2004

HSC Trial Examination

Chemistry

Instructions to Candidates:

* Reading time allowed: 5 minutes
* Writing Time allowed: 3 hours
* Use a Black or Blue pen
* A Pencil should be used for diagrams
* Approved calculators may be used.
* A **Data sheet, Formula List** and **Periodic table** are attached to the back of this Paper and should be removed for use.
* Write your Student No. at the TOP of EACH Page in the space provided.

Examination instructions:

Total marks – 100

This examination has **TWO** Sections:

Section I. CORE Pages **2 – 21**

75 marks

This section has **TWO** parts:

Part A - 15 marks **Questions 1 to 15**

15 Multiple Choice questions
All questions should be attempted.
Allow about 30 minutes for this Part.

Part B - 60 marks **Questions 16 to 26**

Written Response questions
All questions should be attempted.
Marks for each question are shown on the Paper.
Allow about 1 hour 45 minutes for this Part.

Section II. OPTION Pages **22 – 31**

25 marks **Questions 27-28**
Allow about 45 minutes for this section.

Appendices

Section I
75 marks

Part A – 15 marks
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.

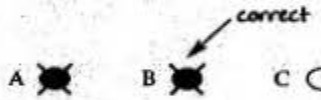
Sample: 2 + 4 = (A) 2 (B) 6 (C) 8 (D) 9

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.

A ● B ✖ C ○ D ○

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



Start Here →

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 ○

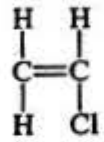
Section 1

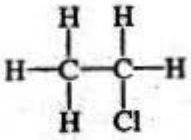
PART A: Multiple choice – 15 Marks

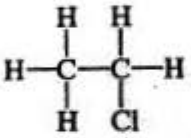
Attempt All Questions 1 - 15

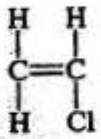
Record your answers on the multiple-choice answer sheet on page 2.

1. Which of the following provides the correct information about the monomer known as vinyl chloride?

A.  Chloroethene

B.  Chloroethane

C.  Chloroethene

D.  Chloroethane

2. Which of the following molecules is produced by a condensation reaction?

A. Polyvinylchloride

B. Polyethylene

C. Cellulose

D. Styrene

3. The heat of combustion of ethanol is 1360kJ/mol. Approximately how much energy would be produced theoretically by the complete combustion of 11.5g of ethanol?

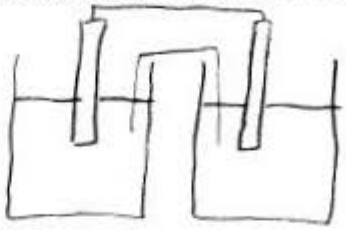
A. 118 kJ

B. 340 kJ

C. 521 kJ

D. 5440 kJ

4. A student constructed a galvanic cell using two different metals in electrolytes of the nitrate of the metals (1 mol L^{-1}) solution. The combination of metals which would give the greatest potential difference is:



A. magnesium and zinc

B. zinc and nickel

C. manganese and silver

D. nickel and silver

5. Which of the following equations could represent the formation of a transuranic element in a nuclear reactor?

A. $^{238}_{92}U + ^{4}_{2}He \rightarrow ^{239}_{94}Pu + 3^{1}_{0}n$

B. $^{238}_{92}U \rightarrow ^{234}_{90}Th + ^{4}_{2}He$

C. $^{2}_{1}H + ^{2}_{1}H \rightarrow ^{3}_{1}H + ^{1}_{1}H$

D. $^{1}_{0}n + ^{238}_{92}U \rightarrow ^{88}_{38}Sr + ^{136}_{54}Xe + 12^{1}_{0}n$

6. Citric acid (2-hydroxypropane-1,2,3-tricarboxylic acid) is a weaker acid than sulfuric acid, even though citric acid is triprotic.
Which of the following best explains the above statement?

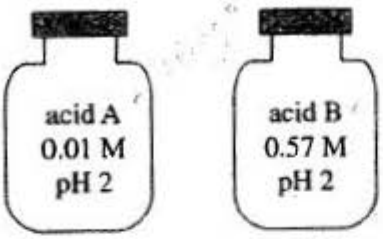
A Citric acid ionises more completely than sulfuric acid

B Sulfuric acid will react completely with a base, but citric acid will only react partially with a base

C Sulfuric acid is diprotic and therefore ionises more easily.

D Citric acid ionises less completely than sulfuric acid.

7. Consider the following reagent bottles of acids:



In comparing these two solutions we can say that

A. the $[H^+]$ is greater in the solution of acid A

B. the $[H^+]$ is greater in the solution of acid B

C. the acids are of equal strength

D. A is the stronger acid

8. Sodium hydrogensulfate can be added to a solution to reduce its pH. The reaction responsible for this is:

A. $HSO_4^-{}_{(aq)} + H_2O_{(l)} \rightarrow H_2SO_{4(aq)} + OH^-{}_{(aq)}$

B. $HSO_4^-{}_{(aq)} + HSO_4^-{}_{(aq)} \rightarrow H_2SO_{4(aq)} + SO_4^{2-}{}_{(aq)}$

C. $HSO_4^-{}_{(aq)} + H_2O_{(l)} \rightarrow H_3O^+{}_{(aq)} + SO_4^{2-}{}_{(aq)}$

D. $Na^+{}_{(aq)} + H_2O_{(l)} \rightarrow NaOH_{(aq)} + H^+{}_{(aq)}$

9. Consider the following equilibrium in aqueous solution:

$$CN^- + HSO4^- \leftrightarrow HCN + SO_4^{2-}$$

Select the correct statement:

A. CN^- is acting as an Arrhenius acid

B. If the equilibrium lies to the right, then HCN is a stronger Bronsted-Lowry acid than HSO_4^-.

C. In the reverse reaction, HCN acts as a Bronsted-Lowry base.

D. HSO_4^- and SO_4^{2-} are a Bronsted-Lowry acid/conjugate base pair.

10. A student titrating sodium hydroxide solution with sulfuric acid, which is delivered from the burette. The burette should be given a final rinse with:

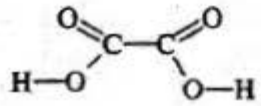
A. a sodium hydroxide solution

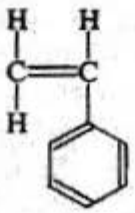
B. distilled water

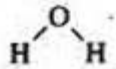
C. a detergent solution

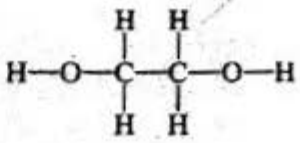
D. the sulfuric acid solution

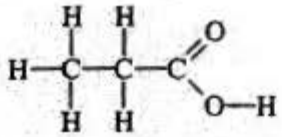
11. Consider the following expanded structural formulas:

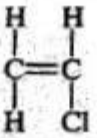
(i) 

(ii) 

(iii) 

(iv) 

(v) 

(vi) 

The compounds which could be reacted together to form a condensation polymer are:

A. (i) and (iv)

B. (ii) and (vi)

C. (iii) and (v)

D. (i) and (ii)

12 The formation of ammonia from its constituent elements can be summarised using the following equation:

$$N_{2(g)} + 3H_{2(g)} \leftrightarrow 2NH_{3(g)}$$

The formation of ammonia is reduced when the reaction is conducted under conditions of

A. high temperature and low pressure

B. low temperature and high pressure

C. high temperature and high pressure

D. low temperature and low pressure

13 A white salt is suspected of being either a phosphate or a carbonate. A test that will quickly identify the anion in this white salt would be:

A. performing the brown ring test

B. adding acid and checking for effervescence

C. dissolving both in water and adding silver ions

D. testing with litmus paper

14. Biological Oxygen Demand is:

A. a measure of the number of aerobic organisms in a sample of water

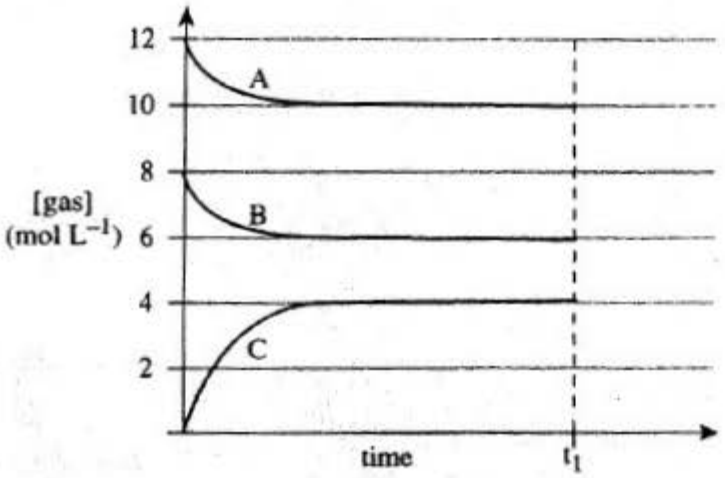
B. a measure of organic wastes that can be broken down by organisms in a body of water

C. a measure of inorganic wastes that can be broken down by anaerobic organisms

D. the quantity of oxygen needed to respire organic wastes in a body of water

15. ***See over page.../p***

15. It is known that gases A and B reach equilibrium as they react together to form gas C. The variation in concentration of these gases was monitored and graphed as illustrated below.



By applying Le Chatelier's principle, it can be predicted that at time t1 the yield of the forward reaction will

A. increase if pressure is increased.

B. decrease if pressure is increased.

C. decrease if pressure is decreased.

D. not be affected by a change in pressure.

Section 1 (continued)

Part B - 60 Marks

Attempt Questions 16-26
Answer the questions in the spaces provided.
Show all relevant working in questions involving calculations.

Question 16 *(6 marks)* **Marks**

(a) Compare the reactivity of alkenes and alkanes and give a reason for the difference. **2**

(b) Describe a test that you used to distinguish between a named alkane and alkene you investigated in the laboratory. Include relevant practical details and chemical equations. **4**

Question 17 *(5 marks)* **Marks**

Analyse the progress in the development of one specific named biopolymer and evaluate its use or potential use. In your analysis, include the name of the specific enzyme or organism used in its synthesis **5**

Question 18 *(6 marks)* **Marks**

Consider the following electrochemical cell:

$$X_{(s)} \mid X^{2+}_{(aq)} \parallel Y^{+}_{(aq)} \mid Y_{(s)}$$

(a) Draw a labeled diagram of this cell, clearly indicating the direction of electron and ion flow. **3**

(b) The EMF of the cell under standard conditions is 0.96V.
Given that the reduction potential for $Y^{+}_{(aq)} + e^{-} \rightleftharpoons Y_{(s)}$ is 0.52V, write the oxidation half-equation for the cell, including its voltage. **2**

(c) The cell will eventually reach a state of equilibrium. Use Le Chatelier's Principle to justify the prediction that if the concentration of $Y^{+}_{(aq)}$ is increased, the voltage will also increase. **1**

Question 19 *(3 marks)* **Marks**

Identify one named radioisotope used in either industry or medicine 3

Describe the way in which the above named radioisotope is used and explain its use in terms of its nuclear and chemical properties

Question 20 *(5 marks)* **Marks**

A titration was carried out using 0.246 mol L^{-1} HCl to standardise 25.0mL aliquots of a solution of the weak base, sodium carbonate. An appropriate indicator was chosen to show the end point of neutralization. The results gained are shown in the table below.

Run	*1*	*2*	*3*	*4*	*5*
Initial burette volume (mL)	0.5	23.6	0.7	23.5	0.2
Final burette volume (mL)	23.5	45.8	23.0	46.2	22.4

(a) Calculate the concentration of the sodium carbonate solution. Justify the steps in your calculation. **3**

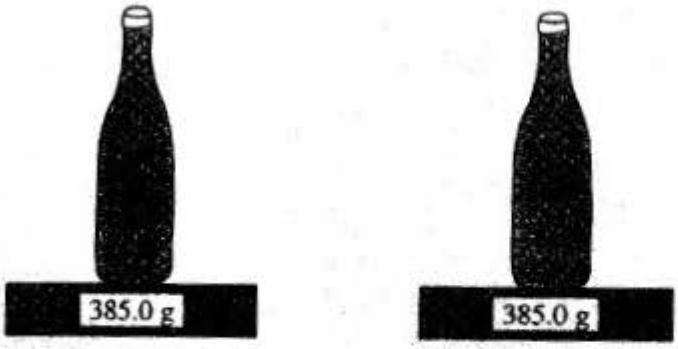
(b) The student had a choice of indicators:

- Methyl orange; changes from red to orange from pH 3.0 to 4.5.
- Phenolphthalein; changes from colourless to pink from pH 8.3 to 10.0

Select the indicator that should be used for this titration, giving a reason for your choice. **2**

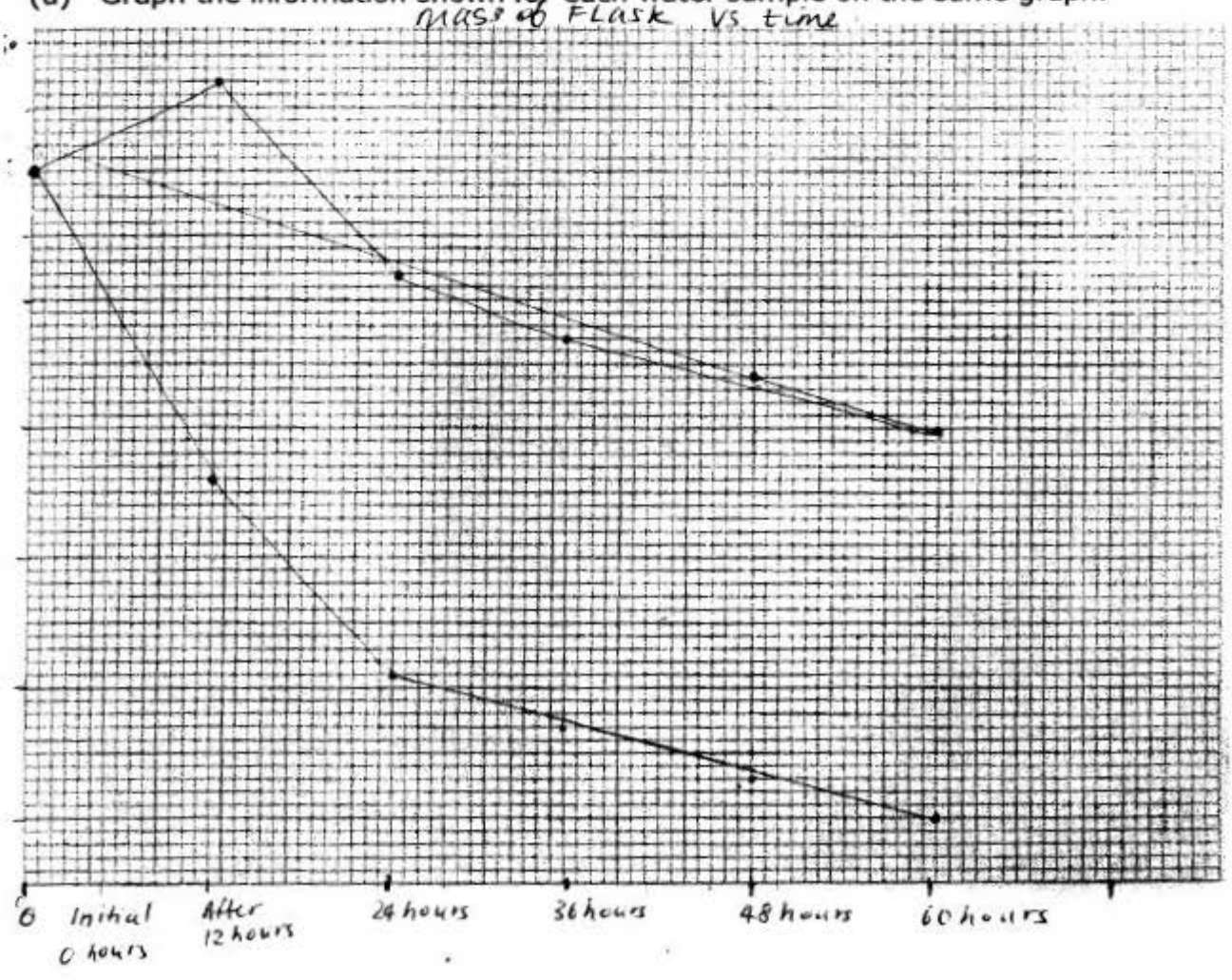
Question 21 *(7 marks)* **Marks**

As part of your practical work you decarbonated a beverage. A student decarbonated a sample of soda water by opening the bottle it was in and leaving it for a period of time, weighing it at regular intervals. She also used a non-carbonated sample of water as a control, recording its mass at the same intervals.



	Mass (g)					
	Initial 0 hours	*After 12 hours*	*24 hours*	*36 hours*	*48 hours*	*60 hours*
Soda water	385.0	382.6	381.1	380.7	380.3	380.0
Plain water	385.0	385.7	384.2	383.7	383.4	383.0

(a) Graph the information shown for each water sample on the same graph. **2**



Question 21 continued

(b) Interpret the trends shown in your graphs including any relationship between them **3**

(c) Use the graph to determine the volume of CO_2 gas produced at 25°C and 100kPa. Show your working. **2**

Question 22 *(8 marks)* **Marks**

Artificial banana essence, pentyl ethanoate, is an ester.

(a) Draw and name the structures of the substances that would be used to manufacture this ester **4**

(b) Draw a fully labelled diagram of the apparatus used to manufacture this ester in the school laboratory including direction of water flow in the condenser. **3**

(c) Describe the purpose of using concentrated sulfuric acid in the preparation of an ester. **1**

(d) Explain the need for refluxing during esterification **1**

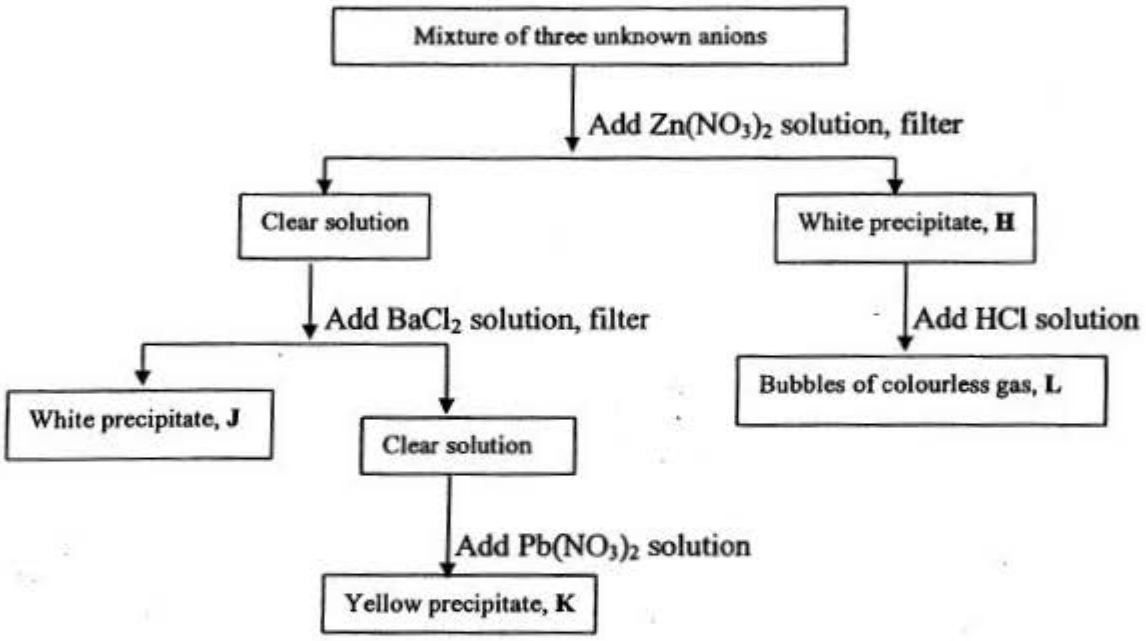
Question 23 *(5 marks)* **Marks**

Refer to the following Table and Flow chart.

Table - Solubility of Ionic compounds

Soluble	Insoluble
Group 1 and NH_4^+ compounds, Nitrates Ethanoates (acetates) (except Ag^+) Chlorides, bromides and iodides (except Ag^+, Pb^{2+}) Sulfates (except Pb^{2+}, Ba^{2+}, Ag^+, Ca^{2+})	Carbonates, sulfites and phosphates (except Group 1 and NH_4^+ compounds) Hydroxides and oxides (except Group 1, NH_4^+, Ba^{2+}, Ca^{2+}) Sulfides (except Groups 1, 2 and NH_4^+)

Flowchart: In order to identify three anions in a solution a student performed the experiments shown in the flowchart below.



(a) Identify any ***one*** of the precipitates, **H, J or K** or the gas, **L** and write the balanced net ionic equation for the reaction involved in its formation. **4**

Letter of precipitate or gas:

Chemical Name

Ionic equation for its formation:

Anions present in the original solution

(b) While looking for some barium chloride to complete the tests above, a student found a reagent bottle labelled "a chloride salt of either barium or magnesium". Describe a simple test that you have carried out in the school laboratory to identify barium ions that would enable this student identify the salt present. **1**

Question 24 *(6 marks)* **Marks**

During your course you performed a first-hand investigation to determine the sulfate content of lawn fertiliser.

(a) Describe the procedure you used and explain the chemistry involved. **3**

(b) Describe the results you obtained (numerical values are not required) and evaluate the reliability of these results. Propose solutions to at least one problem you encountered in the procedure. **3**

Question 25 *(6 marks)* **Marks**

In the late 1970's unprecedented and unanticipated depletions of stratospheric ozone were discovered over the Antarctic and the problem has continued to grow causing much concern among the scientific community. Scientists are increasingly blaming the use of CFCs for this depletion of the ozone.

(a) Name a CFC found in the Troposphere and identify its origins. **1**

(b) Write equations to show the reactions involving CFC's and ozone to demonstrate the removal of ozone from the atmosphere. **2**

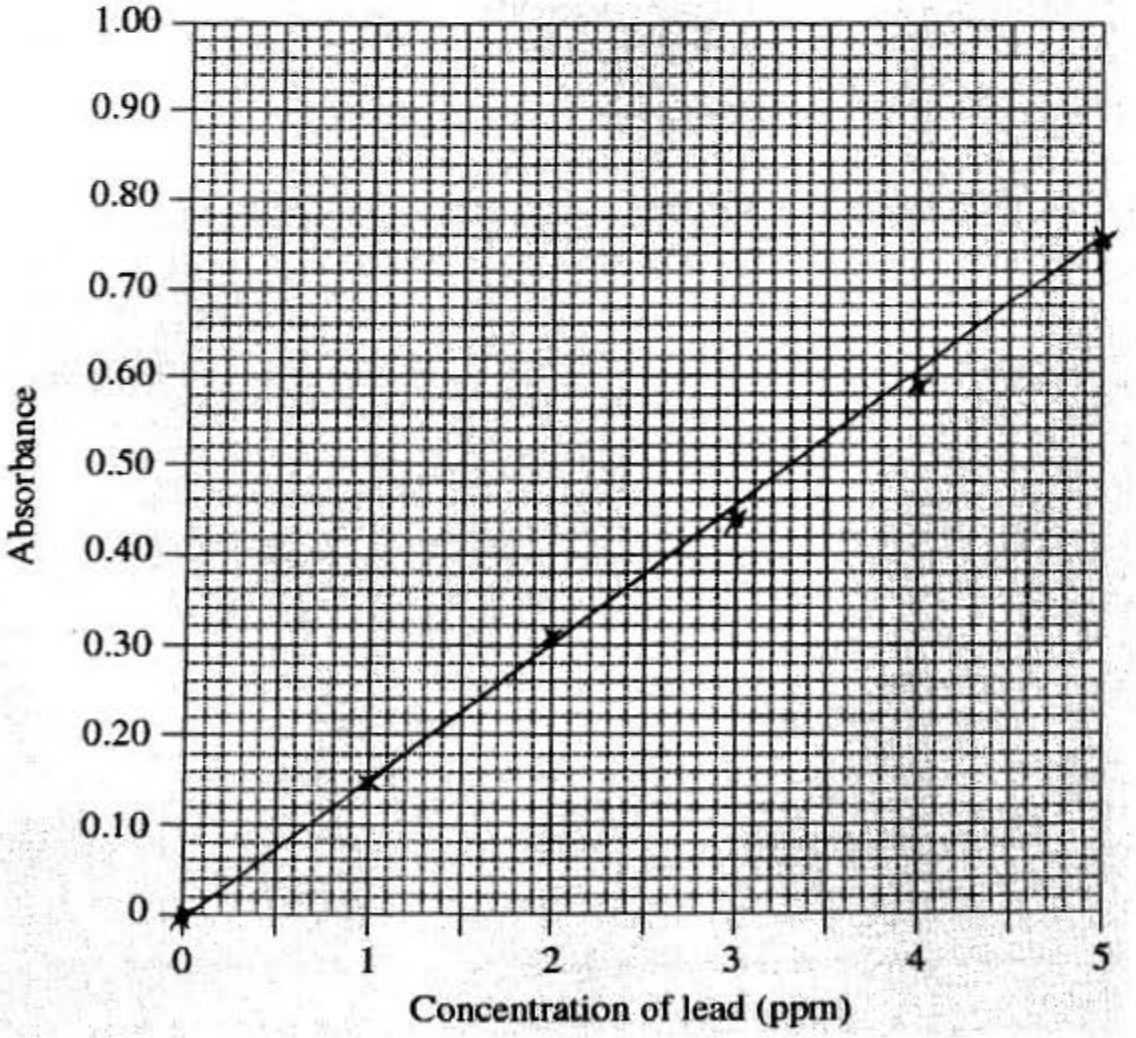
(c) Evaluate the effectiveness of alternative chemicals in use which are replacing CFC's. **3**

Question 26 *(3 marks)* **Mar**

A student decided to measure the concentration of lead (Pb) in the soil around his ho
He prepared five standard lead solutions of known concentration. The absorbance of these solutions was measured. These results are shown in the table.

Concentration of lead standard (ppm)	*Absorbance*
0	0.00
1	0.15
2	0.31
3	0.44
4	0.59
5	0.75

(a) Draw a line graph of these data 2 marks



Question 26 *(continued)* **Marks**

(b) The student prepared solutions from four different soil samples around his home. These solutions were also analysed using the same method. The results are shown in the table below.

Solutions made from soil samples	
Area sampled	*Absorbance*
Front garden bed	0.19
Back garden bed	0.09
Mail box	0.22
Back fence	0.11

Determine the concentration of lead around his front garden bed. **1**

Scots Trial Paper Chemistry 2004

Solutions, syllabus outcomes and marking criteria

PART A: Questions 1-15

Question	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Answer	A	C	B	C	A	D	D	C	D	D	A	A	B	D	D
Outcomes	H9	H9	H10 H12	H6, H7, H8	H6	H8, H10	H8, H10	H8, H10	H6	H11, H12	H9	H10, H14	H11	H11	H10, H14

1 **Correct Answer A**
Chloroethene (with the double bond)

2 **Correct Answer C**
The other molecules apart from cellulose are produced from addition polymerisation.

3 **Correct Answer B**
$n(C_2H_5OH) = m/M$
$= 11.5g/46.07g\ mol^{-1}$
$= 0.249\ mol$

Heat of combustion = 0.249 mol x 1360 kJ/mol
= 339.48
≈ 340 kJ

4 **Correct Answer C**
A gives 1.6V, B gives 0.52V, C gives 1.98V, D gives 1.04V using the table of standard reduction potentials.

5 **Correct Answer A**
Transuranic elements have an atomic number greater than 92.

6 **Correct Answer D**
Acid strength is measured by the extent of ionisation of the acid. Weak acids ionise less than stronger acids.

7 **Correct Answer D**
Since both acids have the same pH, their respective [H+] must be the same. However, acid A is of a lower concentration and so must be a stronger acid.

8 **Correct Answer C**
An increase in [H+] will result in a lower pH. The hydrogen sulfate ion, derived from a polyprotic acid will undergo a hydrolysis reaction to form a more acidic solution.

9 **Correct Answer D**

10 **Correct Answer D**
The solution to be delivered is used as the final rinse to avoid dilution.

11 **Correct Answer A**
Each monomer has two functional groups.

12 **Correct Answer A**
The formation of ammonia is exothermic, and so its yield will increase at lower temperatures. According to Le Chatelier's Principle, in this case the equilibrium will shift to the right as pressure is increased.

13 **Correct Answer B**

14 **Correct Answer D**

15 **Correct Answer D**
The equation for the reaction is A + B □ 2C. Since one mole of each A and B are consumed to form 2 moles of C, there are 2 moles of gas on each side of the equation. Therefore the ratio of moles is unaffected by the change in pressure.

Part B : Questions 16-26

Question 16 (7 marks)

Q.16 (a)

Outcomes assessed: H	Marks
• Correctly states the difference between the reactivity of alkanes and alkenes AND • Gives a valid reason	2
• Correctly states the difference between the reactivity of alkanes and alkenes	1

Specimen answer

Alkenes are more reactive than alkanes because the double bond in alkenes is more amenable to chemical (electrophilic) attack than the single bond in alkanes.

Q.16 (b)

Outcomes assessed: H	Marks
• Correctly names an alkane and an alkene **available in the school science laboratory** AND • Describes a valid distinguishing test including the reagents, their amounts and equipment needed AND • Correctly states the outcome of the test AND • Write a correct chemical equation (with states) for the effect of the test on the **named** alkene	4
• Correctly names an alkane and an alkene **available in the school science laboratory** AND • Describes a valid distinguishing test including the reagents, their amounts and equipment needed AND • Correctly states the outcome of the test OR • Write a correct chemical equation (with states) for the effect of the test *any* alkene	3
• Correctly names an alkane and an alkene **available in the school science laboratory** AND • Describes a valid distinguishing test **without** including equipment needed OR • Correctly states the outcome of the test OR • Write a correct chemical equation (with states) for the effect of the test on *any* alkene	2
• Correctly describes ***some*** aspect of a suitable distinguishing test for alkenes and alkanes **OR** • Write a correct chemical equation (with states) for the effect of the test on *any* alkene	1

Specimen answer

Cyclohexane and cyclohexene can be distinguished from one another by shaking a 1 mL sample of each in separate test tubes with a few drops of bromine water. The cyclohexene will *decolourise* the bromine water the cyclohexane will not.

$$C_6H_{10}(l) \xrightarrow{Br_2(aq)} C_6H_8Br_2(l)$$

OR

$$C_6H_{10}(l) + 2Br_2(aq) \rightarrow C_6H_8Br_2(l) + 2HBr(aq)$$

OR some other valid reaction

Question 17 (5 marks)

Q.17 (a)

Outcomes assessed: H	Marks
• Names a specific biopolymer AND • Identifies the specific enzyme or organism used in its synthesis AND • Identifies its physical and/or chemical properties AND • Identifies its uses or potential uses AND • Evaluates the production of these plastics in terms of cost and possibility of cost effectiveness in developments in genetic technology	5
• Names a specific biopolymer AND • Suggests uses, properties OR its physical and/or chemical properties AND • States the advantage of biodegradability of such a plastic OR • Evaluates the production of these plastics in terms of cost and possibility of cost effectiveness in developments in genetic technology	3 - 4
• Names a specific biopolymer AND/OR • Identifies the specific enzyme or organism used in its synthesis OR • Evaluates the production of these plastics in terms of cost and possibility of cost effectiveness in developments in genetic technology	1 - 2

Specimen answer

Biopolymer:

PHB – polybetahydroxybutanoate

Synthesis details

- Produced by some of the following organisms – Alcaligenes, Clostridium,
- Polymer has similar physical and mechanical properties to polypropylene but different chemical structure.

Uses

- PHB can be used in the production of packaging, e.g. bags, wrapping film etc. The main advantage over polypropylene is that it is biodegradable thus these plastics would rapidly degrade in landfills.

Evaluation

- However the cost of production of these plastics is very much higher than for plastics from petrochemicals.
- Improvements in genetic technology may assist in the future production of these plastics making it more economically viable.

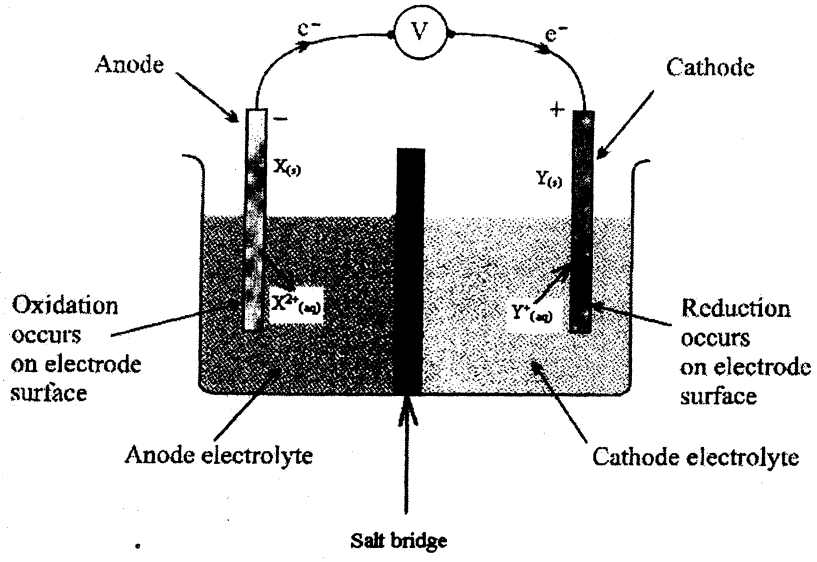
Question 18 (6 marks)

Q.18 (a)

Outcomes assessed: H	Marks
• Correct diagram (including anode, cathode, salt bridge) showing correct directions of electron AND ion movements	3
• Correct diagram (including anode, cathode, salt bridge) showing correct direction of electron movement	2
• Correct diagram (including anode, cathode, salt bridge) but no electron or ion movement OR correct direction of electron or ion movement	1

Specimen answer

Diagram:



Q.18 (b)

Outcomes assessed: H	Marks
• Correct half equation AND voltage	2
• Correct half-equation OR • Correct voltage	1

Specimen answer

Cell voltage:

$E^{\ominus}_{cell} = E^{\ominus}_{ox} + E^{\ominus}_{red}$

$0.96 = E^{\ominus}_{ox} + 0.52$ V

$E^{\ominus}_{ox} = 0.44$ V

Oxidation half-equation:

$X_{(s)} \rightleftharpoons X^{2+}_{(aq)} + 2e^-$, $E^{\ominus}_{ox} = +0.44$ V

Q.18 (c)

Outcomes assessed: H	Marks
• Predicts effect on cell voltage *based on Le Chatelier's principle*	1

Specimen answer

By Le Chatelier's principle, if the concentration of a reactant is increased the equilibrium will be driven to the right, producing a higher concentration of products until a new equilibrium is reached.

Hence, once more Y^+ is available for reduction, the system will respond by producing more $Y_{(s)}$, so the cell voltage will increase once more until the new equilibrium is established.

$X_{(s)} + 2Y^+ \rightleftharpoons 2Y_{(s)} + X^{2+}_{(aq)}$

Question 19 (3 marks)

Q.19

Outcomes assessed: H	Marks
• Names a radioisotope used in medicine or in industry • States it nuclear properties (type of radiation emitted and half life) • Relates its chemical and/or nuclear properties to its medical (or industrial) use	3
• As above but missing any one item	2
• As above but missing any two items	1

Specimen answer

Medical Radioisotope: Iodine-131

Uses

- Used as a **radioactive tracer** to **diagnose** thyroid problems and also to treat cancer of the thyroid (**radiotherapy**).
- It is injected into the blood where it concentrates in the thyroid, particularly where abnormal growth is taking place

Nuclear and chemical properties and how these relate to its uses

- **I-131** is a **gamma emitter** with a **half-life of 8 days**
- The isotope decays as shown in the following equation:

$$^{131}_{53}\mathrm{I} \rightarrow {}^{131}_{54}\mathrm{Xe} + {}^{0}_{-1}\mathrm{e} + \gamma + \bar{\nu}$$

- The γ-radiation from the decay of the isotope **can easily penetrate a patient's body** and be picked up by detectors. It also interferes with the division of cancer cells and kills them.
- The short 8 day half-life means that it **does not remain for long in the patient** to cause long term damage to other tissues.
- The half life is **long enough, however to be delivered to the hospital** from the Lucas Heights reactor where it is produced.
- Research is under way into how to deliver such isotopes more precisely to the sites of cancer

OR...

Industrial Radioisotope: Americium-141

Uses

- Americium-241 is used in industry for quality control (eg. measuring thickness of metal sheet produced by steel mills) and in smoke detectors

Nuclear and chemical properties and how these relate to its uses

- Americium-141 is an alpha and gamma emitter and has a half-life of 432 years

$$^{241}_{95}\mathrm{Am} \rightarrow {}^{237}_{93}\mathrm{Np} + {}^{4}_{2}\alpha + \gamma$$

- The gamma radiation is used to accurately measure the thickness of such things as steel and plastic because the amount of radiation that penetrates a material depends on its thickness.
- The alpha radiation of **Am-241** is used in smoke detectors to ionise the air between two parallel plates and the flow of ions (current) between the plates. This current is constantly monitored. If there is smoke in the air, smoke particles are attracted to ions in the air, making them heavier. This changes the flow of ions between the plates, which in turn sets off the alarm

Question 20 (5 marks)

Q.20 (a)

Outcomes assessed: H	Marks
• Calculation of the correct **average** titre with readings 1 and 4 excluded WITH • **justification** of why the average was used and why readings 1 and 4 should be excluded AND • Correct **calculation** of sodium carbonate concentration	3
• Calculation *without justification* of an **average** titre (with or without readings 1 and 4) AND • *Correct* calculation of sodium carbonate concentration	2
• Correct *balanced* equation. OR • Some correct working	1

Specimen answer

Run	1	2	3	4	5
Initial burette volume (mL)	0.5	23.6	0.7	23.5	0.2
Final burette volume (mL)	23.5	45.8	23.0	46.2	22.4
Volume used	23.0	22.2	22.3	22.7	22.2

Steps in the calculation of the $[Na_2CO_3]$ with justification

- The **average** titre will be calculated to make best use of the data collected.
- However, the first (rough) titre value and the fourth titre value will be **excluded** as they are too far away from the other readings; i.e., readings 2, 3 and 5 are all within 0.1 mL of each other which is within the **precision of the burette** Therefore, the average volume of the *concordant* readings is 22.23mL ≈ 22.2 mL.
- In the calculation of the $[Na_2CO_3]$ the 22.23mL value will be used and the final answer will be rounded off.

Calculation of $[Na_2CO_3]$

$$Na_2CO_{3(aq)} + 2HCl_{(aq)} \rightarrow 2NaCl_{(aq)} + CO_{2(g)} + H_2O_{(l)}$$

$$\frac{n_{Na_2CO_3}}{n_{HCl}} = \frac{(cV)_{Na_2CO_3}}{(cV)_{HC}}$$

$$\frac{1}{2} = \frac{c_{Na_2CO_3} \times 25.0\ mL}{0.0246\ mol\ L^{-1} \times 22.23\ mL}$$

$$c_{Na_2CO_3} = \frac{1}{2} \times 0.0246\ mol\ L^{-1} \times \frac{22.23\ mL}{25.0\ mL}$$

$$c_{Na_2CO_3} = 0.109\ mol\ L^{-1}$$

Q.20 (b)

Outcomes assessed: H10, H12	Marks
• Chooses correct indicator and provides appropriate reason	2
• Chooses correct indicator	1

Specimen answer

Reaction between a strong acid and a weak base will produce a weakly *acidic* solution, so of the two indicators provided, methyl orange should be chosen as its endpoint is acidic region – although perhaps, it is still a little too low to pick up the equivalence point.

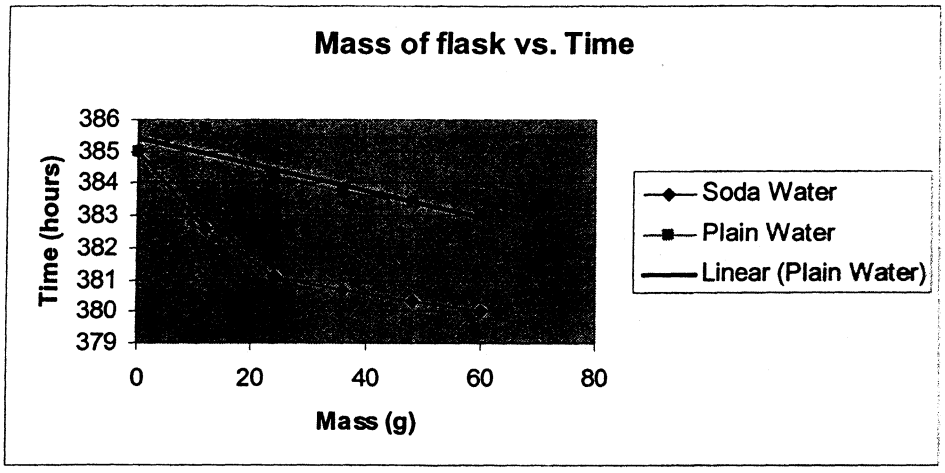
Question 21 *(7 marks)*

Q.21 (a)

Outcomes assessed: H	Marks
• Correctly plots points (axes must be labelled and suitable of scales must be used) AND • draws sound lines of fit for both data sets	2
• Correctly plots points but draws incorrect lines OR plots *one* set of data correctly OR • Plots points for both sets of data correctly without drawing trendlines…	1

Specimen answer

Graph



Q.21 (b)

Outcomes assessed: H	Marks
Interprets the graphs to: • identify the trend in the water graph to be due to evaporation alone AND • identify the trend in the soda water graph to be due to both evaporation **and** CO_2 loss • identify that the trends become virtually identical once most of the dissolved CO_2 gas gone	3
• Identifies two of these trends	2
• Identifies any one trend	1

Specimen answer

- Both graphs show a decrease in mass over time.
  - The water graph shows the loss of mass due to **evaporation alone**.
  - The soda water graph shows the loss of mass due to water evaporation **AND** loss of carbon dioxide gas.
- When no more CO_2 remains the soda water graph parallels the water graph as evaporation continues.

Q.21 (c)

Outcomes assessed: H	Marks
• Correct calculation using mass of carbon dioxide from graph AND • Correct value and formula for molar volume of gas evolved	2
• Correct formula for molar volume of gas but incorrect value from own graphs OR • Correct value from graph used, but incorrect formula for molar volume of gas	1

Specimen answer

From the water graph, the water loss (by both samples) due to ***evaporation*** = 2 g.
The total mass loss of the soda water sample = 5 g. So the ***mass of CO_2 lost*** = 3 g.
Volume of CO_2 gas lost = No. moles x molar volume at 25°C:

$$V_{CO_2} = \frac{3.0\ g}{44\ g\ m\phi l^{-1}} \times 24.79\ L\ m\phi l^{-1} = 1.69\ L$$

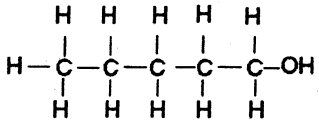
Question 22 *(8 marks)*

Q.22 (a)

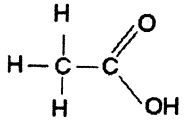
Outcomes assessed: H11, H9, H8	Marks
• Correctly draws the structures of *both* reactants AND • Correctly names (IUPAC) *both* reactants	3
• Correctly draws the structures of *one* reactant AND • Correctly names (IUPAC) *both* reactants **OR** • Correctly draws the structures of *both* reactant AND • Correctly names (IUPAC) *one* reactants	2
• Correctly draws the structure of AND correctly names *one* of the reactants	1

Specimen answer

1-Pentanol



Ethanoic acid

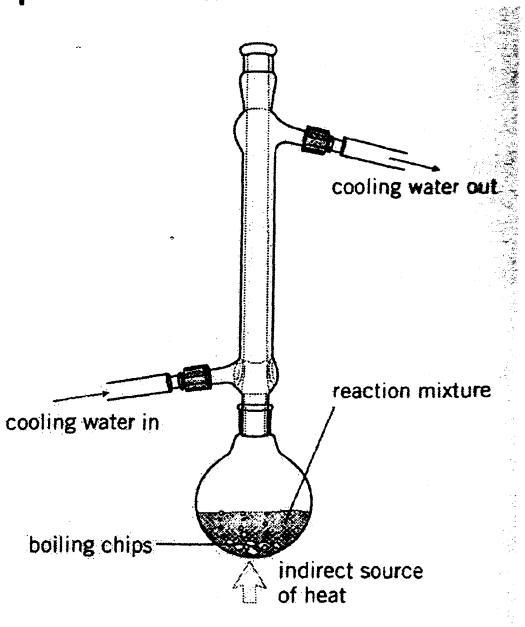


Q.22 (b)

Outcomes assessed: H11, H9, H8	Marks
• Correctly *draws* and *labels* he apparatus required for the production of an ester in the school laboratory including: *(2 marks)* – Round bottom flask (with boiling chips *optional*) – Reflux condenser – Heat source (heating mantle, oil bath, Bunsen [less desirable]; *not water bath*) – Water inlet and outlet (with correct water flow direction labelled) AND • Draws items correctly – 2 dimensional, correct relative sizes…*(1 mark)*	3
• As above, with one or more of the above not included	1-2

-1 mark for each missing/incorrect item

Specimen answer



Q.22 (c)

over page.../p	Marks

Q.22 (d)

over page.../p	Marks

Q.22 (c)

Outcomes assessed: H	Marks
• Correctly identifies concentrated sulfuric acid acting as a catalyst (do no *not* allow 'acting as a dehydrating agent')	1

Specimen answer

Sulfuric acid serves as a **catalyst**

Q.22 (d)

Outcomes assessed: H	Marks
• Correctly explains the need for refluxing	1

Specimen answer

Refluxing allows the reactants to remains in contact at high temperature for an extended time without building up the pressure (as would occur in a sealed flask).
It is also a safety precaution as it prevents the escape of inflammable vapours.

Question 23 *(5 marks)*

Q.23 (a)

Outcomes assessed: H	Marks
• Correctly identifies *any one* three precipitates *or* the gas (the letter identifying the substance ***must*** be quoted) • Writes the correct net ionic equation the formation of the species identified (must include states and correct balancing numbers) (2 marks) • Identifies the anions present in the original solution.	4
• Deduct one mark for each mistake/omission	1-3

Specimen answer

Species *(1 mark)*	**Net ionic equation *(2 marks)***
Precipitate H: Zinc carbonate:	$CO_3^{2-}(aq) + Zn^{2+}(aq) \rightarrow ZnCO_3(s)$
Precipitate J: Barium sulfate:	$SO_4^{2-}(aq) + Ba^{2+}(aq) \rightarrow BaSO_4(s)$
Precipitate K: Lead iodide :	$2I^-(aq) + Pb^{2+}(aq) \rightarrow PbI_2(s)$
Gas L: Carbon dioxide:	$CO_3^{2-}(aq) + 2H^+(aq) \rightarrow H_2O(l) + CO_3(g)$

Anions present in original solution: CO_3^{2-}, SO_4^{2-} and I^-
(symbols or names, ***1 mark***)

Q.23 (b)

Outcomes assessed: H	Marks
• Correctly describes a test that would distinguish the two ions	1

Specimen answer

Test for Ba^{2+} ions: Add a few drops of dilute $H_2SO_4(aq)$ to about a mL of solution in a test tube. The formation of a white precipitate indicates the presence of $BaSO_4$. $MgSO_4$ is soluble.

Question 24 *(6 marks)*

Q.24 (a)

Outcomes assessed: H	Marks
• Outlines a valid procedure. A minimum answer must include accurate weighing, addition of a precipitating agent, filtering, drying and weighing. AND • Describes the chemistry underlying at least *two* of the steps	3
• Outlines a valid procedure. A minimum answer must include accurate weighing, addition of a precipitating agent, filtering, drying and weighing. AND • Describes the chemistry underlying *one* of the steps	2
• Outlines a valid procedure. A minimum answer must include accurate weighing, addition of a precipitating agent, filtering, drying and weighing but fails to describe any of the chemistry involved.	1

Specimen answer

Procedure and chemistry

	Procedure	Underlying chemistry
1	**Accurately weigh** a sample of the fertiliser. **Dissolve** it in 25 mL of distilled water	
2	**Acidify** the solution with 1 mL of conc HCl and dilute to 200 mL. **Heat** gently on a hotplate	**Heating** removes any NO_3^- present as $HNO_3(g)$ and prevents co-precipitation of $Ba(NO_3)_2$. **Acidic conditions** help form an easily filterable precipitate and reduces co-precipitation*
3	**Slowly** add **hot** dilute $BaCl_2$ solution to the ***hot* solution** with thorough stirring * ***In acid solution***, negatively charged SO^{2-} ions are ***primarily* adsorbed** (since a precipitate tends to adsorb it own ions) and some positively charged H^+ *counter ions* (supplied by the acid) are ***secondarily* adsorbed**. The H^+ counter ions neutralise the negative primary layer and allow the particles to coagulate to form the precipitate.	*Barium ions* cause the sulfate to precipitate as insoluble $BaSO_4$ $Ba^{2+}(aq) + SO_4^{2-}(aq) \rightarrow BaSO_4(s)$ Carrying our the precipitation *at elevated temperature* reduces supersaturation which results in the formation of small crystals Carrying out the precipitation in *dilute* solution and the *slow* addition of the $BaCl_2$ precipitating reagent with *thorough stirring* also favours the *growth of large easily filterable $BaSO_4(s)$ crystals and reduces the* co-precipitation of $BaCl_2(s)$ onto them
4	**Cover the solution** containing the precipitate with a watch glass and **Allow it to stand** for 12-24 hours at room temperature.	This is a *digestion* phase: it allows the *precipitate crystals to grow large* which makes them *more readily filterable* and *reduces the amount of contamination by co-precipitation* The volume of solution should not fall below 150 mL *to prevent supersaturation* (which reduces crystal size)
5	**Filter** off the precipitate using a **sintered silica funnel.**	A sintered glass funnel is used instead of filter paper to prevent the reduction of the hot sulfate to sulfide by the carbon in filter paper: $BaSO_4(s) + 4C(s) \rightarrow BaS(s) + 4CO(g)$
6	**Wash** with several small aliquots of hot water	The *small* wash portions remove impurities more efficiently than one larger wash portion *Hot* washings increase the solubility of impurities and increase the speed of filtration *Water* is suitable because $BaSO_4$ is very insoluble in water (3 mg/L at room temperature)
7	**Dry** in a desiccator and **weigh**. Repeat until a constant mass is obtained	Desiccator prevents water from the atmosphere adhering to the crystals

Question 24 *(continued)*

Q.24 (b)

Outcomes assessed: H	Marks
• Summarises the results obtained and assesses their reliability AND • Identifies at least one problem AND • Suggests a feasible procedure that possibly alleviate it.	3
• Summarises the results obtained and assesses their reliability AND • Identifies at least one problem OR • Identifies at least one problem AND • Suggests a feasible procedure that possibly alleviate it.	2
• Summarises the results obtained and assesses their reliability OR • Identifies at least one problem	1

Specimen answer

Assessment of reliability

The results were *not very reliable* because the mass of sulfate obtained was much higher than that expected from the assay on the packet. This was not due to the fact that the determination was carried out only once since all groups in the class obtained similar results.

Problems and solutions

	Problem	Possible Solution
1	Some precipitate passed through the sintered glass funnel	Allow a greater digestion time. Digest at a warm temperature to prevent supersaturation which causes the formation of small crystals.
2	The final precipitate was too heavy	If this was due to coprecipitation of impurities, the $BaCl_2$ precipitating agent should be added more slowly and more washing may be needed after filtration. If this was due to incomplete drying, ignition of the precipitate may be required.

Question 25 *(6 marks)*

Q.25 (a)

Outcomes assessed: H	Marks
Reaction of CFC with ozone	

Specimen answer

Either freon–11 or CFC-11 or trichlorofluoromethane used in **plastics** OR
Freon-12 or CFC-12 or dichlorofluoromethane used in **refrigeration** or **air-conditioning** OR
Freon-13 or CFC-13 or 1,1,2-trochloro-1,2,2-trifluoromethane used as a **solvent**

Q.25 (b)

Outcomes assessed: H	Marks
• Shows the breakdown of a CFC molecule to form a chlorine atom or ClO AND • Shows this free radical attacking the ozone to break it down into O_2	2
• Shows any one equation correctly	1

Specimen answer

Reaction of CFC with ozone

CCl_3F + *ultraviolet light* → Cl + CCl_2F

CCl_2F_2 + *ultraviolet light* → Cl + $CClF_2$

Cl + O_3 → ClO + O_2

ClO + O → O_2 + Cl

Q.25 (c)

Outcomes assessed: H	Marks
• Clearly explains the bonding in the replacement molecule, how it functions including the cost and its efficiency	3
• Suggests the name of the molecule and bonding OR • How the molecule functions including the cost or its efficiency	2
• Suggest the name of the molecule only and how it functions	1

Specimen answer

HFCs (hydrofluorocarbons) are now widely used as replacements for CFCs.
HFCs are compounds containing hydrogen, fluorine and carbon, but no chlorine. They contain C-H bonds and so undergo some decomposition in the troposphere,
They contain no C-Cl bonds so do not form Cl atoms in the stratosphere so their ozone destroying capacity is zero.
HFC-134a, 1,1,1,2-tetrafluoroethane is now widely used in refrigeration and air-conditioning in Australia. It is more expensive than the CFCs it replaces and somewhat less efficient.

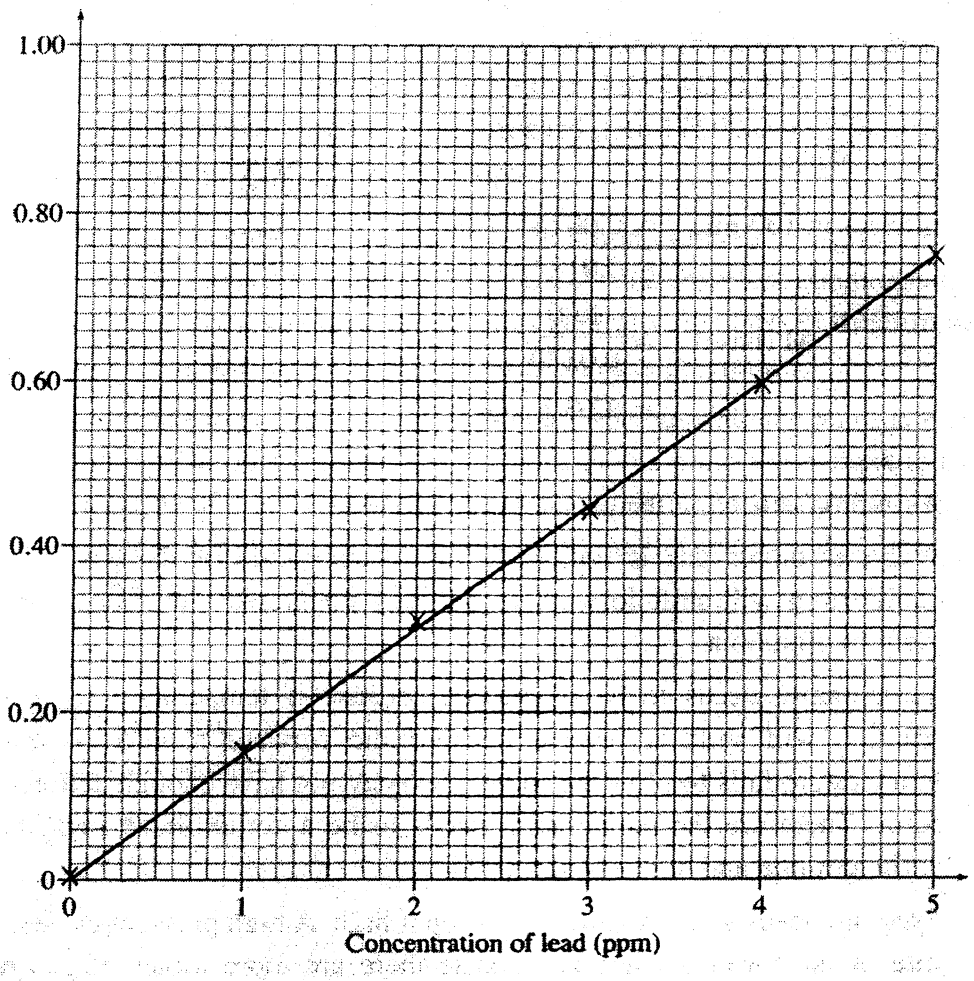
Question 26 *(3 marks)*

Q.26 (a)

Outcomes assessed: H	Marks
• Correctly plotted graph	2
• One point incorrectly plotted or line of fit not drawn correctly	1

Specimen answer

Graph:



Q.26 (b)

Outcomes assessed: H	Marks
• Correct value from own graph	1

Specimen answer

Lead concentration when absorbance is 0.19 = 1.3 ppm (using graph)