Student Number	
Mark / 75	**Section I**
Mark / 25	**Section II**
Mark / 100	**Total**

2007

HIGHER SCHOOL CERTIFICATE
TRIAL EXAMINATION

Chemistry

General Instructions

- Reading time – 5 minutes
- Working time – 3 hours
- Write using black or blue pen
- Draw diagrams using pencil
- Board-approved calculators may be used
- A Data Sheet and a Periodic Table are provided
- Write your Student Number at the top of this page

Total Marks – 100

<u>Section I</u> ~ Pages 2 – 15
75 marks
This section has two parts, Part A and Part B

Part A – 15 marks
- Attempt Questions 1 – 15
- Allow about 30 minutes for this part

Part B – 60 marks
- Attempt Questions 16 – 29
- Allow about 1 hour and 45 minutes for this part

<u>Section II</u> ~ Pages 16 – 17
25 marks
- Attempt Question 30
- Allow about 45 minutes for this section

Section I
75 marks

Part A – 15 marks
Attempt Questions 1 – 15
Allow about 30 minutes for this part

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.

                     correct

         A ✖   B ✖   C ◯   D ◯

Answer Box for Questions 1 – 15

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 ◯

1 What is the catalyst used in the Haber process?

(A) iron oxide
(B) vanadium oxide
(C) platinum
(D) sulfuric acid

2 How many isomers are exist for $C_3H_6F_2$?

(A) 3
(B) 4
(C) 5
(D) 6

3 Which application is an industrial use of ammonia?

(A) The industrial production of sodium hydroxide.
(B) The preparation of agricultural fertiliser.
(C) The final step in the Contact process.
(D) As a flocculent in water purification.

4 Which ion can cause water hardness?

(A) Cl^-
(B) SO_4^{2-}
(C) Na^+
(D) Ca^{2+}

5 Which element is transuranic and contains only radioactive isotopes?

(A) Pm
(B) Po
(C) Pu
(D) Pa

6   Which of the following will favour the production of ammonia in the Haber process?

   (A)   Increasing the temperature.
   (B)   Decreasing the concentration of $N_2(g)$.
   (C)   Increasing the pressure of the system.
   (D)   Increasing the volume of the system.

7   Which solution has the lowest pH?

   (A) 0.1 mol L^{-1} CH_3COOH
   (B) 0.1 mol L^{-1} HCl
   (C) 0.1 mol L^{-1} H_2SO_4
   (D) 0.1 mol L^{-1} NH_3

8   What is the pH of a $5 \times 10^{-5} \text{ mol L}^{-1}$ solution of nitric acid?

   (A)   4.3
   (B)   5.0
   (C)   9.7
   (D)   11.5

9   Which device could be used to detect the leakage of radiation from a nuclear reactor?

   (A)   Atomic absorption spectrometer
   (B)   Scintillation counter
   (C)   Cyclotron
   (D)   Data logger

10   All of the following substances can be purchased at a supermarket.
         Which substance is basic?

   (A) C_2H_5OH
   (B) $C_6H_{12}O_6$
   (C) $NaCl$
   (D) $NaHCO_3$

11 A student constructs a galvanic cell in order to measure the cell potential between magnesium and silver half-cells.

What is the cell potential $E^\ominus$ (e.m.f.) for the cell?

(A) – 1.56 V
(B) 0.76 V
(C) 3.16 V
(D) 3.96 V

12 What conditions were assumed when determining the cell potential in Question 11?

	Electrolyte	*Temperature*
(A)	1 mol L^{-1} AgNO$_3$(aq)	0°C
(B)	2 mol L^{-1} NaNO$_3$(aq)	25°C
(C)	0.1 mol L^{-1} MgSO$_4$(aq)	25°C
(D)	1 mol L^{-1} AgNO$_3$(aq)	25°C

13 One of the common plastics used for drink bottles is polyethylene terephthalate (PET).
This condensation polymer plastic is formed from two monomers, terephthalic acid and 1,2-ethanediol:

terephthalic acid: HOOC-C$_6$H$_6$-COOH   1,2-ethanediol: HO-(CH$_2$)$_2$-OH

Which equation shows the reaction involved?

(A)   HOOC-C$_6$H$_6$-COOH + HO-(CH$_2$)$_2$-OH → HOOC-C$_6$H$_6$-COO-(CH$_2$)$_2$-OH

(B)   HOOC-C$_6$H$_6$-COOH + HO-(CH$_2$)$_2$-OH → HOOC-C$_6$H$_6$-COO-(CH$_2$)$_2$-OH + H$_2$O

(C)   HOOC-C$_6$H$_6$-COOH + HO-(CH$_2$)$_2$-OH → —(HOOC-C$_6$H$_6$-COOHHO-(CH$_2$)$_2$-OH)—

(D)   HOOC-C$_6$H$_6$-COOH + HO-(CH$_2$)$_2$-OH → —(OC-C$_6$H$_6$-COO-(CH$_2$)$_2$-O)— + 2H$_2$O

14 Elements D, J, Q and T are located in Groups I, II, III, and VI respectively of the Periodic Table. Which oxide is the most acidic?

(A) D_2O

(B)   JO

(C) Q_2O_3

(D) TO_3

15 Which of the following changes could be caused by acid rain?

(A) $Fe(s) \rightarrow Fe^{2+}(aq) + 2e^-$

(B)   The pH of the water in a lake could change from 7.6 to 8.3.

(C) $2O_3(g) \rightarrow 3O_2(g)$

(D) $2H_2O(l) \rightarrow 2H_2(g) + O_2(g)$

Section I (continued)

Part B – 60 marks
Attempt Questions 16 – 29
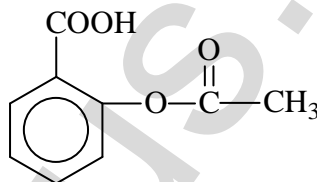**Allow about 1 hour and 45 minutes for this part**

Answer the questions in the spaces provided.

Show all relevant working in questions involving calculations.
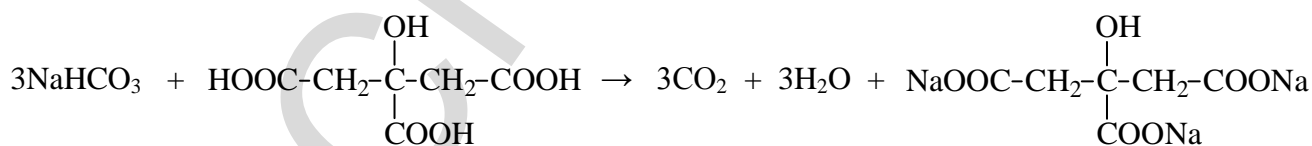

Question 16   (5 marks)

An Alka-Seltzer® effervescent headache tablet contains 0.32 g of aspirin, 1.7 g of sodium hydrogen carbonate and 1.2 g of citric acid.

(a)   Aspirin has a structural formula of…

Clearly identify, by circling and labelling, the alkanoic acid and ester functional groups on the structure above.   **(2 marks)**

(b)   The equation below shows the reaction between sodium hydrogen carbonate and citric acid in the tablet. Calculate the volume of carbon dioxide produced at 25°C and 100 kPa.   **(3 marks)**

$$3NaHCO_3 \; + \; \underset{\substack{\text{COOH}}}{\overset{\substack{\text{OH}}}{HOOC\text{-}CH_2\text{-}C\text{-}CH_2\text{-}COOH}} \; \rightarrow \; 3CO_2 \; + \; 3H_2O \; + \; \underset{\substack{\text{COONa}}}{\overset{\substack{\text{OH}}}{NaOOC\text{-}CH_2\text{-}C\text{-}CH_2\text{-}COONa}}$$

Question 17   (7 marks)

Sanjay is given a research project with the aim of determining the molecular mass of ruseic acid by titration with sodium hydroxide. Ruseic acid is a weak, monoprotic acid which is a water soluble solid.

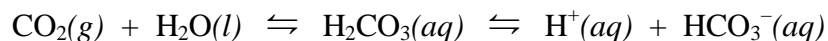The diagram shows his titration planning procedure.
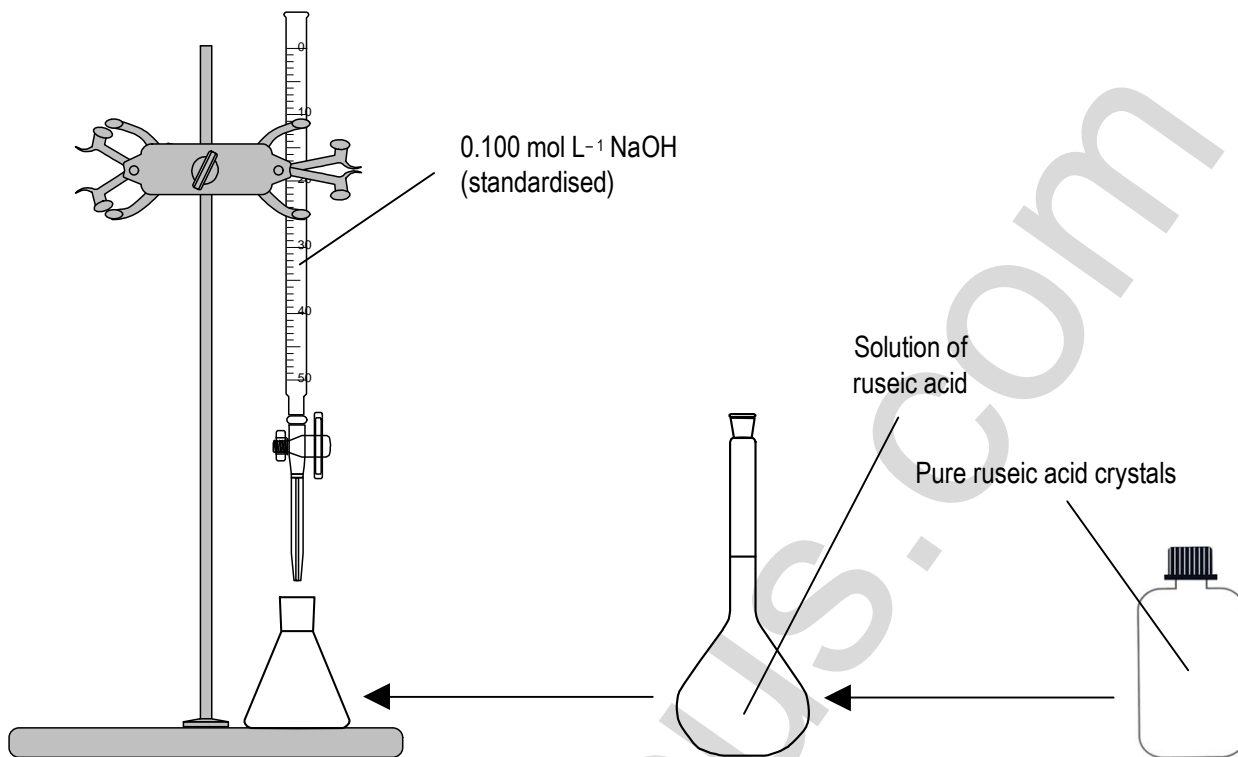
Identify the data Sanjay should record to prepare a ruseic acid solution and then titrate it; and
write the sequence of calculations which he must solve to determine the molecular mass of ruseic acid.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Question 18   (3 marks)

All natural bodies of water contain this buffer system…

$$CO_2(g) + H_2O(l) \leftrightharpoons H_2CO_3(aq) \leftrightharpoons H^+(aq) + HCO_3^-(aq)$$

(a)   Qualitatively describe the effect of this buffer when acid rain falls on a small lake.   **(1 mark)**

(b)   The hydrogen carbonate ion is an amphiprotic species.
Write balanced chemical reactions showing it acting as an acid and a base.   **(2 marks)**

Question 19   (4 marks)

The table shows comparative data for 1–propanol and acetic acid.

	Molecular mass ($g\ mol^{-1}$)	Boiling Point ($°C$)
1–propanol	60.094	97.2
acetic acid	60.052	117.9

(a)   Explain the difference in the boiling points.   **(2 marks)**

(b)   Write the balanced chemical equation for the reaction between 1–propanol and acetic acid and
state the conditions required for the reaction. Give the IUPAC name for the organic product. **(3 marks)**

Question 20 (3 marks)

Describe the benefits and problems associated with the use of one named radioactive isotope in medicine.

_____

_____

_____

_____

_____

_____

_____

_____

Question 21 (3 marks)

Describe the conditions and chemistry associated with the preparation of ethanol.

_____

_____

_____

_____

_____

_____

_____

_____

_____

Question 22   (4 marks)

A spirit burner containing 1-propanol was used to heat water in an aluminium can in order to determine the heat of combustion per mole of the alkanol. The empty can had a mass of 177.1 g and when filled with water had a mass of 347.8 g. The spirit burner containing 1-propanol had a mass of 235.6 g at the beginning of the investigation. The initial temperature of the water in the can was 23.5°C. The spirit burner was lit and extinguished when the water temperature reached 33.5°C. On reweighing, the spirit burner weighed 235.0 g.

(a)   Calculate the molar heat of combustion for 1-propanol.   **(3 marks)**

_____

_____

_____

_____

_____

_____

_____

(b)   State one reason why the molar heat of combustion determined from this investigation would not be the same as that found in a standard chemical reference book.   **(1 mark)**

_____

_____

_____

_____

Question 23   (6 marks)

The dry cell and lead-acid cell have been useful commercial galvanic cells.
With reference to ONE of these cells:

(a)   Write half-equations to describe the chemistry occurring at the anode and cathode.   **(2 marks)**

_____

_____

(b)   Write an overall equation for the cell.   **(1 mark)**

_____

_____

(c)   Describe the electrolyte used.   **(1 mark)**

_____

_____

(d)   Describe one use of this particular cell.   **(1 mark)**

_____

_____

(e)   Describe one limitation of using this cell.   **(1 mark)**

_____

_____

Question 24   (4 marks)

Justify the synthesis and use of a named biopolymer.

Question 25   (3 marks)

(a)   Write two balanced chemical equations showing the combustion of a fuel under different conditions. **(2 marks)**

(b)   Identify one harmful product formed.   **(1 mark)**

Question 26   (6 marks)

You performed first hand investigations to analyse water samples using qualitative and quantitative analysis.

(a)   Distinguish between qualitative and quantitative analysis.   **(2 marks)**

Question 26 (continued)

(b) Complete the following table to show how the ions listed can be identified. **(4 marks)**

Ion	Reagent	Observation if ion is present
$CO_3{}^{2-}$		
Cl^-		
Ca^{2+}		
Fe^{3+}		

Question 27 (2 marks)

Draw the Lewis electron dot structure for ozone and indicate the coordinate covalent bond on the diagram.

Question 28 (4 marks)

Identify two additives in town water supplies and give reasons for their addition.

Question 29   (5 marks)

Discuss problems associated with the uses of CFCs and analyse their effects on the atmosphere using appropriate chemical equations.

Section II

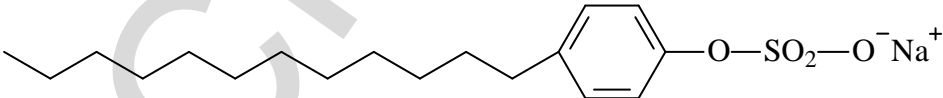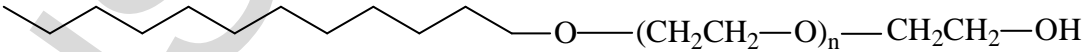**25 marks**
Attempt Question 30
Allow about 45 minutes for this section

Answer the question in a writing booklet. Extra writing booklets are available.

Show all relevant working in questions involving calculations.

Question 30 — Industrial Chemistry   (25 marks)

(a)   While developing his process, Haber started one experiment with a mixture consisting of 0.500 mol nitrogen gas and 0.800 mol hydrogen gas in a 1.00 L container. He found that, at equilibrium at a certain temperature, 0.150 mol of ammonia gas was present.

     (i)   Write a balanced chemical equation for the reaction.   **(1 mark)**

     (ii)   Calculate the equilibrium constant for the reaction at that temperature.   **(2 marks)**

(b)   Describe and justify the conditions for the industrial production of sulfuric acid.   **(7 marks)**

(c)   The table shows diagrammatically the structure of anionic and nonionic detergents.
Using the structures in the table, explain how anionic detergents and nonionic detergents act to clean oily materials.   **(2 marks)**


Structure of anionic detergent

$-O-SO_2-O^- Na^+$

Structure of nonionic detergent

$-O-(CH_2CH_2-O)_n-CH_2CH_2-OH$

(d)   Define saponification.   **(1 mark)**

(e)   Compare the three electrolysis methods used to produce sodium hydroxide in terms of their cathode reactions and the technical difficulties associated with each process.   **(4 marks)**

(f)   (i)   The flow chart shows the Solvay process.

Explain the processes occurring at labelled stages 1, 2, and 3 including the relevant chemical equations.   **(6 marks)**
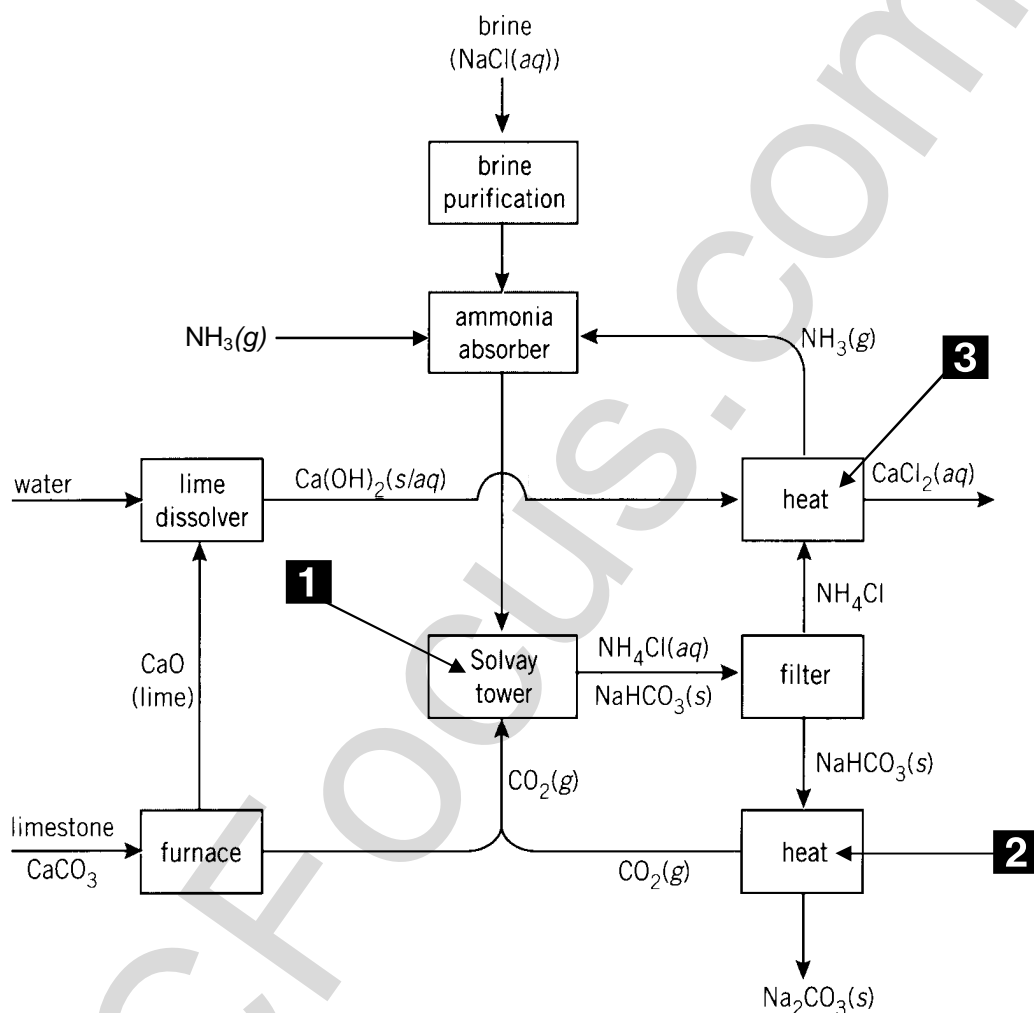
(ii)   Discuss an environmental issue associated with the Solvay process and explain how this issue is addressed.   **(2 marks)**