Sydney Girls High School

2001
Trial Higher School Certificate Examination

Chemistry

General Instructions

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

Section I Pages 2 – 10

Total marks (**75**)

This section has two parts, Part A and Part B

Part A
Total marks (**15**)
- Attempt questions 1 – 15
- Allow about 30 minutes for this part

Part B
Total marks (**60**)
- Attempt questions 16 – 28
- Allow about 1 hour and 45 minutes for this part.

Section II Pages 11 – 12

Total marks (**25**)

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

Section I
Total marks (75)

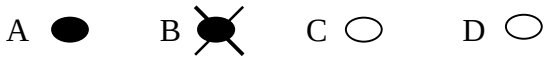
Part A
Total marks (15)
Attempt questions 1 – 15
Allow about 30 minutes for this part

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

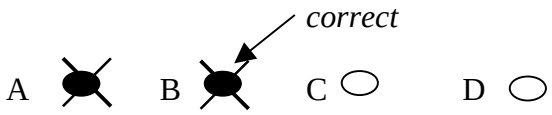
Sample 2 + 4 = (A) 2 (B) 6 (C) 8 (D) 9

A ○ B ● C ○ D ○

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



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



1 The conjugate base of the molecular ion, hydrogen citrate ($HC_6H_5O_7^{2-}$) is –

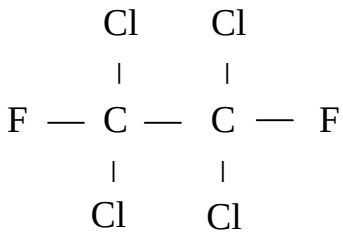
(A) $H_2C_6H_5O_7$

(B) $H_2C_6H_5O_7^{-}$

(C) $C_6H_5O_7^{2-}$

(D) $C_6H_5O_7^{3-}$

2 The correct IUPAC name for the following CFC is -



(A) 1,1,2,2-tetrachloro-1,2-difluoroethane
(B) 1,2-difluoro-1,1,2,2-tetrachloroethane
(C) tetrachlorodifluoroethane
(D) 1,1,1,1-tetrachloro-1,2-difluoroethane

3 According to the Bronsted-Lowry definition, which of the following equations shows the hydrogen sulfide ion, HS^- acting as a base?

(A) $HS^- + NH_4^+ \rightarrow H_2S(g) + NH_3(g)$

(B) $2\ HS^- + Cu^{2+} \rightarrow Cu(HS)_2(s)$

(C) $HS^- + O^{2-} \rightarrow OH^- + S^{2-}$

(D) $HS^- + Cl_2(g) \rightarrow S(s) + H^+ + 2Cl^-$

4 The following gas concentrations were measured in a reaction vessel undergoing the Haber process.

$[N_2] = 0.52\ mol\ L^{-1}$ $[H_2] = 1.56\ mol\ L^{-1}$ $[NH_3] = 2.61\ mol\ L^{-1}$

Select the value for the equilibrium constant K (in mol^2L^{-2}), using the data provided.

(A) 0.29
(B) 3.22
(C) 3.45
(D) 8.40

5 Which of the following is the best definition for a Lewis acid?

(A) A proton donor
(B) An hydroxide ion acceptor
(C) An electron pair acceptor
(D) An electron pair donor

6 Consider the following equilibrium

$Ba(OH)_2(s) \Leftrightarrow Ba^{2+} + 2OH^-$

Select the correct statement for this equilibrium system.

(A) If the pH of the system is increased the equilibrium will shift to the right
(B) The addition of sodium sulfate will shift the equilibrium to the right.
(C) If the pH of the system is decreased the equilibrium will shift to the left.
(D) Adding barium nitrate solution will shift the equilibrium to the right.

7 Select the pH of the final solution formed when 25.0 mL of 2.0 mol L^{-1} nitric acid is diluted systematically to a total volume of 500 mL using distilled water.

(A) 0.10
(B) 0.25
(C) 0.70
(D) 1.00

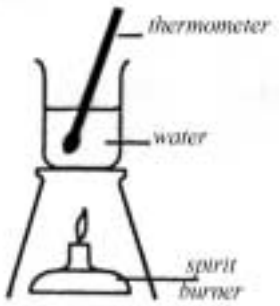
8 Which product(s) is/are formed when bromine and 2-pentene are mixed?

(A) 2-bromopentene and hydrogen bromide
(B) 2-bromopentane and hydrogen bromide
(C) 2,3-dibromopentane
(D) 2,2-dibromopentane

9 A student was asked to identify two unlabelled bottles one containing ethane and the other ethene. The simplest method she could use to identify the two samples is to observe which one –

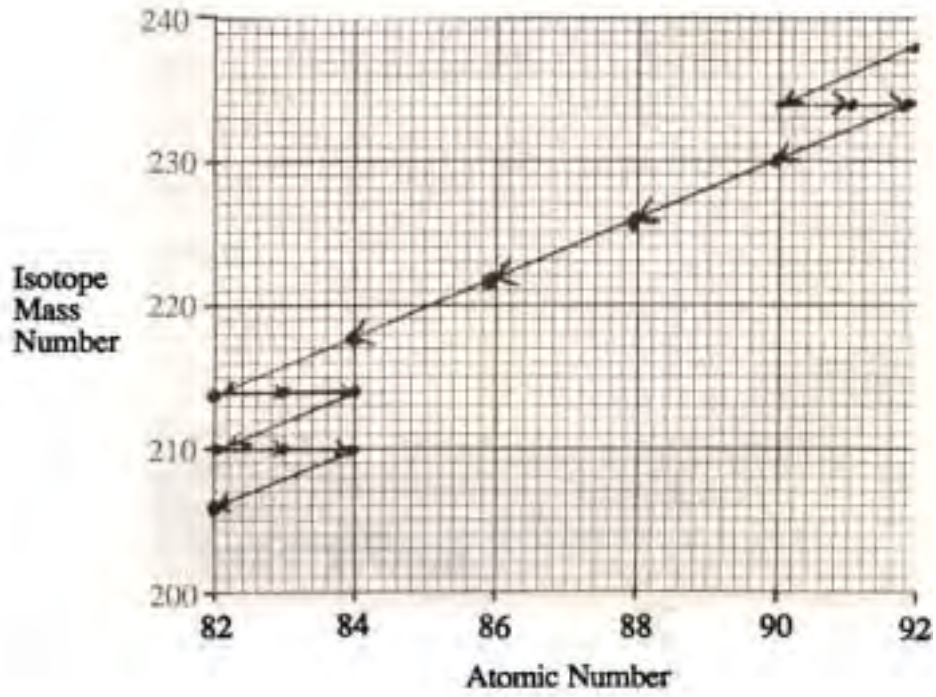
(A) forms a plastic
(B) reacts with bromine
(C) combusts easily
(D) dissolves in ethanol

10 The equipment shown below was used to measure the Heat of Combustion of ethanol. In this experiment it was found that the combustion of 0.40 g of ethanol produced an energy change of 6.80 kJ. Which of the following in kJ mol^{-1} is the calculated value for the Molar Heat of Combustion?



(A) 0.059
(B) 2.70
(C) 125
(D) 782

11 The following diagram shows the decay of uranium – 238.



The nuclear equation for the step producing polonium – 218 from another radioisotope would be –

(A) $^{222}_{86}Rn \rightarrow {}^{218}_{84}Po + {}^{4}_{2}He$

(B) $^{218}_{83}Bi \rightarrow {}^{218}_{84}Po + {}^{4}_{2}He$

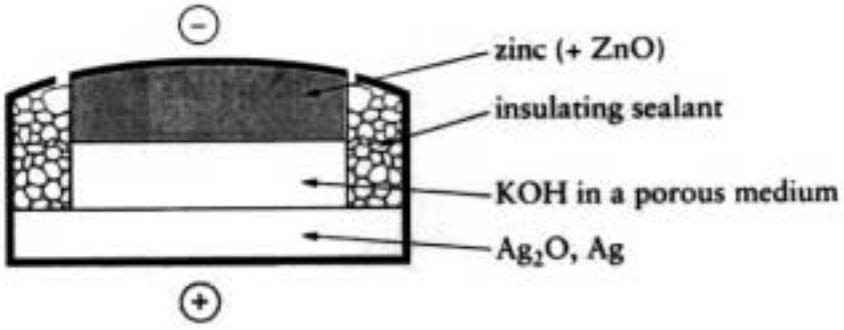
(C) $^{218}_{84}Po \rightarrow {}^{218}_{84}Po + \gamma$

(D) $^{218}_{85}At + {}^{0}_{-1}\beta \rightarrow {}^{218}_{84}Po$

12. Which of the following pieces of evidence is most likely to convince scientists that atmospheric concentrations of oxides of sulfur and nitrogen are increasing?

(A) A noticeable melting of polar ice caps.
(B) A large number of limestone caves world wide.
(C) A decrease in the pH of many European lakes.
(D) An worldwide increase in the average per household car ownership.

13 Study the following diagram of a silver oxide button cell.



The most likely reaction occurring at the cathode would be –

(A) $Zn \rightarrow Zn^{2+} + 2e^-$

(B) $Zn^{2+} + 2e^- \rightarrow Zn$

(C) $Ag_2O + H_2O \rightarrow 2Ag + 2OH^-$

(D) $Ag_2O + Zn(s) \rightarrow 2Ag(s) + ZnO$

14 In which atmospheric layer is the ozone lpocated when acting as an ultraviolet (UV) shield?

(A) troposphere

(B) stratosphere

(C) mesosphere

(D) ionosphere

15 The equation that best represents the fermentation process is -

(A) $C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$

(B) $C_6H_{12}O_6 + 6O_2 \rightarrow 6H_2O + 6CO_2$

(C) $C_6H_{12}O_6 + 6H_2O \rightarrow 2C_2H_5OH + 2CO_2$

(D) $2C_2H_5OH + 2CO_2 \rightarrow C_6H_{12}O_6$

Section I

Part B

Total marks (60)
Attempt questions 16 – 26
Allow about 1 hour and 45 minutes for this part

Answer Questions 16 – 21 in the Part B1 Answer Booklet.
Answer Questions 22 – 26 in the Part B2 Answer Booklet.

Show all relevant working in questions involving calculations.

Marks

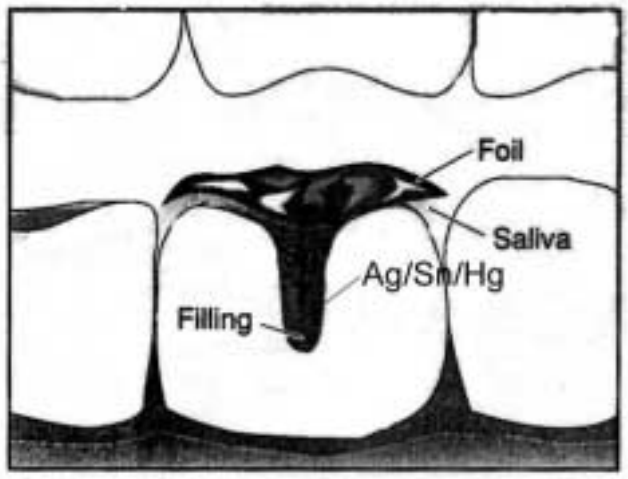
Question 16 (3 marks)

(a) Describe one use of a named radioisotope in medicine and in industry. **2**

(b) Briefly describe how radioisotopes such as these are made. **1**

Question 17 (3 marks)

Observe the diagram and equations below which explains why people with metal fillings in their teeth, often feel pain if they bite on a piece of aluminium foil.



$$Al \rightarrow Al^{3+} + 3e^-$$

$$O_2 + 4H^+ + 4e^- \rightarrow 2H_2O$$

Explain how this diagram can be interpreted as a galvanic cell. **3**

Marks

Question 18 (6 marks)

Most metals are not found in their pure form and must be extracted from their ore before they are useful. Some ores are refined by reduction in a furnace others by the process of electrolysis.

(a) Explain why most metals are found as ores. **1**

(b) Describe how one named metal is refined electrolytically, including details about the necessary conditions. **3**

(c) Name the oxidant for the process you have outlined in part (b). **1**

Question 19 (7 marks)

O_2 and O_3 are two allotropes of oxygen

(a) Using two stated physical and/or chemical properties, describe how these allotropes differ from one another. **2**

(b) Draw the Lewis electron dot structures for both allotropes, identifying the coordinate covalent bond on your diagram. **2**

(c) With the aid of chemical equations explain how ozone can be destroyed by chlorofluorocarbons (CFCs). **3**

Question 20 (3 marks)

Many fresh water lakes are 'buffered' by a mixture of carbonic acid from rain and hydrogen carbonate leached from rocks and soils.

Explain what 'buffered' means. Use equations for the reactions occurring when acid and alkali are added to the lake water in your explanation. **3**

Question 21 (4 marks)

Cerussite ($PbCO_3$) is a mineral. Describe chemical tests, which could be used to separately identify each of Pb^{2+} and CO_3^{2-} ions. Include expected observations and appropriate equations. **4**

Question 22 (5 marks)

Banana flavouring was prepared by refluxing ethanoic acid with 1-pentanol in the presence of a small volume of concentrated sulfuric acid.

(a) Write an equation for this reaction and name the products formed. **2**

(b) Draw a fully labelled diagram of the refluxing equipment. **1**

(c) The banana flavouring was separated by shaking the reaction mixture with water in a separating funnel, and then discarding the aqueous layer. Explain. **2**

Marks

Question 23 (7 marks)

Ammonia is produced according to the following equation

$$N_{2(g)} + 3H_{2(g)} \leftrightarrow 2NH_{3(g)} \qquad \Delta H = -92.4 \text{ kJmol}^{-1}$$

(a) Referring to Le Chatelier's Principle only, describe two different ways that the production of ammonia can be increased. **2**

(b) Explain why a compromise temperature of about 700 K is used for the manufacture of ammonia. **1**

(c) Assess the significance of Haber developing this process in 1908. **2**

(d) During the industrial production of ammonia, continual monitoring is crucial. Explain why, using two specific examples of the monitoring process. **2**

Question 24 (6 marks)

A sample of vinegar (ethanoic acid) of concentration 1.00 mol L^{-1} has a pH of 3.0.

(a) Write an equation to show the ionisation of ethanoic acid in water. **2**

A 25 mL sample of this 1.00 mol L^{-1} vinegar requires the same volume of 0.50 mol L-1 sodium hydroxide solution to reach the equivalence point of a titration as does a 25 mL sample of 1.00 mol L^{-1} hydrochloric acid solution.

(b) Explain why the same volume of NaOH is required for each titration. Use Le Chatelier's Principle in your explanation. **2**

(c) Sketch the graph of pH versus volume of NaOH added for the vinegar titration. **1**

(d) Justify your choice of appropriate indicator for the titration using the data in the table provided. **1**

Indicator		
red cabbage juice	red → pink 3.0 → 4.1	green → yellow 11.8 → 13.1
Thymol	red → yellow 1.3 → 2.4	yellow → blue 10.2 --. 11.3
Alizarin	yellow → red 5.7 → 6.8	Red → blue 11.1 → 12.4

Marks

Question 25 (5 marks)

Lactic acid $CH_3CH(OH)CO_2H$ is used to make a polymer X and propene (CH_3CHCH_2) is used to make a different polymer Y. The polymers X and Y have different physical properties.

(a) Name the two types of polymerisation. **1**

(b) Use appropriate equations to contrast the method of polymerisation in forming X and Y. **2**

(c) Use a specific example to describe how a structural feature of a polymer affects one of its physical properties. **2**

Question 26 (4 marks)

Atomic Absorption Spectroscopy (AAS) is used to measure the concentration of mercury in many seafoods, including oysters. A sample of oysters was prepared, by grinding up 1.0 kg of oysters then extracting the mercury using nitric acid and making up a solution of total mass 5.0 g.

The absorbance of standard solutions of mercury and of the oyster sample is shown in the table below.

mercury sample	absorbance
1 ppm standard solution	30
5 ppm standard solution	38
9 ppm standard solution	46
13 ppm standard solution	54
oyster sample	35

(a) Use this data to plot a calibration graph and then calculate the concentration of mercury in the prepared oyster sample. **2**

(b) Calculate the concentration of mercury in the original oysters used in sample 1. **2**

Question 27 (4 marks)

Ascorbic acid has the molecular formula $C_6H_8O_6$. When 4.401 g of ascorbic acid was added to excess sodium carbonate solution, 612 mL of carbon dioxide (measured at 25°C and 101.3 kPa) gas was formed.

(a) How many moles of carbon dioxide were formed? **1**

(b) Write an ionic equation for the reaction of hydrogen ions with carbonate ions. **1**

(c) Determine whether the ascorbic acid is monoprotic, diprotic or triprotic. Explain your reasoning. **2**

Question 28 (4 marks)

"As chemists learn how to use micro-organisms they are producing solutions to the looming crises in both the petroleum industry and the petrochemical industry." **4**

Evaluate this statement.

Section II – Option – Shipwrecks and Salvage

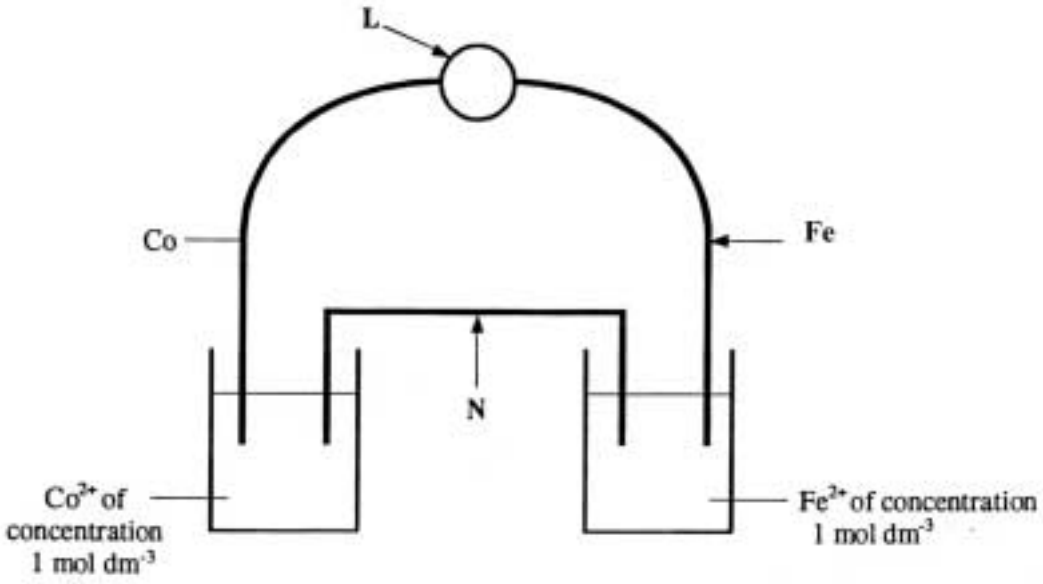
Total marks (25)
Attempt all parts of this question
Allow about 45 minutes for this section

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

Show all relevant working in questions involving calculations.

Marks

(a) A galvanic cell is set up as shown.



Given that cobalt is a more active metal than iron.

(i) Name and state the function of **L**. **1**

(ii) Name the part labelled **N** and explain how it performs its function. **2**

(iii) Write the two half equations as oxidation. **2**

(iv) Which of the two metals forms the anode in the cell? **1**

(v) How would this cell be represented in shorthand notation? **1**

Marks

The cell has been set up to determine the standard electrode potential of the $Co_{(s)} | Co^{2+}$ system. The experimental emf or potential difference of the cell is found to be 0.13 V.

(v) Use the experimental value for the cell potential difference and the Data Sheet to calculate the Standard Reduction Potential of the $Co_{(s)} | Co^{2+}$ system. **3**

(vi) Would the emf or potential difference of the cell become larger, smaller or remain the same if the $Co_{(s)} | Co^{2+}$ half of the cell were replaced with a metal that was more reactive than cobalt, but less reactive than iron? Explain your answer. **2**

(b) A steel hull of a ship can quickly corrode in the ocean environment. Various methods are used to prevent this corrosion.

(i) Explain how the corrosion of steel is an electrochemical process using equations in your answer. **2**

(ii) Account for the fact that corrosion of ocean going ships occurs more rapidly than that of freshwater ships. **1**

(iii) Would a ship corrode more quickly on the ocean surface or at great depths? Justify your answer. **1**

(iv) Describe two methods used to prevent ships corroding. **2**

(c) A student sets up an electrochemical cell with two platinum electrodes placed in dilute sodium chloride solution. Oxygen gas is produced at one platinum electrode and hydrogen gas at the other. The volume of hydrogen gas produced is double that of oxygen gas produced.

(i) Draw and label a diagram to represent the cell. **1**

(ii) Discuss the volumes of gas produced in terms of Faraday's First Law. **1**

(iii) The electrolyte is changed from dilute sodium chloride solution to molten sodium chloride. Predict the products of the reaction. **2**

(d) Account for the fact that aluminium is very useful as a building material eg window frames, even though it is a reactive metal. **2**