CHRIST CHURCH GRAMMAR SCHOOL

Year 12 Chemistry
Trial Examination 2012

TIME ALLOWED FOR THIS PAPER

Reading time before commencing work: Ten minutes

Working time for the paper: Three hours

MATERIAL REQUIRED/RECOMMENDED FOR THIS PAPER

To be provided by the candidate
Pens, pencils, calculator satisfying the conditions set by Curriculum Council.

To be provided by the supervisor
This Question/Answer Booklet; Multiple-choice Answer Sheet; Chemistry Data Sheet.

Section 1		Section 2			Section 3			Totals		
Mark	Out of	Q	Mark	Out of	Q	Mark	Out of		Mark	Out of
	25	26		10	37		19	Section 1		50
		27		8	38		16	Section 2		70
		28		6	39		16	Section 3		80
		29		8	40		14	Total		200
		30		4	41		15			
		31		3				**Total**		**%**
		32		4						
		33		6						
		34		5						
		35		12						
		36		4						
		Total		70	Total		80			

STRUCTURE OF THE PAPER

Section	Format	No. of questions set	No. of questions to be attempted	Recommend time (minutes)	Marks Allocated	Marks
1	Multiple Choice	25	ALL	50	25	25%
2	Short Answer	11	ALL	60	70	35%
3	Extended Response	5	ALL	70	80	40%

Instructions to candidates

1. Answer the questions according to the following instructions

   Section 1: Answer all questions on the separate Multiple-choice Answer Sheet provided. For each question shade the box to indicate your answer. Use only a blue or black pen to shade the boxes. If you make a mistake, place a cross through the square and shade a new answer. Do not erase or use correction fluid. Marks will not be deducted for incorrect answers. No marks will be given if more than one answer is completed for any one question.

   Section 2 and 3: Write your answers in the Question/ Answer Booklet.

2. When calculating numerical answers, show your working or reasoning clearly. Express numerical answers to three significant figures and include appropriate units where applicable.

3. You must be careful to confine your answers to the specific question asked and to follow instructions that are specific to a particular question.

4. Spare pages are included at the end of the booklet. They can be used for planning your responses and/ or as additional space if required to continue an answer.

   • Planning: If you use the spare pages for planning, indicate this clearly at the top of the page.
   • Continuing an answer: If you need the space to continue an answer, indicate in the original answer space where the answer is continued, i.e. give the page number. Fill in the number of the question(s) that you are continuing to answer at the top of the page.

5. The Chemistry Data Sheet will be collected with your Question/answer Booklet

Section 1: Multiple-choice   **25% [25 Marks]**

This section has **25** questions. Answer **all** questions on the Multiple-choice Answer Sheet provided. Use only blue or black pen to shade the boxes. If you make a mistake, place a cross through that square. Do not erase or use correction fluid. Marks will not be deducted for incorrect answers. No marks will be given if more than one answer is given for any question.

Suggested working time for this section is 50 minutes.
_____

1.   Which group of elements is arranged in order of increasing electronegativity?

        A.   Li, F, Si, C

        B.   Si, C, Li, F

        C.   Li, C, Si, F

        D.   Li, Si, C, F

2.   Consider the successive ionisation energies of a particular element in the third period.

Ionisation	1st	2nd	3rd	4th	5th	6th	7th
Ionisation energy ($MJ\ mol^{-1}$)	1.02	1.91	2.92	4.96	6.28	21.3	25.4

        The group to which this element belongs and the charge on its most common and stable ion, would be:

        A.   group 5 and 3–

        B.   group 15 and 3–

        C.   group 15 and 5+

        D.   group 17 and 1–

3.   Which of the following statements is true about the trends in the periodic table?

        A.   The melting points of group 16 elements tend to decrease from top to bottom.

        B.   The melting points of group 14 fluorides tend to increase from top to bottom.

        C.   Each of the group 14 elements has the highest melting point of their period.

        D.   The first ionisation energy and the radii of elements in period 3 decrease from left to right.

4.   Which of the following can form hydrogen bonds with water?

$NH_2CH_2COOHHC\ell$ CH_4 CH_3CHO

A. CH_4 only

B. $HC\ell$ and CH_4 only

C. NH_2CH_2COOH and CH_3CHO only

D. NH_2CH_2COOH only

5.   Which of the following represents the correct shapes of each of the molecules $PC\ell_3$, HCN, F_2O and H_2CO?

|	$PC\ell_3$	H_2CO	F_2O	HCN
A.	pyramidal	pyramidal	bent	bent
B.	trigonal planar	pyramidal	linear	bent
C.	pyramidal	trigonal planar	bent	linear
D.	trigonal planar	trigonal planar	linear	linear

6.   Which statement about the behaviour of a catalyst in a chemical reaction is correct? A catalyst provides an alternative pathway with:

A.   a lower activation energy for the forward reaction only.

B.   a higher activation energy for the forward reaction only.

C.   a lower activation energy for both the forward and reverse reactions.

D.   a higher activation energy for both the forward and reverse reactions.

7.   Consider the following equilibrium: $H_2(g) + I_2(g) \rightleftarrows 2 HI(g)$

The equilibrium constant is 160 at 500 K and 54 at 700 K. This would indicate that the forward reaction is:

A.   fast

B.   slow

C.   exothermic

D.   endothermic

The next three questions refer to the following equilibrium:

$$4\ NH_3(g)\ +\ 5\ O_2(g)\ \rightleftarrows\ 4\ NO(g)\ +\ 6\ H_2O(g) \qquad \Delta H\ =\ -908\ kJ\ mol^{-1}$$
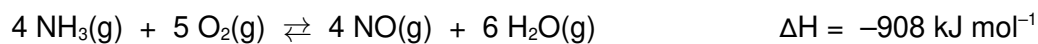
8.   The equilibrium constant for this system is given by:

   A. $\dfrac{[NH_3]^4\ [O_2]^5}{[NO]^4\ [H_2O]^6}$

   B. $\dfrac{4[NH_3]\ 5[O_2]}{4[NO]\ 6[H_2O]}$

   C. $\dfrac{[NO]^4}{[NH_3]^4\ [O_2]^5}$

   D. $\dfrac{[NO]^4\ [H_2O]^6}{[NH_3]^4\ [O_2]^5}$

9.   If the temperature of an equilibrium mixture of these gases was increased at constant volume, then:

   A.   the mass of NH_3 would increase and K would increase.

   B.   the mass of NH_3 would increase and K would decrease.

   C.   the mass of NH_3 would decrease and K would increase.

   D.   the mass of NH_3 would decrease and K would decrease.

10.   A decrease in the volume of an equilibrium mixture of these gases at constant temperature would cause:

   A.   a decrease in the amount of NO.

   B   a decrease in the rate of the forward reaction.

   C.   the value of K to increase.

   D   none of the above.

11.   Consider the following information regarding two solutions.

   Solution 1:   20.0 mL of 0.100 mol L^{-1} HCℓO has a pH of 4.27

Solution 2:   20.0 mL of 0.100 mol L^{-1} HCN has a pH of 5.11

The two solutions are combined. Which of the following would be present in the mixture at the highest concentration?

A. H_3O^+

B.   HCN

C. $HC\ell O$

D. $C\ell O^-$

12.   The pH of an aqueous solution is found to be 12.00. Which of the following solutions is consistent with this observation?

   A. 1.00×10^{-12} mol L^{-1} sodium hydroxide.

   B. 5.00×10^{-3} mol L^{-1} barium hydroxide.

   C. 1.00×10^{-12} mol L^{-1} nitric acid.

   D. 1.00×10^{-1} mol L^{-1} potassium hydroxide.

13.   Which of the conditions best describes the solutions of the three salts?

	$KC\ell$	Na_2HPO_4	NH_4NO_3
A	neutral	basic	acidic
B	acidic	neutral	acidic
C	neutral	acidic	basic
D	basic	basic	basic

14.   In standardising a sodium hydroxide solution by titrating 20.00 mL aliquots against a

standard hydrochloric acid solution, a student experienced difficulty in obtaining consistent values for the volume of acid added.

Which of the following sequential steps could be responsible for this lack of precision?

A.   The burette was cleaned and rinsed thoroughly with the standard acid solution before being filled.

B.   Several 250 mL conical flasks were washed, and rinsed thoroughly with the sodium hydroxide solution.

C.   A clean pipette was rinsed with the sodium hydroxide solution and a 20.0 mL aliquot was carefully pipetted into each conical flask.

D.   To each flask in turn, standard hydrochloric acid solution was added with care from the burette until the end point was observed, and the volume added was recorded.

15.   Using 0.100 mol L^{-1} NaOH, a student titrated a 25.0 mL aliquot of a 0.100 mol L^{-1} weak monoprotic acid, and separately titrated 25.0 mL of a 0.100 mol L^{-1} strong monoprotic acid.

Which statement about the volume of base required to reach the equivalence point is correct?

A.   The weak acid will require a smaller volume of 0.100 mol L^{-1} NaOH than the strong acid.

B.   The weak acid will require the same volume of 0.100 mol L^{-1} NaOH as the strong acid.

C.   The weak acid will require a larger volume of 0.100 mol L^{-1} NaOH than the strong acid.

D.   The volume of 0.100 mol L^{-1} NaOH required will depend on the mass of each acid used.

16.   How many different carboxylic acid isomers have the molecular formula $C_5H_{10}O_2$?
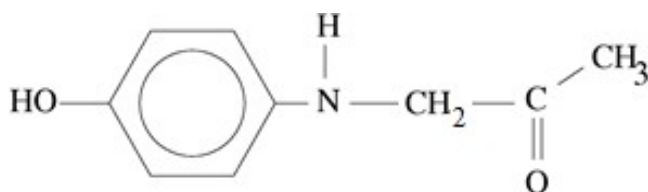
A.   5

B.   4

C.   3

D.   2

17.   Consider the following diagram:

$$C_3H_6Br_2 \xleftarrow{\quad Br_2 \quad} X \xrightarrow{\quad Y \quad} C_3H_7OH$$

X → (H₂/catalyst) → Z
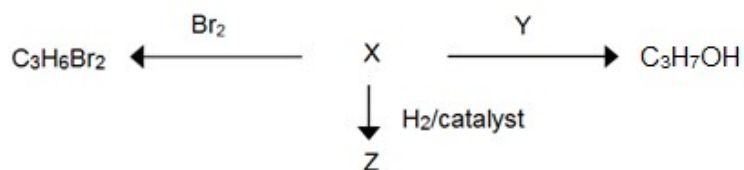
The formulae of substances X, Y and Z are probably:

	X	Y	Z
A.	C_3H_8	NaOH	C_3H_8
B.	C_3H_8	H_2O	C_3H_6
C.	C_3H_6	HNO_3	C_3H_8
D.	C_3H_6	H_2O	C_3H_8

18.   Consider the structure below:

Which of the following correctly identifies two functional groups in this compound?

A.   primary amine and ketone

B.   alcohol and ketone

C.   amino acid and alcohol

D.   alcohol and carboxylic acid

19.   In which of the following are substances listed in order of increasing boiling point?

A.   lithium, sodium, magnesium

B.   dimethylpropane, methylbutane, pentane

C.   propanoic acid, butanol, butanone

D. NH_3, PH_3, AsH_3

20.   Which of the following mixtures would **not** act as a buffer?

        A.   NaF and HF

        B. NH_3 and NH_4Cl

        C. $NaCl$ and HCl

        D. KCH_3COO and CH_3COOH

21.   In which of the following does the oxidation number of an element decrease by 3?

        A.   NO   → NO_3^-

        B. MnO_2 → MnO_4^-

        C. PH_4^+ →   P

        D. CrO_4^{2-} → Cr^{3+}

22.   If three beakers were prepared containing:

                I $Fe_{(s)}$ in nickel(II) nitrate solution
                II $Pb_{(s)}$ in nickel(II) nitrate solution
                III $Ni_{(s)}$ in lead(II) nitrate solution

        then a reaction could occur in beakers:

        A.   **II** and **III** only

        B.   **I** and **III** only

        C.   **I** only

        D.   **II** only

23.   Pieces of four different metals J, L, M and N were separately placed into four

solutions containing J^{2+}, L^{2+}, M^{2+} and N^{2+} ions respectively and the observations listed below:

I   Metal L remained unchanged in all four solutions.

II   Displacement reactions were observed when metal M was placed in solutions of L^{2+} and J^{2+}, but not in N^{2+}.

Which of the following electrochemical cells would produce the largest cell potential?

A. $L / L^{2+} // N^{2+} / N$

B. $M / M^{2+} // J^{2+} / J$

C. $J / J^{2+} // L^{2+} / L$

D. $L / L^{2+} // M^{2+} / M$

24.   What is the function of the salt bridge in an electrochemical cell?

A.   To allow the movement of ions between the two half-cells to maintain electrical neutrality.

B.   To supply the ions necessary for oxidation and reduction.

C.   To allow the electrons to move from the anode to the cathode.

D.   To keep the level of the solutions equal in both half-cells.

25.   In the extraction of gold from its ore, the gold must initially be dissolved into solution. This occurs by the MacArthur-Forrest process in which the crushed, gold-bearing ore is mixed with sodium cyanide solution and air passed through it.

The reaction that occurs is:

$$4\ Au(s) +\ 8\ CN^-(aq)\ +\ 2\ H_2O(\ell)\ +\ O_2(g)\ \rightarrow\ 4\ [Au(CN)_2]^-(aq)\ +\ 4\ OH^-(aq)$$
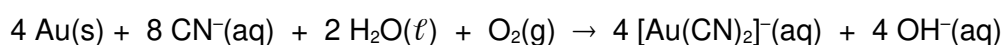
Which one of the following statements is correct?

A.   The gold is the oxidant.

B.   Cyanide ions are reduced.

C.   The oxidation state of the gold changes from 0 to −1.

D.   The oxygen acts as the oxidant in the reaction.

Section 2:   Short answer   **35% [70 Marks]**

This section has **11** questions. Answer **all** questions. Write your answers in the space provided. Spare pages are included at the end of this booklet. They can be used for planning your responses and/or as additional space if required to continue an answer.

When calculating numerical answers, show your working or reasoning clearly. Express numerical answers to three significant figures and include appropriate units where applicable.

- Planning: If you use the spare pages for planning, indicate this clearly at the top of the page.
- Continuing an answer: If you need the space to continue an answer, indicate in the original answer space where the answer is continued, i.e. give the page number. Fill in the number of the question(s) that you are continuing to answer at the top of the page.

Suggested working time for this section is 60 minutes.

_____

Question 26   **[10 marks]**

An electrochemical cell using Cu/Cu^{2+} and Cr/Cr^{3+} is shown below.
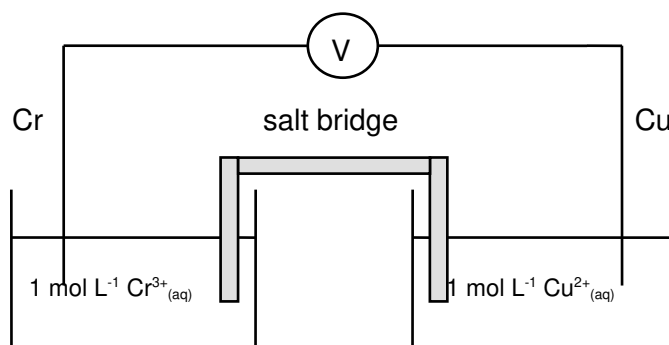
(a)   Write the cathode and anode reactions for this cell:

     cathode _____ anode _____
                                                                [2 marks]

(b)   On the diagram show the flow of electrons and the direction in which the anions move.
                                                                         [2 marks]

(c)   A strong electrolyte is usually used as a salt bridge. Why is sodium carbonate solution, $Na_2CO_3(aq)$, unsuitable?

_____

_____
                                                                         [2 marks]

(d)   Both electrodes have a mass of 10.0 g at the start of the operation of the cell. After 10 minutes the mass of one electrode has changed to 10.56 g. What is mass of the other electrode?

_____

_____

_____

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[4 marks]

Question 27   **[8 marks]**

Information for two acids are as follows :

0.001 mol L^{-1} solution of $HClO_4$ has a pH = 3 and 0.001 mol L^{-1} solution of $HClO$ has a pH = 5.3.

(a)   Using information given above explain, with equations if possible, why $NaClO_4(aq)$ has a pH = 7 but $NaClO(aq)$ has a pH > 7.

_____

_____

_____

_____

_____

_____

[4 marks]

(b)   Again, using the given information, what chemicals could be used for a buffer solution?

_____ and _____   [1 mark]

(c)   Explain what happens with the aid of an equation if HCℓ (aq) is added to the buffer in (b).

_____

_____

_____

_____

_____

_____

[3 marks]

Question 28   **[6 marks]**

The pH of pure water at 90°C is 6.13.

(a)   What is the K_w, the equilibrium constant for water, at 90°C ? Show all working.

_____

_____

_____

_____

_____

_____

[3 marks]

(b)   Using this information determine whether the self ionization of water,
        $H_2O(\ell) \rightleftarrows H^+(aq) + OH^-(aq)$, is an exothermic or endothermic reaction. Show all working.

_____

_____

_____

_____

_____

_____

[3 marks]

Question 29   **[8 marks]**

The products when the oxidants nitric acid, HNO_3 and sulfuric acid, H_2SO_4 are reacted with copper metal and zinc depend on the concentration of the acids.

If the concentrated HNO_3 acid is used a brown gas is obtained and if concentrated H_2SO_4 is used sulfur dioxide gas is produced.

(a) Write the half equation for concentrated nitric acid producing a brown gas.

_____

[2 marks]

(b) Now write the full equation for the reaction between copper and concentrated nitric acid.

_____

[2 marks]

(c) In relation to the reduction potential for Cu^{2+} to Cu, what can you say about the reduction potential of concentrated nitric acid?

_____

[1 mark]

(d) Write the full equation for the reaction between concentrated sulfuric acid and zinc.

_____

_____

_____

[3 marks]

Question 30   **[4 marks]**

Glycine is an amino acid with the formula H_2NCH_2COOH

(a)   Give the shape about the following highlighted atoms:

N _____

C _____

O _____

[3 marks]

(b)   Write the formula of the species that is present when the glycine molecule is placed in a neutral solution (pH = 7).

_____

[1 mark]

Question 31   **[3 marks]**

The first four successive ionization energies ($kJmol^{-1}$) for three elements X, Y and Z are listed below.

These elements could be Mg, Li, Ca or Na.

Place your choice for X, Y and Z into the last column of the table.

element	1st value	2nd value	3rd value	4th value	answer
X	738	1450	7733	10542	
Y	598	1145	4912	6491	
Z	496	4562	6910	9543	

Question 32   **[4 marks]**

Draw the valence structures (electron dot diagrams) for the following, showing all valence electrons as either **..** or — .

a) NH_4CN	b) $COCl_2$ molecule

Question 33   **[6 marks]**

When two compounds, X and Y, are reacted with Br_2(aq) in the absence of light, the final product in both reactions was 1,1,2-tribromopropane.

(a)   Draw the structure and give the IUPAC name of X and Y.

compound	structure	name
X		
Y		

[4 marks]

(b)   Draw a piece of the addition polymer polypropene giving three repeating units in your answer.

[2 marks]

Question 34   **[5 marks]**

When compounds **A** and **B** are reacted in the presence of concentrated sulfuric acid, a sweet smelling liquid **X** with formula $CH_3CH_2COOCH_2CH_3$ is produced.

Compound **A** can also be oxidized using acidified potassium permanganate to give compound **C** that reacts with $Na_2CO_3(s)$ to give a colourless gas.

(a)   IUPAC Name of **X**   _____   [1 mark]

(b)   Write the IUPAC name and the structure of compound **B**

      Structure _____   Name _____

                                                             [2 marks]

(c)   Write an ionic equation for reaction between compound **C** and $Na_2CO_3(s)$

_____

                                                             [2 marks]

Question 35   **[12 marks]**

When chlorine gas is added to water, the following equilibrium is established:

$$Cl_2(g) + H_2O(\ell) \rightleftharpoons HClO(aq) + H^+(aq) + Cl^-(aq) \qquad \Delta H > 0$$

(a)   Write the equilibrium constant expression for this reaction.

[1 mark]

(b)   Complete the following table. Answers should be given as "increase", "decrease" or "no change".

Change made to the equilibrium system	Effect on rate of forward reaction after equilibrium has been re-established	Effect on pH of solution after equilibrium has been re-established
Decrease the temperature of the system at constant volume.		
Acidify the system by the addition of a small quantity of concentrated nitric acid		
Addition of a small amount of silver nitrate solution		
Decrease the pressure of $Cl_2(g)$ at constant temperature.		

[8 marks]

(c)   When a change was made to the system, the K value increases.

(i)   What change was made to the system? _____ [1 mark]

(ii)   Explain your answer

_____

_____

_____
[2 marks]

Question 36   **[4 marks]**

The boiling point of ethanol, CH_3CH_2OH is lower than the boiling point of butan-1-ol, $CH_3CH_2CH_2CH_2OH$ but the solubility of ethanol in water is higher than the solubility of butan-1-ol in water. Explain these facts.

_____

_____

_____

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END OF SECTION 2

Section 3: Extended answer   **40% [80 Marks]**

This section contains **five** questions. You must answer **all** questions. Write your answers in the spaces provided.

When calculating numerical answers, show your working or reasoning clearly. Express numerical answers to three significant figures and include appropriate units where applicable.

Spare pages are included at the end of the booklet. They can be used for planning your responses and/ or as additional space if required to continue an answer.
   • Planning: If you use the spare pages for planning, indicate this clearly at the top of the page.
   • Continuing an answer: If you need the space to continue an answer, indicate in the original answer space where the answer is continued, i.e. give the page number. Fill in the number of the question(s) that you are continuing to answer at the top of the page.

Suggested working time for this section is 70 minutes.
_____

Question 37   **[19 marks]**

There are numerous trends and patterns that occur in chemistry. Many of these can be explained using a knowledge of bonding.

(a)   The electronegativity of an element was first proposed by Linus Pauling and can be used to explain some physical properties of substances.

(i)   State how electronegativity changes down Group 1 and explain why this trend occurs.

_____

_____

_____

_____

_____
                                                                        [3 marks]

(ii)   State how electronegativity changes across Period 3 and explain why this trend occurs.

_____

_____

_____

_____

_____
                                                                        [3 marks]

(b)   The boiling points of alcohols with the molecular formula $C_4H_{10}O$ are 82°C, 99°C, 108°C and 118°C. The secondary alcohol has a boiling point of 99°C and has been added to the table for you. Complete the following table by identifying the class of each alcohol and assigning a boiling point.

Structure of isomer	Class of alcohol	Boiling Point (°C)
	Secondary	99

[10 marks]

(c)   Explain why the isomers with the **lowest** and **highest** boiling points differ.

_____

_____

_____

_____

_____

_____

_____

[3 marks]

Question 38   **[16 marks]**

An alloy containing iron and manganese was analysed using the following method.

Step 1: 2.30 g of the alloy was first warmed with 100 mL of dilute nitric acid creating a solution of Fe^{3+} and Mn^{2+} ions.

Step 2: Excess sodium bismuthate, $NaBiO_3$, was then added to the solution of Fe^{3+} and Mn^{2+} ions. When treated with sodium bismuthate, the bismuthate ion, BiO_3^-, forms Bi^{3+} and Mn^{2+} forms MnO_4^-.The resulting solution turned purple.

Step 3: Bismuthate ions were then removed . The solution produced in Step 2 was diluted to a total volume of 250 mL. Three 20.0 mL aliquots were titrated with 0.0920 mol L^{-1} of iron (II) sulphate (these aliquots were acidified). The resulting average titre of iron (II) sulfate with the solution was found to be 25.3 mL.

(a)   What is the oxidation number of Bi in BiO_3^- ion?

_____

                                                                        [1 mark]

(b)   Write a balanced half equation for the reduction process in Step 2.

_____

                                                                        [2 marks]

(c)   Write a balanced half equation for the oxidation process in Step 2.

_____

                                                                        [1 mark]

(d)   Write the overall equation that occurs in Step 2.

_____

                                                                        [2 marks]

 (e)   Write a balanced redox equation for the titration in Step 3 between Fe^{2+} and MnO_4^-.

_____

                                                                        [2 marks]

(f)   Determine the % by mass of manganese in the alloy.

_____

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[5 marks]

(g)   Suggest why hydrochloric acid would have been an unsuitable choice for acidifying the
solution in Step 3 of the method used. Give a suitable equation to justify your answer.

Explanation

_____

_____

_____

Equation

_____

[3 marks]

Question 39   **[16 marks]**

Guanine is one of the building blocks that makes up DNA. Guanine contains only carbon, nitrogen, oxygen and hydrogen. To determine the empirical formula of guanine a series of experiments were conducted.

Combustion Analysis
Combustion of 6.15 g of guanine produced 8.95 g of carbon dioxide.
In a separate combustion reaction, a 5.20 g mass of guanine produced 1.55 g of water.

Conversion of Nitrogen to Ammonia
A further sample of 4.00 g of guanine was boiled with an excess of sulfuric acid and then neutralised with sodium hydroxide. This converts all the nitrogen in guanine to ammonia.

Volumetric Analysis
The resulting solution was titrated with 5.91 mol L^{-1} hydrochloric acid until the solution was neutralised. Using a suitable indicator for the reaction, the titre was found to be 22.4 mL.

(a)   Determine the empirical formula of guanine.

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[9 marks]

(b)   When vapourised at 300°C at a pressure of 111.1 kPa, a 2.65 g sample of guanine was found to occupy a 752 mL volume. Determine the molecular mass and then the molecular formula for guanine.

_____

_____

_____

_____

_____

_____

[3 marks]

(c)   Amino acids are the building blocks of substances called peptides. The structure for alanine is shown below.

$$O=C(OH)-C(H)(CH_3)-NH_2$$ Alanine
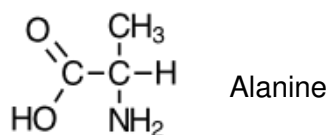
Draw the structure of the peptide formed when three alanine molecules react.
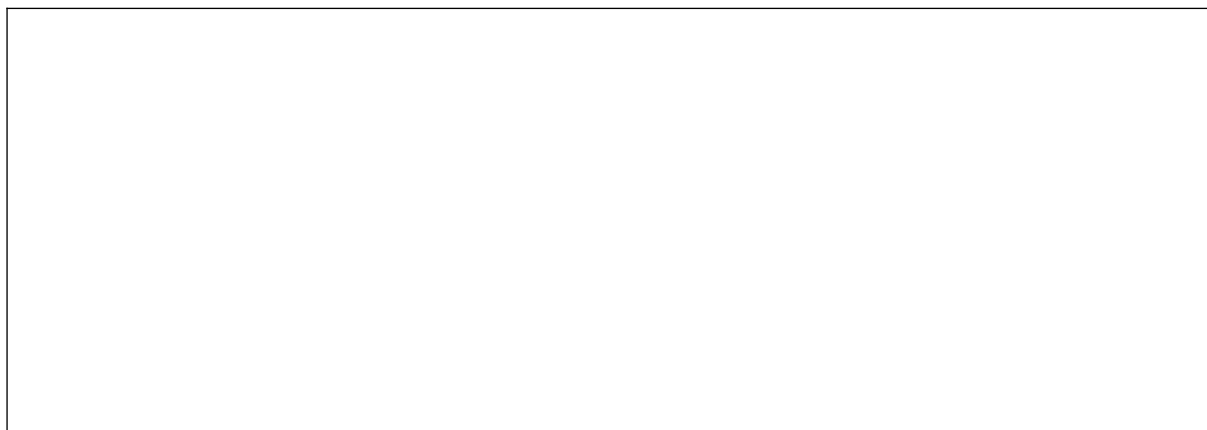
[2 marks]

(ii)   Draw the structure of alanine in a high pH solution.

[2 marks]

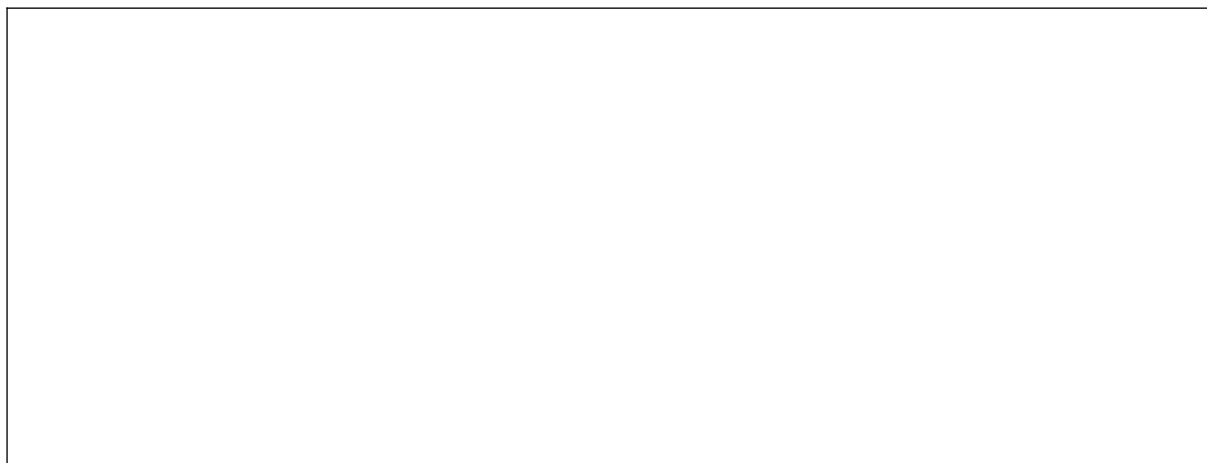**Question 40**   **[14 marks]**

An industrial method for the production of hydrogen cyanide (HCN) occurs by the reaction of carbon monoxide with ammonia gas in the presence of platinum:

$$2\ CH_4\ (g) + 2\ NH_3\ (g) + 3\ O_2\ (g) \rightleftarrows 2\ HCN\ (g) + 6\ H_2O\ (g) \qquad \Delta H = -481\ kJ$$

(a)   Discuss how you could change the following conditions of this reaction to achieve the maximum yield and rate of production of hydrogen cyanide and explain your choices using appropriate theories.

(i)   Temperature

_____

_____

_____

_____

_____

_____

                                                                              [4 marks]

(ii)   Pressure

_____

_____

_____

_____

_____

                                                                              [3 marks]

(iii)   Catalyst

_____

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                                                                              [2 marks]

(b)   Hydrogen cyanide has a molar mass of 27.03 g mol^{-1} and boils at 26.0°C. Nitrogen gas has a molar mass of 28.02 g mol^{-1} and boils at -196°C. Account for the difference in boiling points.

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[5 marks]

Question 41   **[15 marks]**

29.0 mL of 0.312 mol L^{-1} sodium phosphate and 29.0 mL of 0.438 mol L^{-1} cobalt (II) chloride solutions were mixed together. A precipitate was formed. (Assume volumes are additive).

(a)   Write an ionic equation for the reaction.

_____

                                                                                   [2 marks]

(b)   Determine the limiting reagent for the reaction. Justify your answer with appropriate calculations.

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                                                                                   [5 marks]

(c)   Determine the dry mass, in grams, of the precipitate formed.

_____

_____

_____

_____

_____

                                                                                   [2 marks]

(d)   Using the information from parts (a) and (b) give a full observation for the chemical reaction.

_____

_____

[2 marks]

(e)   Determine the concentrations, in mol L^{-1}, of the ions remaining in solution.

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[4 marks]

END OF EXAMINATION