blood. However, in this instance, the average absorbance of 0.143 is not valid for the actual absorbance of the sample as reading 4 is significantly different from the other reliable readings. Reading 4 is an outlier and should not have been included in the calculation of the average. Thus the lead level determined from this average cannot be relied upon.

(d)

Marking Criteria	Marks
Correctly identifies a reagent and constructs an ionic equation to show the reaction of this reagent with lead ions.	2
Correctly identifies a reagent	1

Sample Answer

A solution of potassium iodide can detect lead ions as it forms a bright yellow precipitate.

$Pb^{2+}_{(aq)} + 2\ I^-_{(aq)} \rightarrow PbI_{2\,(s)}$

Question 26 (2 marks)

Marking Criteria	Marks
Explains that solutions containing carbonate ions are basic with supporting hydrolysis equation.	2
Identifies that solutions containing carbonate ions are basic.	1

Sample Answer
Rain water is slightly acidic (pH 6.5) and dissolves some of the calcium carbonate. The carbonate ion reacts with water to form a basic solution as shown by the presence of the OH- ion in the equation. This results in the water having a higher pH.
$CO_3^{2-}{}_{(aq)} + H_2O_{(l)} \rightarrow HCO_3^-{}_{(aq)} + OH^-{}_{(aq)}$

OPTION QUESTION Q27

a i) Outlines the role of electron movement and ion migration in the operation of the pile and provides one equation for the anode or cathode reaction. 2 marks

Identifies one feature of how the pile works. 1 mark

Sample answer
In a voltaic pile with Zn and Ag, Zn is oxidized $Zn \rightarrow Zn^{2+} + 2e^-$
The electrons produced are transferred via an external circuit to the Ag electrode, where water is reduced. Ions in the brine solution between the two metals migrate (+ve towards Zn and –ve towards the Ag) to complete the circuit.

ii) Describes the work of both scientists in the area of electrochemistry and analyses how their work has improved our understanding of electrochemistry 3-4 marks

Outlines the work of both or the work and contribution of either scientist 2 marks

Identifies one contribution of either scientist 1 mark

Sample answer
Davy made use of Volta's work in the development of cells via electron-transfer reactions in the area of electrolysis-that is, he used electricity the cells produced to decompose solutions such as alkalis, and then solid samples of potassium and sodium hydroxide, producing metallic potassium and sodium. He therefore isolated pure samples of these elements for the first time. He went on to isolate other metals such as calcium and magnesium. He also did research on the nature of corrosion and found that corrosion on copper could be reduced from contact of the copper with zinc. Thus Davy's work was significant in that it applied electrochemistry to useful applications.
Faraday contributed much of the current electrochemical terminology we use today, including the term electrolyte, anode (site of oxidation) and cathode (site of reduction). He also termed 'anions' for the negatively charged particles which move towards the anode and 'cations' for the positive particles which move towards the cathode. His work emphasised the significance of ion movement to the functioning of electrochemical cells. He also experimentally developed quantitative laws relating to electrolysis.

b i) Gathering information - collecting from a wide range of sources
- use of key words when searching
- using book indexes
- using search engines 2 marks
(half mark each if mentioned)

Processing – identifying source
- noting date of publication
- summarizing or tabulating information
- not using irrelevant information 2 marks
(half mark each if mentioned)

Sample answer

To gather this information I collected material from a range of sources such as books and internet sites. I used key words to find the information and entered these into search engines for internet articles or looked in the index of books.

I looked at the source of the information to see if they were a recent publication and up to date. I also checked the publisher of books to see if they were a reputable source such as a textbook or accredited text and I checked the source of internet articles as government and university sites would be more reliable. Relevant information was summarized and tabulated. Irrelevant information was discarded.

ii) Comparing two specifically named types of steel, their percentage composition, their properties and a correct use. 4 marks

Incorrectly naming the steel, not giving accurate compositions, properties or uses looses half a mark,

Samlpe answer

Mild steel contains less than 0.2% carbon which makes it inexpensive, relative soft, malleable and easy to work. It also corrode slowly. It can be used for car bodies, nails and machinery.

Structural steel has more carbon between 0.2 and 0.5%. This makes it harder and stronger than mild steel and the higher concentration of carbon makes it corrode quicker. It is used to make girders and railway lines and structural supports in buildings and ships.

c i) Outlining the physical and electrochemical protection provided by the Zn and Al. 3 marks

Outlining the physical or electrochemical protection provided by the Zn and Al. 2 marks

Mentioning one aspect of the physical or electrochemical protection provide by the Zn and Al. 1 mark

Sample answer

Physical protection is provided by the coating which excludes the access of oxygen and water to the steel as both Zn and Al are passivating metals which form impervious oxides which reform if the surface is scratched.

Electrochemical protection is also provided as both Zn and Al are more active than iron. These will oxidize preferentially making the steel a cathode making it a non corrosive environment.

ii) Explaining how graphite can create a corrosion cell 2 marks

Stating that carbon increases rates of corrosion 1 mark

Sample answer

Graphite will form a cathode creating a cell in which the voltage is high enough for Zn and Al to act as anodes and corrode quickly. This will reduced the protection provided to the steel.

d i) Correct analysis of the conditions in each test tube and using the results to discuss the conditions required for corrosion demonstrated by the experiment. 3 marks

Analysis of condition in each test tube related to corrosion 2 marks

Analysis of condition in some of the test tube. 1 marks

Sample answer

Tube 1 has water present, the oxygen has been removed but can diffuse back into the water over 3 days Slight rusting has occurred.

Tube 2 has water present but no oxygen as it cannot diffuse back into the water. No rusting has occurred.

Tube 3 has oxygen and water.The nail has rusted.

Tube 4 has oxygen in the tube but all water has been absorbed by the silica crystals. No rusting has occurred.

The results show that oxygen and water on their own will not cause rusting. Only oxygen and water will cause rusting.

ii) Using a series of equation, with an explaination, to show the sequential nature of rusting. 3 marks

Using a series of equations only. 2 marks

Using 2 relevant equations related to the sequence of rusting 1 mark

Sample answer

In rusting, iron is oxidized $Fe \rightarrow Fe^{2+} + 2e^-$

Water is reduced $0_2 + 2H_2O + 4e^- \rightarrow 4OH^-$

Migration of ions then occurs and hydroxide move to site of oxidation and reacts with iron ions

$Fe^{2+} + 2OH^- \rightarrow Fe(OH)_2$

The Iron Hydroxide produced is further oxidized to rust

$4Fe(OH)_2 + O_2 \rightarrow 2(Fe_2O_3.H_2O) + 2H_2O$