

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

Data Sheet Page 32

Periodic Table Page 33

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.

A B C D

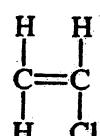
correct**Start
Here →**

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 X
- A 12. A B C D ↗
13. A B C D
- 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.**

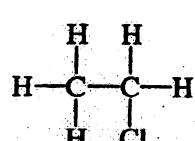
1. Which of the following provides the correct information about the monomer known as vinyl chloride?

A.



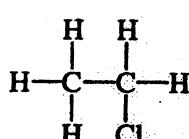
Chloroethene

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 1360 kJ/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

$$1360 \text{ kJ/mol}$$

$$11.5 \text{ g}$$



$$1360 \text{ kJ/mol} \times \frac{11.5}{46}$$

$$= 0.25 \text{ mol}$$

$$1360 / 1 \text{ mol}$$

*worst likely
to be reduced
to be oxidised*

*FURTHEST
apart in activity
in series*

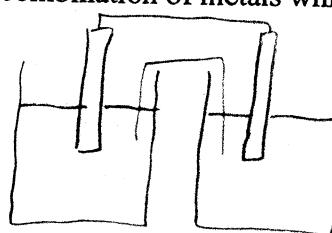
.Page 4

Scots HSC Trial Chemistry 2004

Student number:

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?

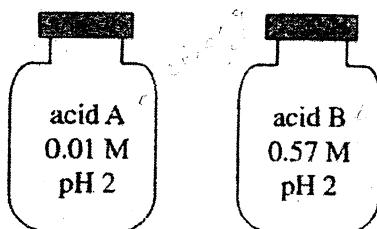
- A. $^{238}_{92}\text{U} + ^4_2\text{He} \rightarrow ^{239}_{94}\text{Pu} + 3^1_0\text{n}$
- B. $^{238}_{92}\text{U} \rightarrow ^{234}_{90}\text{Th} + ^4_2\text{He}$
- C. $^2_1\text{H} + ^3_1\text{H} \rightarrow ^3_1\text{H} + ^1_1\text{H}$
- D. $^1_0\text{n} + ^{238}_{92}\text{U} \rightarrow ^{88}_{38}\text{Sr} + ^{136}_{54}\text{Xe} + 12^1_0\text{n}$

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:



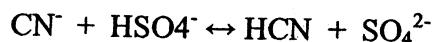
In comparing these two solutions we can say that

- 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. $HSO_4^{-\text{(aq)}} + H_2O_{\text{(l)}} \rightarrow H_2SO_4^{-\text{(aq)}} + OH^{-\text{(aq)}}$
- B. $HSO_4^{-\text{(aq)}} + HSO_4^{-\text{(aq)}} \rightarrow H_2SO_4^{-\text{(aq)}} + SO_4^{2-\text{(aq)}}$
- C. $HSO_4^{-\text{(aq)}} + H_2O_{\text{(l)}} \rightarrow H_3O^{\text{+(aq)}} + SO_4^{2-\text{(aq)}}$
- D. $Na^{\text{+(aq)}} + H_2O_{\text{(l)}} \rightarrow NaOH_{\text{(aq)}} + H^{\text{+(aq)}}$

9. Consider the following equilibrium in aqueous solution:

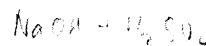


Select the correct statement:

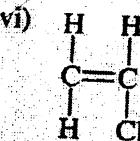
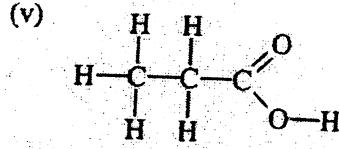
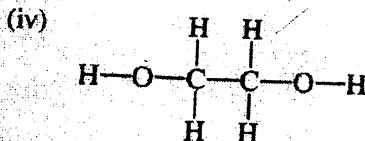
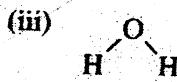
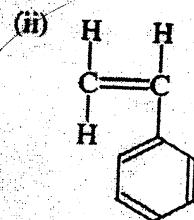
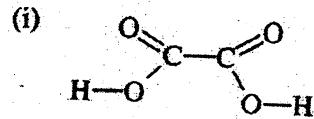
- A. CN^- is acting as an Arrhenius acid
- B. If the equilibrium lies to the right, then HCN is a stronger Bronsted-Lowry acid than HSO_4^- .
- C. In the reverse reaction, HCN acts as a Bronsted-Lowry base.
- D. HSO_4^- and SO_4^{2-} are a Bronsted-Lowry acid/conjugate base pair.

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



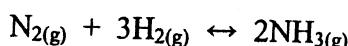
11. Consider the following expanded structural formulas:



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:



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:

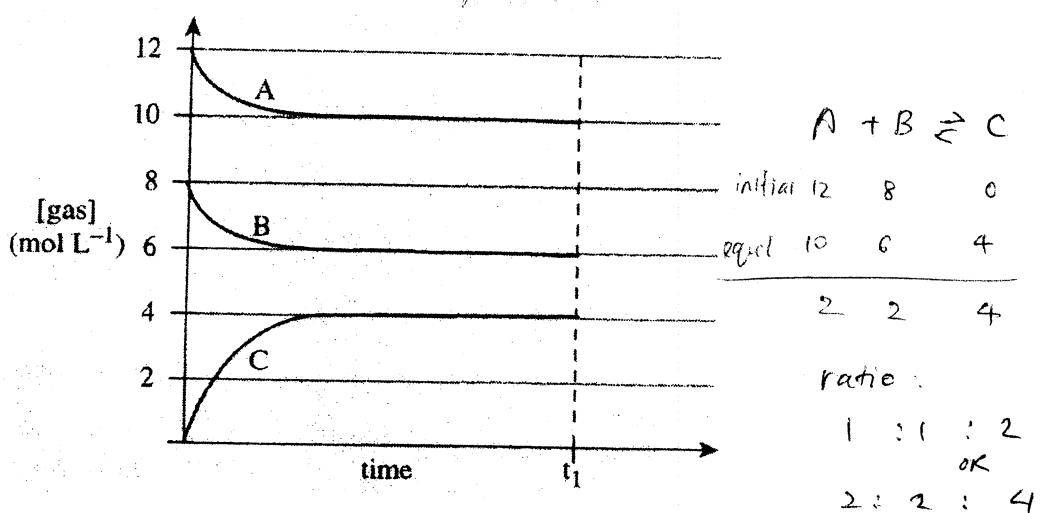
- A. performing the brown ring test
- B. adding acid and checking for effervescence
- C. dissolving both in water and adding silver ions
- D. testing with litmus paper

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 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 t_1 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)

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

Q: What is the difference between alkenes and alkynes?

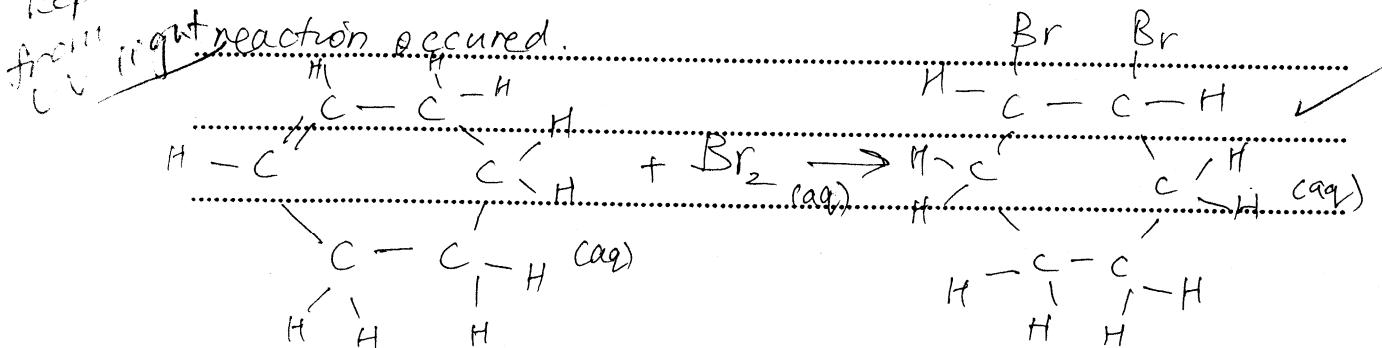
A: Alkenes are more reactive than alkynes because it has an extremely reactive double bond rather than the single bond in alkynes. The electrons in the electron density around the double bond repel each other more easily and thus is more reactive.

- (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.

① In two separate test tubes 5 ml of Cyclohexane and

- Give names cyclohexane were poured in.
- Give volumes
- equipment ② Then 3 drops of bromine water were added to each and
- Show you then both were gently shaken to mix.
looking for

* This only works ~~if~~ was noticed that the cyclohexane remained the same colour, while cyclohexene went colourless. This ^{(except as a) (b)}



cyclohexene went colourless ~~due~~ because it was able to react, ~~as if it was~~ due to its reactive double bond.

Question 17 (5 marks)

PHB

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

The biopolymer PHB, polyhydroxyl butyrate, was discovered ^{produced by} Maurice Leguigney by the company Pasteur Institute in ^{A. caligenes}, however for the first few decades there was very little progress in its development. ^{then during the 1960's} It was then grown by ^{the bacteria} The gene was then inserted into ~~E. coli~~ where PHB^{-V} (Bipol) was able to be developed while part of Cargil and Dow. From this period progress was more rapid most likely due to the developments in ^{genetic engineering} ~~biotechnology~~. The gene was able to be inserted into crops, such as ^{Corn, beetroot} Currently it has been used to make biodegradable shampoo bottles, razor heads and handles which can be flushed down the toilet. This is very valuable because it doesn't add to land-fill and but biodegrades. This is ~~more~~ especially valuable for countries such as Japan, which already charge money to bury rubbish.

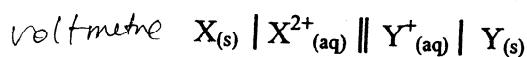
However can readily be expensive

But as fossil fuels & plastics become more expensive

Alcaligen eutropius fed A cell diet glucose withdrawn \rightarrow PHB secreted.

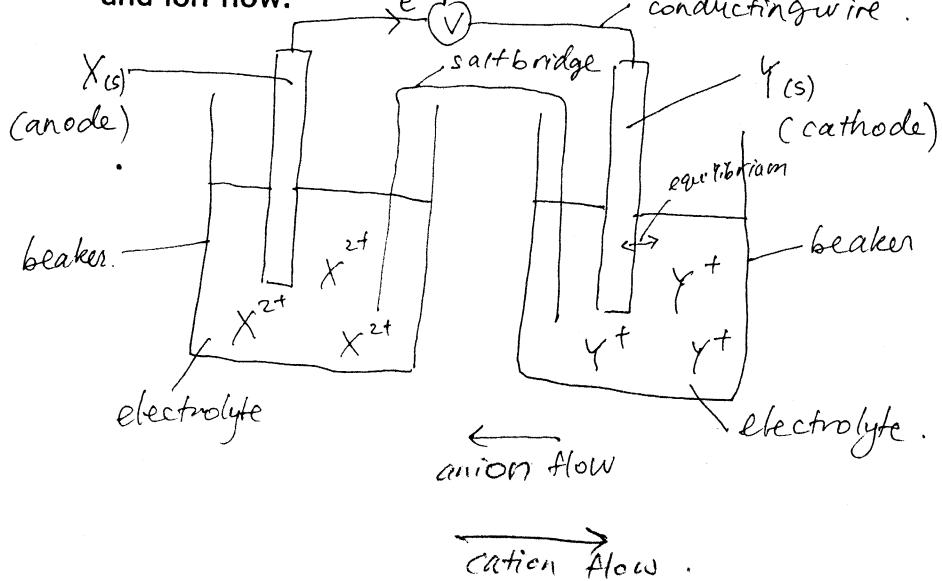
Question 18 (6 marks)**Marks**

Consider the following electrochemical cell:



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

3

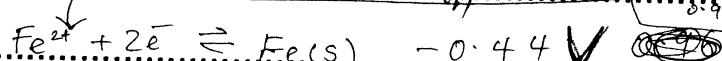
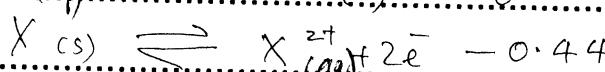
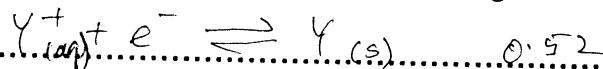


* Ruler.
* Neat.

- (b) The EMF of the cell under standard conditions is 0.96V.

Given that the reduction potential for $Y^+_{(aq)} + e^- \rightarrow Y_{(s)}$ is 0.52V, write the oxidation half-equation for the cell, including its voltage.

* STATES 2

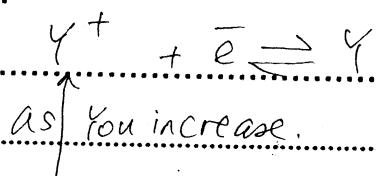


* VOLTAGE

* EQUATIONS

- (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



equilibrium moves to right.

uses more electrons..

\therefore electron push would increase.

\therefore more voltage.

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

medicine

* DESCRIBE THE WAY IT'S USED

- drunk
- 2nd
- exp
enses

Iodine-131 is used in medicine to diagnose thyroid cancer and under/over active thyroids. This is because iodine is selectively absorbed by the thyroid only.

Iodine-131 is also very good to use as it releases low energy gamma rays which can pass through the body & be detected by medical instruments. It is also very good to use because it has a short half life of a few days which means it decomposes quickly and thus less harm to the body. The alpha & beta particles released allow it to be effective in destroying cancerous cells.

Question 20 (5 marks)**Marks**

A titration was carried out using 0.246 mol L^{-1} HCl to standardise 25.0 mL 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

$\text{HCl} + \text{Na}_2\text{CO}_3 \rightarrow \text{H}_2\text{O} +$ Calculation		Justification
$n(\text{HCl}) = CV = 0.246 \times 0.0222$ $= 5.46 \times 10^{-3} \text{ mol}$		0.0 222 was used as 22.2 ml was a repeated figure in titration & those are the most accurate & reliable.
$n(\text{Na}_2\text{CO}_3) = \frac{5.46 \times 10^{-3}}{2}$ $= 2.73 \times 10^{-3} \text{ mol}$		Because the ratio is 1:2 $\text{Na}_2\text{CO}_3 + 2\text{HCl} \rightarrow \text{CO}_2 + \text{H}_2\text{O} + 2\text{NaCl}$
$n(\text{Na}_2\text{CO}_3) = \frac{1}{V} = \frac{2.73 \times 10^{-3}}{0.025}$ $= 0.109 \text{ M}$		Because concentration is measured - in moles per volume. \rightarrow methyl orange would be used.

- (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

methyl orange should be used as the reaction between a strong acid and weak base will result in a weak acid. Therefore methyl orange which changes colour in a weak acid range 3.0 - 4.5 would be suitable.

Question 21 (7 marks)**Marks**

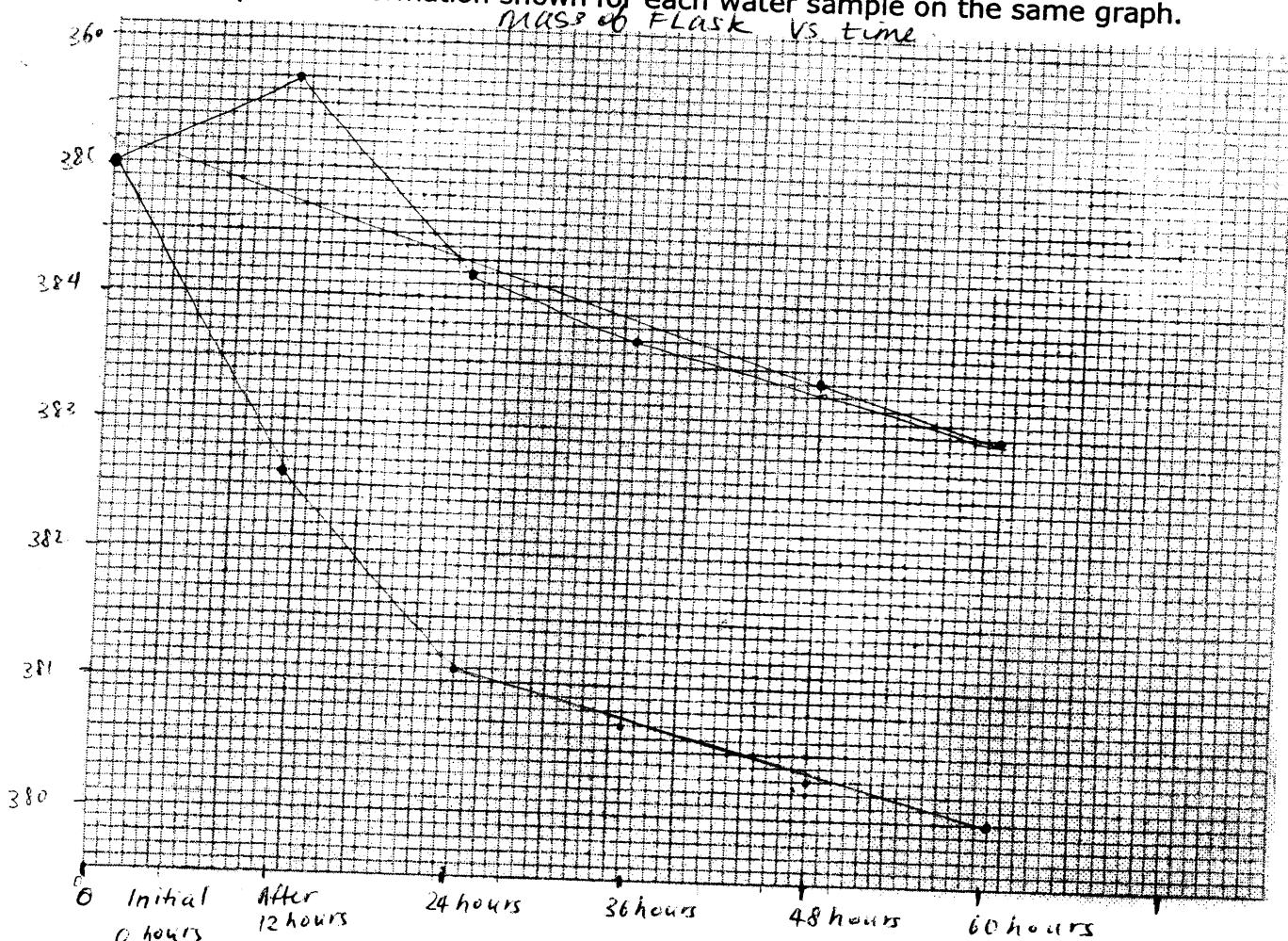
As part of your practical work you decarbonated a beverage. A student decarbonated a sample of soda water by opening the bottle it was in and leaving it for a period of time, weighing it at regular intervals. She also used a non-carbonated sample of water as a control, recording its mass at the same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

Both after 24 hours lost mass occurs at a more linear, constant rate than was smaller than previous.

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.

- (c) Use the graph to determine the volume of CO₂ gas produced at 25°C and 100kPa. Show your working.

2

$$\text{mass water loss} : 2 \text{g}$$

$$\text{mass from soda water lost} : 5 \text{g}$$

$$\begin{aligned} \text{mass CO}_2 \text{ lost} &= 5 - 2 \\ &= 3 \text{ grams} \end{aligned}$$

$$V = 0.068 \times 24.79$$

$$= 1.69 \text{ L}$$

$$n(\text{CO}_2) = \frac{3}{44}$$

$$= 0.068 \text{ moles}$$

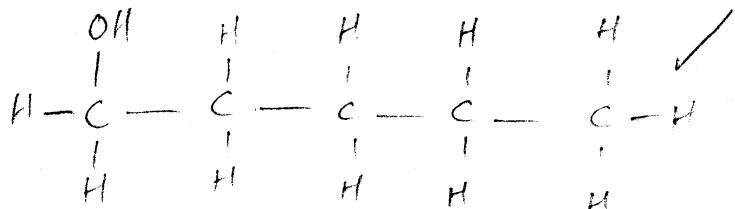
Question 22 (8 marks)**Marks**

Artificial banana essence, pentyl ethanoate, is an ester.

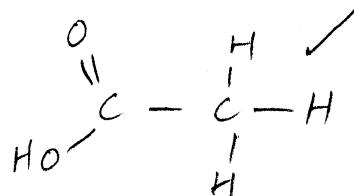
- (a) Draw and name the structures of the substances that would be used to manufacture this ester

4

1-pentanol

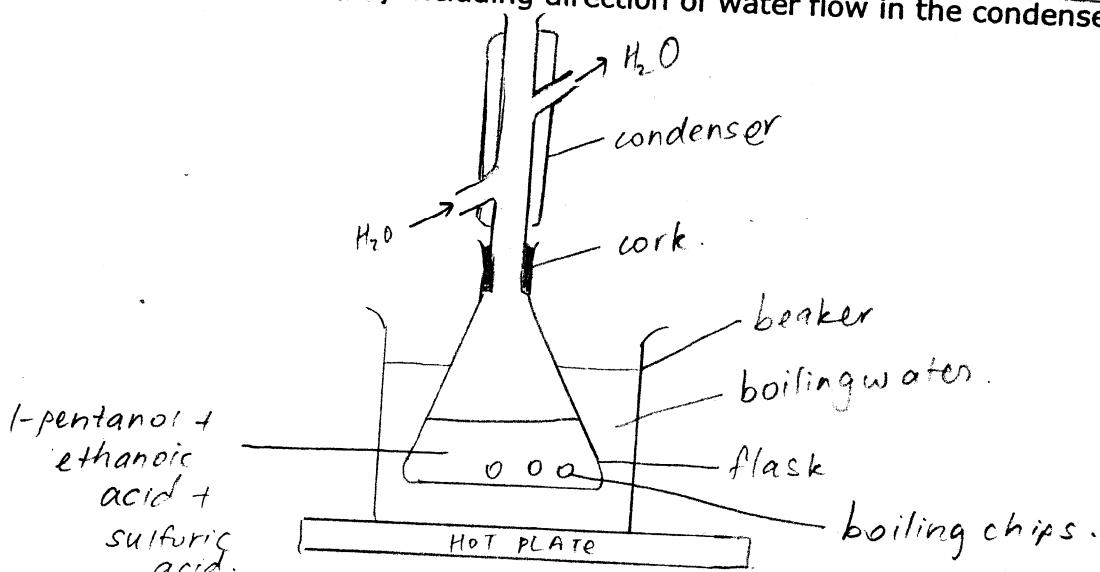


ethanoic acid



- (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

Sulfuric acid acts as a catalyst in the preparation of an ester as otherwise it is a slow equilibrium reaction.

- (d) Explain the need for refluxing during esterification

1

refluxing is important from preventing the volatile products from escaping. It condenses the vapours returning them back into the mixture for further heating.

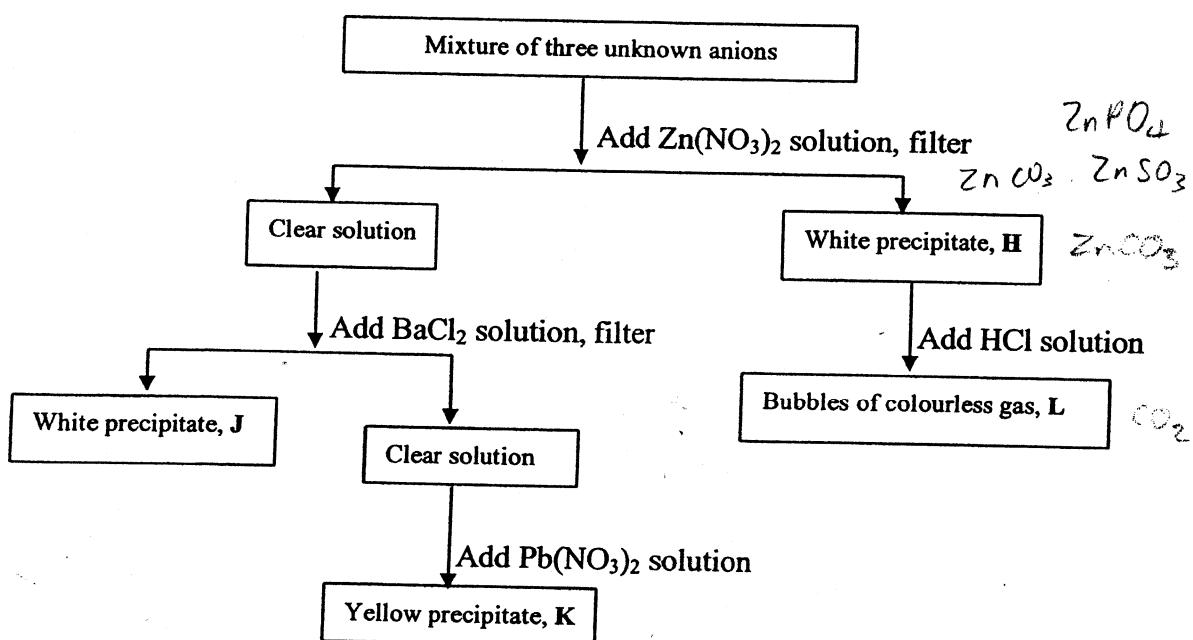
Question 23 (5 marks)**Marks**

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.

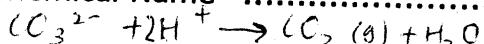


- (a) Identify any **one** of the precipitates, H, J or K or the gas, L and write the balanced net ionic equation for the reaction involved in its formation.

4

Letter of precipitate or gas: ... (L) carbon dioxide ✓

Chemical Name carbon dioxide ✓

Ionic equation for its formation: $\text{ZnCO}_3 + 2\text{HCl} \rightarrow \text{CO}_2 \text{ (g)} + \text{H}_2\text{O} + \text{ZnCl}_2$ (not ionic!!)Anions present in the original solution CO_3^{2-} ✓

- (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.

..... a white precipitate would form if 1

..... H_2SO_4 is added. or pale green flame for flame

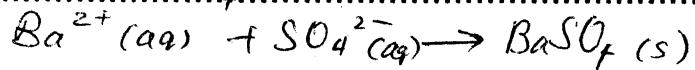
+ 2 S +

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

- ① Accurately weigh 5 grams of ammonium sulfate fertilizer was dissolved in 250 ml in a volumetric flask in hot water to dilute.
- ② 100 ml of this solution was pipetted into a flask.
- ③ It was then acidified with few drops of HCl to precipitate out any carbonate ions. It was then brought to the boil. To remove any NO_3^- present as HNO_3 , thus preventing co-precipitation of $\text{Ba}(\text{NO}_3)_2$.
- ④ Slowly, hot dilute BaCl_2 solution was added from a burette with thorough stirring until no more precipitate formed. Barium ions cause the sulfate to precipitate as insoluble BaSO_4 .



- (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

Results were NOT very reliable
 There were many problems that were encountered, firstly being that much of the BaSO_4 precipitate passed through the low grade standard filter paper used at schools, thus a lower mass of sulfate would have been calculated. This problem can be improved by using analytical filter paper or a sintered glass funnel.

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

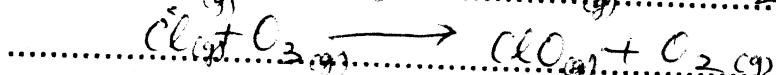
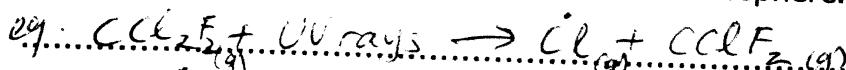
CCl_2F_2 is a CFC found in the troposphere
that is used in refrigerant and propellants.

Freon-11 ($\text{CFC}-11$) is used in plastics

CFC-12 used in refrigeration or air-conditioning.

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

2



$\text{ClO}_{(\text{g})} + \text{O}_{(\text{g})} \rightarrow \text{Cl}_{(\text{g})} + \text{O}_2_{(\text{g})}$. Thus a chlorine radical is produced again, laden with potential to start the cycle again.

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

3

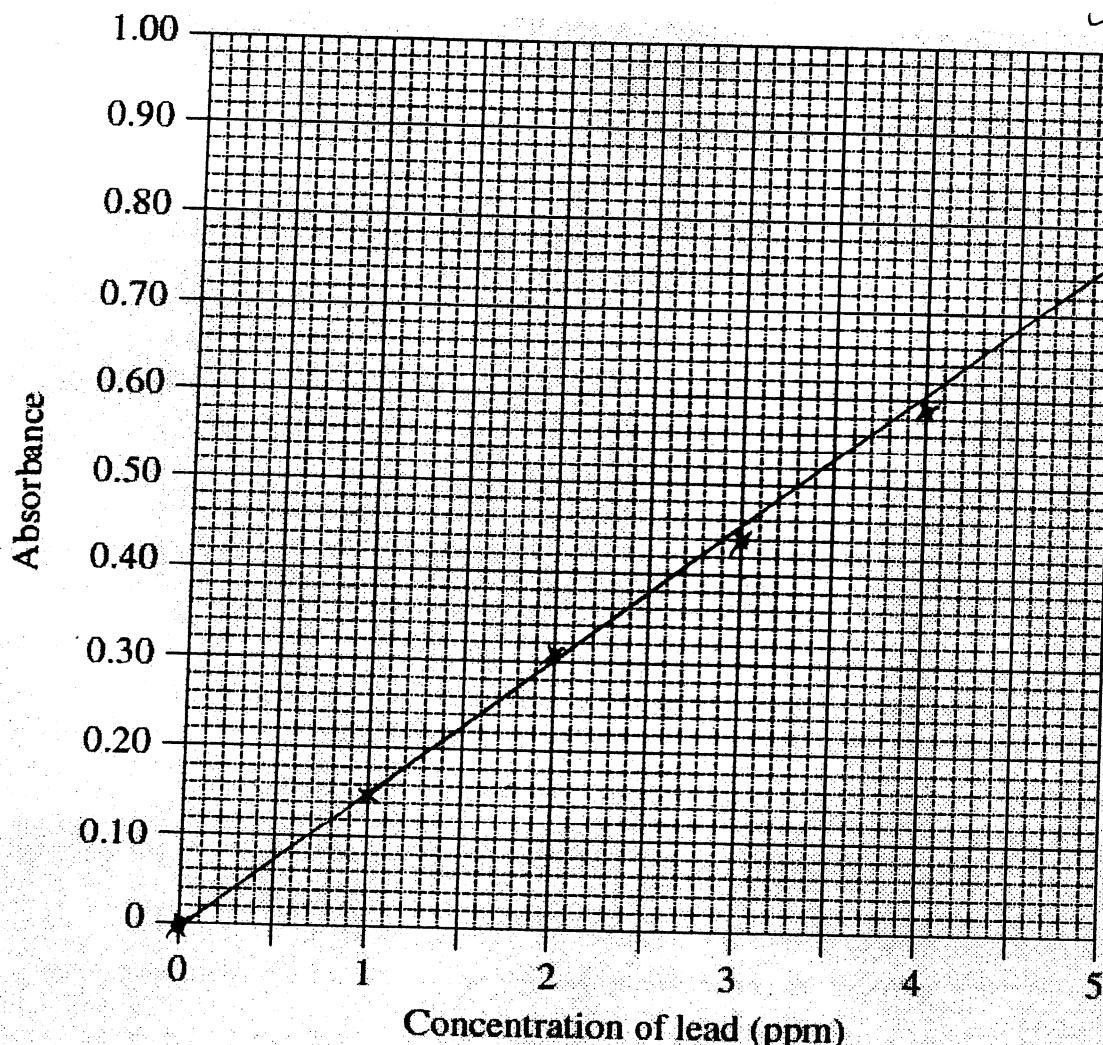
✓ CFC's were first temporarily replaced by HCFC, hydrochlorofluorocarbons, which containing an extra C-H is easily broken and reactive; thus it usually reacts in the troposphere before it reaches the stratosphere. Being heavier, it ~~also~~ takes longer to reach the ~~stratosphere~~ stratosphere. HCFC's were then replaced by HFC which ~~do not have~~ zero ozone potential because it does not contain the destructive Cl atom. Such replacements have been very effective as 2004 was the first year where ~~ozone~~ ozone levels were seen to recover. Although less effective in use and thus less economical, its effectiveness ~~is~~ environmental make the alt. chemicals worth it.

Question 26 (3 marks)

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

<i>Concentration of lead standard (ppm)</i>	<i>Absorbance</i>
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



Question 26 (continued)

- (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.

Marks

<i>Solutions made from soil samples</i>	
<i>Area sampled</i>	<i>Absorbance</i>
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.

.....slightly.....more than.....approximate.....1.ppm.....,.....1.3 ppm.....

1