Centre Number

Student Number

CATHOLIC SECONDARY SCHOOLS
ASSOCIATION OF NEW SOUTH WALES

2006
TRIAL HIGHER SCHOOL CERTIFICATE EXAMINATION

Chemistry

Afternoon Session
Friday 4 August 2006

Total marks – 100

Section I Pages 3-21

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

Section II Pages 25-34

25 marks
- Attempt ONE question from Questions 30-34
- Allow about 45 minutes for this section

General Instructions

- Reading time – 5 minutes
- Working time – 3 hours
- Write using blue or black pen
- Draw diagrams using pencil
- Board-approved calculators may be used
- Use the Data Sheet and Periodic Table provided
- Use the Multiple Choice Answer Sheet provided
- Write your Centre Number and Student Number at the top of this page and on page 9

EXAMINERS

Bronwen Hegarty (convenor)	Educational Consultant
Dallas Demeny	Ravenswood School, Gordon
Jo McGrouther	St. Vincent's College, Potts Point
Troy McMurrich	Oakhill College, Castle Hill
Mark Shore	Queenwood School, Mosman
Alan Wilson	Caroline Chisholm College, Glenmore Park

Source
Question 28 – http://www.csiro.au/files/mediaRelease/mr1999/Ozone.htm

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 provided

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1 Why can ethylene be transformed readily into other compounds?

(A) It is a product of both fossil fuels and biomass.

(B) It has a highly reactive double bond.

(C) It easily loses two H atoms.

(D) It can be catalytically cracked to form many different alkanes.

2 $n\ (HO\text{-}C_6H_{10}O_4\text{-}OH) \rightarrow H\text{-}(O\text{-}C_6H_{10}O_4)_n\text{-}OH + (n\text{-}1)\ H_2O$

What type of reaction is this?

(A) catalytic cracking

(B) condensation polymerisation

(C) addition polymerisation

(D) oxidation and reduction

3 A student was investigating the heat of combustion of ethanol. She used an ethanol burner that had an initial mass of 68.0 g. She then lit the burner and placed it under a beaker containing 500 mL of water. After a few minutes, she noticed that the water temperature had risen from 24°C to 38°C and the burner now weighed 66.5 g.

She made the assumption that only the water was heated.

What would be the student's value for the heat of combustion for ethanol?

(A) 87.8 J mol^{-1}

(B) 29.3 kJ mol^{-1}

(C) 899 kJ mol^{-1}

(D) 1350 kJ mol^{-1}

4 Consider the following reaction involving hydrogen ions.

$$2Na(s) + 2H^{+}(aq) \rightarrow H_2(g) + 2Na^{+}(aq)$$

Which statement about the hydrogen ions in this reaction is correct?

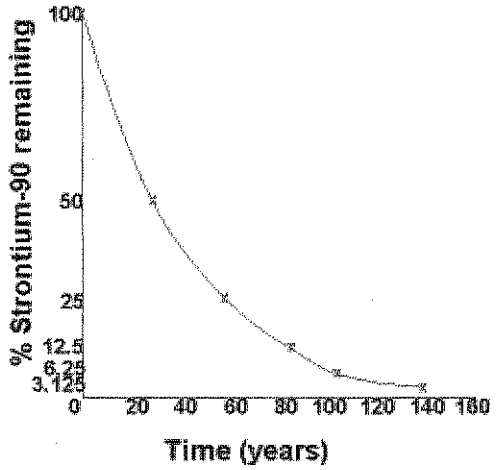
(A) They undergo an increase in oxidation state.

(B) They are classified as the oxidising agent.

(C) They lose electrons.

(D) They undergo an acid-base reaction with the sodium metal.

5 The graph shows the radioactive decay of strontium-90.



What is the approximate half-life of strontium-90?

(A) 30 years

(B) 50 years

(C) 80 years

(D) 140 years

6 An unknown chemical was extracted from a soil sample and sent to your laboratory. One of the first tests you carried out was to determine the pH of the chemical by using indicators. The following are the results:

Indicator	Colour
Phenolphthalein	Colourless
Methyl orange	Yellow
Bromothymol blue	Blue

How should your laboratory classify the soil sample?

(A) strongly acidic

(B) slightly acidic

(C) neutral

(D) slightly alkaline

7 The pH of a 0.1 mol L^{-1} solution of a monoprotic acid was measured by a student and found to be close to 3. What proportion of the acid molecules remains unconverted to ions?

(A) 0 %

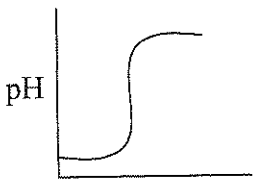
(B) 1 %

(C) 60 %

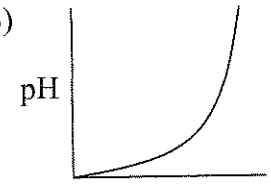
(D) 99 %

8 Which of the following curves would represent the change in pH in a conical flask when a solution of hydrochloric acid (from a burette) is added to a solution of sodium hydroxide (in the conical flask)?

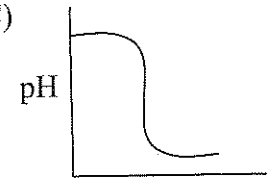
(A)



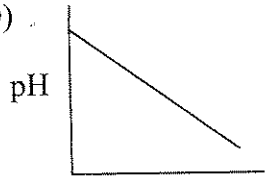
(B)



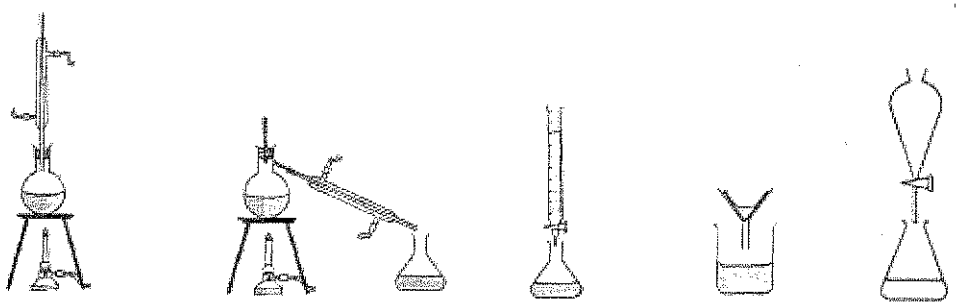
(C)



(D)



9 The following diagrams show equipment you have used in carrying out first-hand investigations in the school laboratory.



P Q R S T

Students were asked to perform an experiment in 3 steps:

Step1: The ester, ethyl propanoate, was prepared from ethanol, propanoic acid and a small amount of concentrated sulfuric acid.
Step 2: An impure sample of the ester was then separated from any unreacted acid, alcohol and sulfuric acid.
Step 3: A pure sample of the ester was collected.

The equipment used in each step of this experiment was:

	Step 1	Step 2	Step 3
(A)	P	T	Q
(B)	P	Q	S
(C)	Q	R	T
(D)	Q	T	S

10 Calculate the mass of carbon dioxide formed when 74.4 L of oxygen gas at 100 kPa and 25 °C completely combusts a sample of ethanol.

(A) 44 g
(B) 50 g
(C) 88 g
(D) 132 g

11 Identify the catalyst used in the Haber process.

(A) a zeolite
(B) concentrated sulfuric acid
(C) dilute sulfuric acid
(D) iron oxide

12 Identify the ion present in an unknown solution that produces bubbles with the addition of dilute nitric acid.

(A) Cl^-

(B) CO_3^{2-}

(C) PO_4^{3-}

(D) SO_4^{2-}

13 The three equations below summarise a series of reactions occurring in the atmosphere.

CCl_3F + UV radiation $\rightarrow$ $Cl\bullet$ + $\bullet CCl_2F$

$Cl\bullet$ + O_3 $\rightarrow$ $\bullet ClO$ + O_2

$\bullet ClO$ + O $\rightarrow$ $Cl\bullet$ + O_2

What do these three equations explain?

(A) Production of oxygen gas in the troposphere.

(B) Formation of ozone in the stratosphere.

(C) Absorption, by ozone, of harmful UV radiation.

(D) Production, destruction and regeneration of chlorine atoms.

14 $CHCl_2CF_3$ and $CHClFCClF_2$ are

(A) isomers

(B) isotopes

(C) allotropes

(D) CFCs

15 The treatment of water to make it suitable for human consumption is a process which occurs in steps.

Identify the INCORRECT statement relating to this process.

(A) The pH of the water is increased by the addition of lime or sodium hydroxide to assist in coagulation.

(B) Salts such as alum or iron (III) chloride are added to bring about coagulation and sedimentation of suspended materials.

(C) Chloride ions are added to kill bacteria in the water.

(C) Fluoride salts may be added to assist in the prevention of tooth decay in children.

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Centre Number

Chemistry
Section I (continued)

Student Number

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 (3 marks) **Marks**

(a) Using a labelled diagram, demonstrate how polystyrene can be produced from its monomer. **2**

(b) Explain ONE use of this polymer in terms of ONE of its physical properties. **1**

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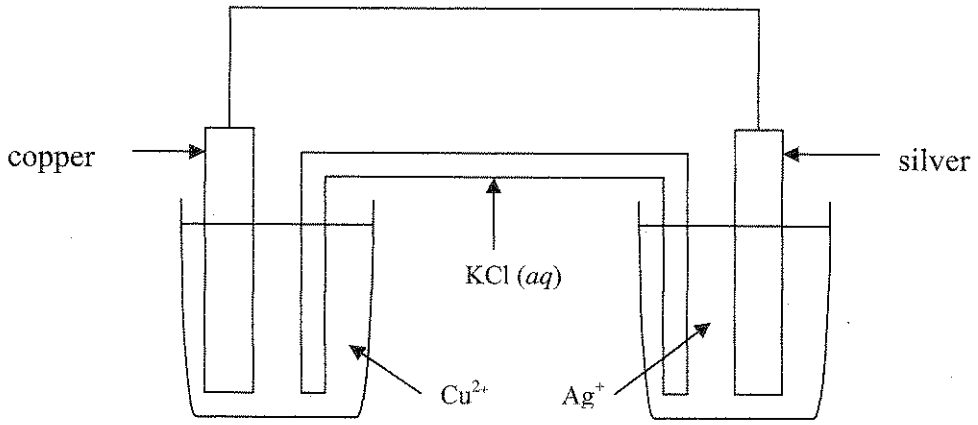
Question 17 (6 marks) **Marks**

In order to produce a cell with a voltage between 1.1 V and 1.2 V, a student constructed the following galvanic cell.



(a) Label the cathode on the above diagram. **1**

(b) Explain why KCl (*aq*) would be an *inappropriate* choice for the salt bridge in this cell. **2**

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(c) Calculate the cell potential, showing relevant half-equations, in order to evaluate the student's selection of electrodes and electrolytes. (Assume standard conditions.) **3**

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Question 18 (2 marks) **Marks**

Name an isotope used in industry. Explain how its use is related to its properties. **2**

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Question 19 (2 marks) **Marks**

Cobalt – 60 forms when cobalt – 59 captures a neutron.

(a) Write a balanced nuclear equation for this reaction. **1**

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(b) Explain why cobalt – 60 is produced in a nuclear reactor rather than a cyclotron (particle accelerator). **1**

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Question 20 (7 marks)

Marks

Fossil fuels are currently the dominant source of both energy and raw materials needed for the production of polymers. However, the supply of fossil fuels is finite and rapidly diminishing. In the near future, a replacement source of both energy and polymer raw materials will need to be found and one potential source is ethanol. **7**

Using appropriate chemical equations, assess the potential of ethanol as a resource to replace fossil fuels for the supply of both polymers and energy.

Question 21 (4 marks) **Marks**

(a) SO_2, K_2O, N_2O_5, CaO

From the list of oxides above, identify:

(i) a basic oxide **1**

(ii) an acidic oxide **1**

(b) Write a balanced equation for a reaction which illustrates the acidic or basic nature of one of the oxides you identified in part (a). **1**

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(c) Aluminium oxide is classified as amphoteric. Define the term amphoteric. **1**

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Question 22 (3 marks) **Marks**

(a) State an industrial use for a named ester. **1**

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(b) (i) Draw the structural formula for the ester produced in the reaction between 1-butanol and ethanoic acid, in the presence of concentrated sulfuric acid. **1**

(ii) Name this ester. **1**

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Question 23 (8 marks) **Marks**

Hydrogen sulfide gas is extremely toxic if inhaled, has an unpleasant smell (rotten eggs) and is highly flammable. Stringent precautions are required when handling it.

(a) Explain why hydrogen sulfide is classified as a WEAK acid. **1**

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(b) Explain (with the aid of a chemical equation) why H_2S is considered a Bronsted-Lowry acid. **2**

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(c) Identify ONE conjugate acid-base pair involved in the equation you have written in (b) above. **1**

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Question 23 continues on page 15

Question 23 (continued) **Marks**

(d) Hydrogen sulfide *(g)* is formed when hydrochloric acid reacts with zinc sulfide.

$ZnS\ (s) + 2HCl\ (aq) \rightarrow ZnCl_2\ (aq) + H_2S\ (g)$

In an experiment performed in a fume cupboard 50.0 mL of 0.10M HCl was added to 0.11 g of solid zinc sulfide.

(i) Which reagent is in excess? *Show Your Working*. **2**

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(ii) What volume of hydrogen sulfide *(g)* is produced at 298K and 100 kPa in this experiment **2**

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End of Question 23

Question 24 (5 marks) **Marks**

Caustic soda (sodium hydroxide) can be used to strip paint off furniture.
A 3.0 g container of caustic soda was dissolved in water and the volume of the solution was made up to 3.0 L.
The sodium hydroxide solution was then titrated with 0.026 mol L^{-1} hydrochloric acid solution.

(a) Calculate the concentration of the sodium hydroxide solution in mol L^{-1}. *Show your working*. **1**

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(b) Determine the pH of the hydrochloric acid solution. **1**

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(c) Evaluate the use of sodium hydroxide as a *primary standard*. **3**

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Question 25 (4 marks) **Marks**

The Haber Process has been used for over 90 years for the industrial production of ammonia. This process must be carefully managed and monitored by industrial chemists. **4**

Analyse the impact of changes in pressure and temperature on the yield and rate of production of ammonia during the Haber Process.

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Question 26 (2 marks) **Marks**

Explain why incomplete combustion of carbon-based fuels is considered a problem for the environment and identify how scientists can reduce the possibility of incomplete combustion occurring. **2**

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Question 27 (5 marks) **Marks**

(a) Identify the purpose of using standard solutions in atomic absorption spectroscopy (AAS). **1**

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(b) Assess the impact of atomic absorption spectroscopy (AAS) on scientific understanding of the effects of ONE trace element that you have studied. **4**

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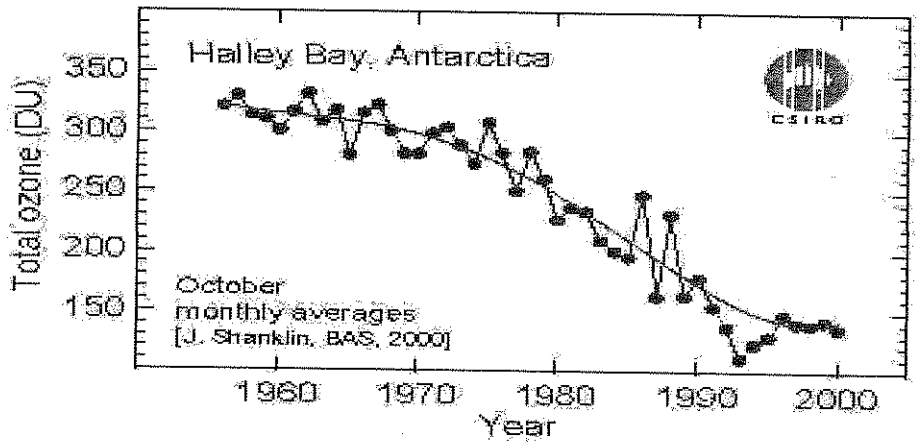
Question 28 (4 marks)

Marks

This graph summarises the atmospheric ozone concentrations measured at Halley Bay.



(a) Identify the trends or patterns described by the graph. **2**

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(b) Explain ONE method of obtaining the data in the graph. **2**

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Question 29 (5 marks) **Marks**

The hardness of a sample of water was investigated using the following methods.

Method A

25.0 mL samples of water were titrated against ethylenediamine tetra-acetic acid (EDTA) with Eriochrome Black T indicator. 21.7 mL of EDTA was required. The hardness was calculated to be equivalent to 17 mg/L of $CaCO_3$.

Method B

Three drops of detergent were added to separate vials containing 5 mL samples of distilled water, hard water and the sample. After shaking the vials ten times the heights of froth were compared. The procedure was repeated twice. As the amount of froth in the three samples was only slightly less than in the distilled water the sample was determined to be soft.

(a) Identify which of the TWO methods is classified as *qualitative*. **1**

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(b) Using the following table, the results from Method A indicated the sample was soft. **1**

Water Hardness Scale	
Concentration of $CaCO_3$	**Classification**
less than 20 ppm	soft
20-60 ppm	slightly hard
60-120 ppm	moderately hard
more than 120 ppm	hard

Justify this conclusion.

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Question 29 continues on page 21

Marks

(c) Compare the appropriateness of Method A and Method B for determining the hardness of the water. **3**

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End of Question 29

Chemistry
Section II

25 marks
Attempt ONE question from Questions 30-34
Allow about 45 minutes for this section

Answer the question in a SEPARATE writing booklet.

Show all relevant working in questions involving calculations.

Question 30 – Industrial Chemistry (25 marks) **Marks**

(a) The gas carbon oxyfluoride (COF_2) decomposes to the gas tetrafluoromethane (CF_4) and carbon dioxide.

$2COF_2(g) \Leftrightarrow CF_4(g) + CO_2(g)$

The reaction is carried out at 200°C in a fixed volume 5.00 L container. Initially 0.400 mol of carbon oxyfluoride is present in the flask. At equilibrium 0.080 mol of carbon oxyfluoride remains.

(i) Write the expression for the equilibrium constant for this reaction. **1**

(ii) Determine the value of the equilibrium constant. **3**

(iii) An increase in temperature results in 0.090 mol of carbon oxyfluoride being present at equilibrium. Is the decomposition of carbon oxyfluoride exothermic or endothermic? Explain your answer **1**

(b) Outline the steps and conditions necessary for the industrial production of H_2SO_4 from its raw materials. **4**

(c) During the course of your studies you performed a first-hand investigation to identify the products of electrolysis of NaCl.

(i) Use equations to identify the products when both concentrated NaCl and dilute NaCl solutions are electrolysed. Explain the tests you used to identify the products in each case. **4**

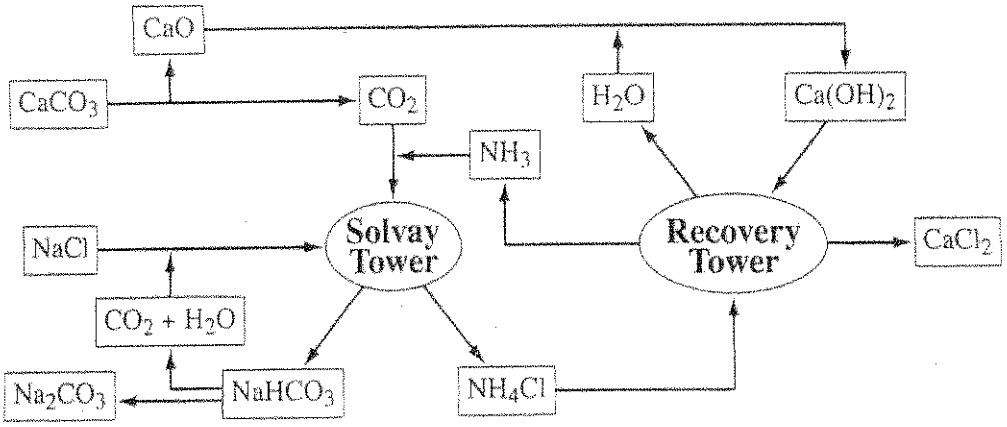
(ii) What would be the products of electrolysis of *molten* sodium chloride? **1**

(d) During the past 50 years, different classes of synthetic detergents have been developed to replace soap as the dominant cleaning agent. Assess the impact on the environment of the use of these synthetic detergents as a replacement for soap. **5**

Question 30 continues on page 27

Question 30 (continued) **Marks**

(e) The flow chart below summarises the Solvay Process.



(i) What are the raw materials needed for this industrial process? **1**

(ii) Write equations for the steps in the process which result in the formation of sodium hydrogen carbonate and ammonium chloride. **2**

(iii) The outputs of the Solvay process include sodium carbonate and a waste chemical product. Identify this waste product and explain how the disposal of this waste influences the choice of location of the manufacturing plant. **3**

End of Question 30