CRANBROOK SCHOOL

YEAR 12

TERM 3, 2002

TRIAL HSC COURSE EXAMINATION

Chemistry

General Instructions

- Reading time – 5 minutes
- Working time – 3 hours
- Write using black or blue pen
- Draw diagrams using pencil
- A Data Sheet and Periodic Table are provided at the back of this paper
- Write your Student Number at the top of pages

Section I Pages 2 - 26

Total marks (**100**)
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 (**85**)
- Attempt Questions 16 - 32
- Allow about 2 hours and 30 minutes for this part

The content and format of this paper do not necessarily reflect the content and format of the HSC examination paper.

Student Number: | | | | | | | | | |

Section 1
Total marks (100)

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:

Student Number: | | | | | | | | | |

1. The process of catalytic cracking

(A) changes a long chain alkane into only two short chain alkanes
(B) involves reactions on the surface of an inorganic catalyst
(C) cracks the solid catalyst into fragments to increase its surface area
(D) remove nitrogen oxides from car exhausts

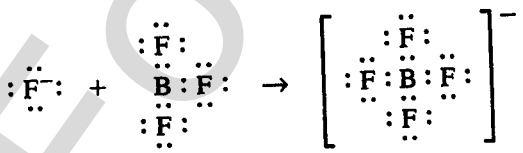
2. Which of the following substances would have the lowest solubility in ethanol?

(A) water
(B) ethanoic acid
(C) iodine
(D) silicon dioxide

3. The pH of a 5.0×10^{-5} mol L^{-1} solution of barium hydroxide is:

(A) 4.0
(B) 4.3
(C) 9.7
(D) 10.0

4. The diagram below represents the reaction between the fluoride ion F^-, and boron trifluoride BF_3 to from the fluoroborate ion BF_4^-.



In this reaction the boron trifluoride is behaving according to the model of one of the following substances. Which one?

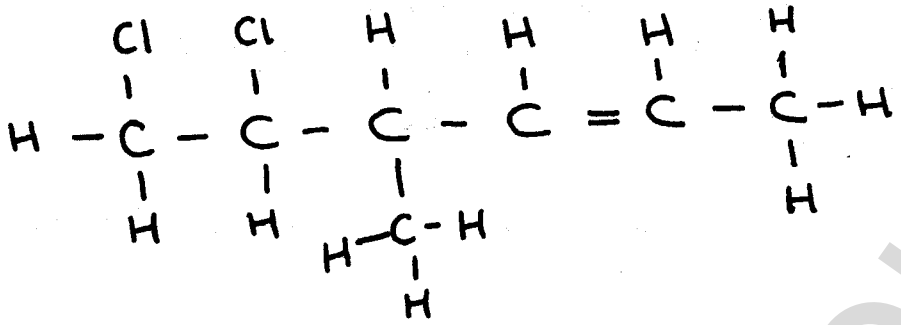
(A) A Lewis base
(B) A Lewis acid
(C) A Bronsted-Lowry base
(D) A Bronsted-Lowry acid

5. What is the oxidation state of sulfur in the hydrogensulfite ion, HSO_3^-?

(A) +3
(B) +4
(C) -3
(D) -4

Student Number:

6. The systematic name for the compound below is:

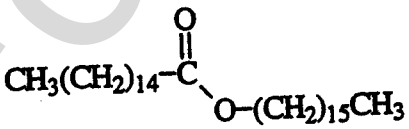


(A) 1, 2 - dichloro - 3 - methyl - 4 - hexene
(B) 3 - methyl - 1, 2 - dichloro - 4 - hexene
(C) 5, 6 - dichloro - 4 - methyl hexene
(D) 5, 6 - dichloro - 4 -methyl - 2 - hexene

7. A major test that is used to monitor possible eutrophication of waterways is:

(A) hardness of water
(B) turbity of water
(C) pH of water
(D) quantitative phosphate and nitrate content of water

8. Cetyl palmitate ($C_{32}H_{64}O_2$) is the most common substance in whale blubber. Its structure is shown in the diagram below:



Cetyl palmitate is an

(A) alkane
(B) ester
(C) alkanoic acid
(D) alcohol

9. Which of the following is a transuranic element?

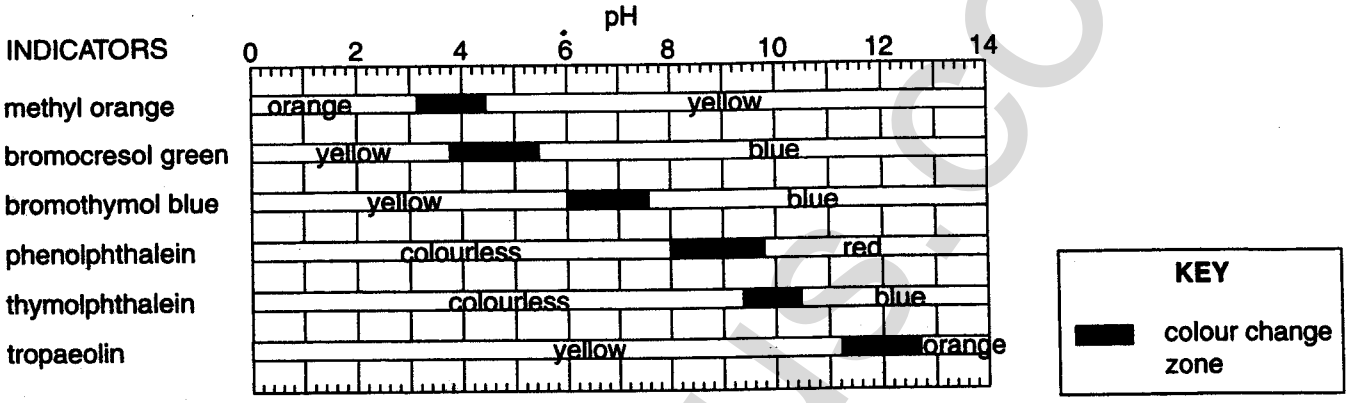
(A) thallium
(B) einsteinium
(C) thorium
(D) selenium

Student Number: | | | | | | | | | |

10. An organic chemist is most likely to be working in the area of:

(A) polymer manufacture
(B) manufacture of ammonia
(C) research into methods to extract metals from their ores
(D) analysis of water samples

11. The chart below shows the colour of some indicators and the pH range over which they change colour.



This table shows the pH range of four different substances.

Substances	pH
orange juice	3 - 4
milk	6·3 - 6·6
seawater	8 - 9
household ammonia	12

One of these substances was tested using four indicators. The following table shows the results.

Indicator	Colour
methyl orange	yellow
bromothymol blue	blue
thymolphthalein	colourless
tropaeolin	yellow

Which substance was tested?

(A) orange juice
(B) milk
(C) seawater
(D) household ammonia

12. Biopolymer chemistry is a new and rapidly expanding field. It is envisaged that in the future many materials will be made from or contain biopolymers. Which of the following statements is true?

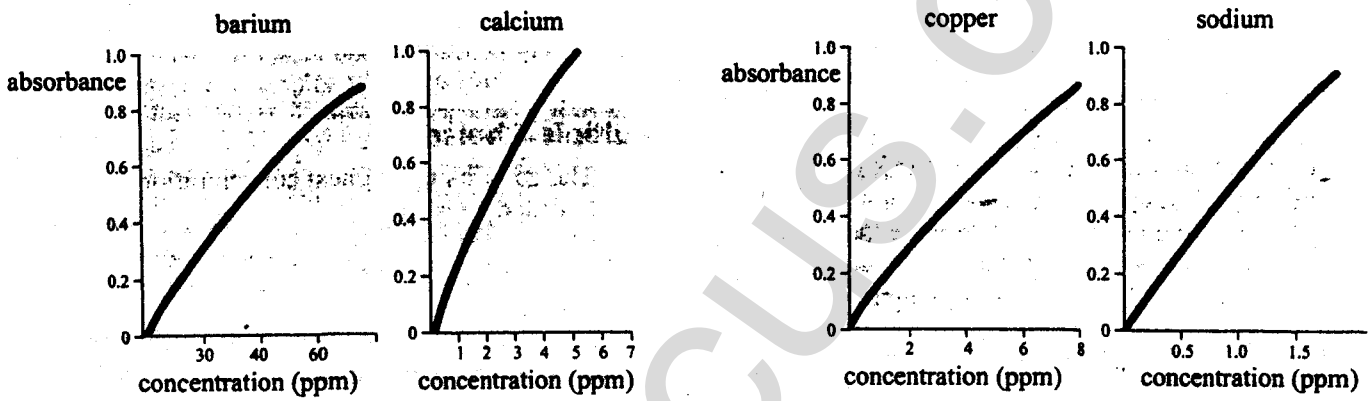
(A) The majority of manufactured biopolymers are produced by the modification of wool.
(B) Biopolymers can only be produced by plants.
(C) The petrochemical industry is the main source of biopolymers.
(D) A major advantage of biopolymers is that they will degrade naturally.

Student Number: | | | | | | | | | |

13. Using an atomic absorption spectrometer, the wavelengths of radiation absorbed by some elements are found to be:

[illegible]	[illegible]
barium	553.6
calcium	422.7
copper	327.4
sodium	589.0

Standard solutions of these elements produced the following calibration curves.



A sample of stormwater is then analysed and the following results are obtained.

[illegible] emitted by [illegible]	Absorbance
422.7	0.25
589.0	0.92
553.6	0.3
327.4	0.6

The element present with a concentration of 1.5ppm is:

(A) sodium
(B) copper
(C) barium
(D) calcium

Student Number: | | | | | | | | | |

14. The relationship between an element's position on the periodic table and the acidic or basic nature of its oxide is best described by which one of the following statements?

(A) Elements with the lowest first ionisation energy in any period usually form acidic oxides.
(B) Elements that have medium to high melting points are more likely to make acidic oxides.
(C) Elements that form covalent bonds are more likely to make acidic oxides.
(D) Elements which are excellent conductors of electricity usually make acidic oxides.

15. In 1908 in Germany, Fritz Haber showed:

$$N_2(g) + 3H_2(g) \Leftrightarrow 2NH_3(g) \qquad \Delta H = -92kJ$$

This is now an important industrial process. Which of the following changes is most likely to increase the yield of NH_3?

(A) increasing the temperature.
(B) decreasing the pressure.
(C) increasing the amount of N_2 gas.
(D) decreasing the amount of N_2 gas.

Student Number: | | | | | | | | | |

Section 1 (continued)

Part A – 85 marks
Attempt Questions 16 - 32
Allow about 2 hours and 30 minutes for this part

Answer the questions in the spaces provided.

Show all relevant working in questions involving calculations.

Marks

Question 16 (4 marks)

(a) Strontium-90 is a radioactive isotope with a half-life of 28.1 years. It decays to release a beta particle. This isotope can be produced in some nuclear reactors. It is particularly dangerous because it replaces calcium in milk and bone tissue and its accumulation usually leads to bone cancer or leukaemia

(i) Write an equation to describe the nuclear decay of strontium-90. **1**

(ii) What instrument could be used to detect this type of radiation? **1**

(a) Identify one named radioisotope, other than that given above, that is used in medicine. Describe the way in which this radioisotope is used and relate this use to its chemical properties. **2**

Student Number: | | | | | | | | | |

Marks

Question 17 (7 marks)

(a) Describe the conditions under which fermentation of sugars is promoted and summarise the chemistry of the fermentation process. **3**

(b) Assess the potential of ethanol as an alternative fuel and discuss the advantages and disadvantages of its use. **4**

Student Number: | | | | | | | | | |

Marks

Question 18 (7 marks)

Chlorine is used for the manufacture of C_2H_3Cl, a monomer that undergoes addition polymerisation.

(a) In the space below draw the full structural formula for C_2H_3Cl and give the systematic name for the monomer C_2H_3Cl. **2**

(b) In the space below draw the structural formula of the polymer that is produced from C_2H_3Cl, with at least three monomer units and give this polymers common name. **2**

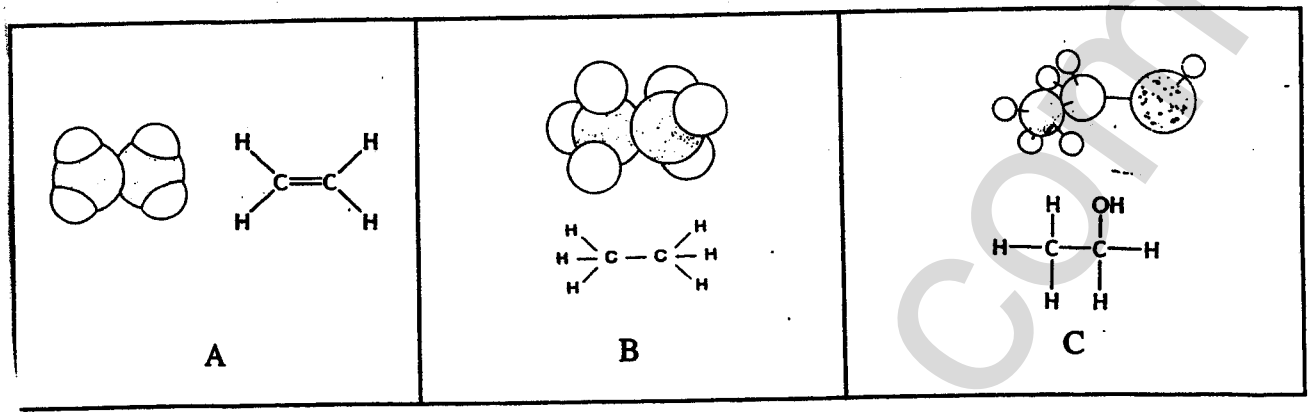
(c) In terms of its ***structure*** and ***properties*** evaluate the usefulness of this polymer for garden hoses and water pipes. **3**

Student Number: | | | | | | | | | |

Marks

Question 19 (5 marks)

The following illustrations represent the molecules of three carbon compounds which are important sources of energy or raw materials for the production of other materials.



(b) Describe a simple laboratory test to distinguish between Compound A and Compound B. **2**

(b) The boiling points of substances A, B and C are:

Substance	Boiling Point °C
A	-103.7
B	-88.6
C	78.3

Explain the trends in the boiling points of the three structures in terms of their structure and bonding. **3**

Question 19 continues on next page

Student Number: | | | | | | | | | |

Marks

Question 19 (continued)

Student Number: | | | | | | | | | |

Marks

Question 20 (6 marks)

During your study of Module 9.2 - The Identification and Production of Materials, you will have carried out a first-hand investigation to measure the difference in potential of different combinations of metals in an electrolyte solution.

(a) Draw the working cell that you constructed for one combination of metals and ***label it fully.***

On your cell, show the flow of ions and the flow of electrons. **4**

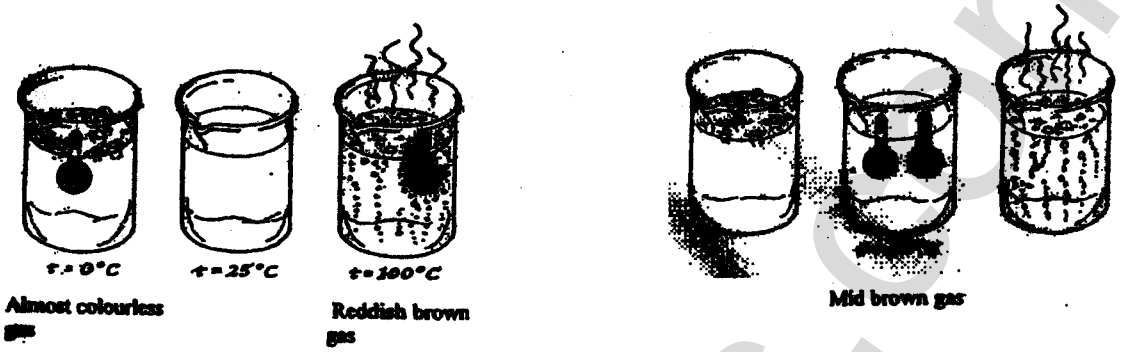
(b) Write the overall equation for the reaction and calculate the standard potential for your working cell. **2**

Student Number: | | | | | | | | | |

Marks

Question 21 (8 marks)

Two sealed tubes containing identical mixtures of dark brown NO_2 and colourless N_2O_4 are placed into beakers of hot water and iced water as shown in the diagram below. They are then moved to a beaker of water at room temperature. The observations made by students of the two tubes have been added to the labelled diagrams.



(a) An equation describing the equilibrium mixture is:

$$2NO_2(g) \Leftrightarrow N_2O_4(g)$$
(dark) (colourless)

(i) Is the reaction as written endothermic or exothermic? Explain your answer in terms of Le Chatelier's principle. **2**

(ii) Given that Sydney's air contains high levels of nitrogen oxides and following on from the student's experimental observations, predict what you would see as you look over the Sydney skyline on a hot, still summers day.
Explain your prediction. **1**

Question 21 continues on next page

Student Number: | | | | | | | | | |

Marks

Question 21 (continued)

(b) Evidence shows that the overall **global** concentrations of NO_2 in the atmosphere has not increased significantly over the last century.

Discuss the human activities that generate localised increases in NO_2 concentrations and the chemical processes which prevent localised increases from being dispersed globally.

Explain how these chemical processes pose a further threat to the environment.

Support your answer with relevant chemical equations. **5**

Student Number: | | | | | | | | | |

Marks

Question 22 (3 marks)

The following table gives the solubility of carbon dioxide in water at various temperatures

Temperature °C	Solubility/g of CO_2 per 100g of water
0	0.33
10	0.23
20	0.17
30	0.13
40	0.097

(a) Describe the trend in the solubility of carbon dioxide with change in temperature. **1**

(b) One test for carbon dioxide is to bubble the gas through a solution of calcium hydroxide, when initially a white precipitate of calcium carbonate is formed according to the equation:

$$CO_2(g) + Ca(OH)_2(aq) \rightarrow CaCO_3(s) + H_2O(l)$$

Calculate the volume of carbon dioxide gas measured at 25°C and 101.3 kPa needed to produce 0.50 g of calcium carbonate by the reaction. **2**

Student Number: | | | | | | | | | |

Marks

Question 23 (3 marks)

Potassium hydrogen phosphate (K_2HPO_4) forms an amphiprotic species in water that is involved in the buffering of living cells.

(a) Write an equation showing how K_2HPO_4 can act as an acid in water. **1**

_____

(b) Write an equation showing how K_2HPO_4 can act as a base in water. **1**

_____

(c) From one of your equations above clearly identify a conjugate pair. **1**

_____

Student Number: | | | | | | | | | |

Marks

Question 24 (5 marks)

A student to make the ester propyl butanoate used the process of reflux.

(a) Describe the procedure used by the student, including all chemicals, to make but not isolate the ester. **3**

(b) Give the chemical equation for the reaction, to produce propyl butanoate, including full structural formula for all the organic (carbon) compounds. **2**

Student Number: | | | | | | | | | |

Marks

Question 25 (7 marks)

In an experiment to determine the concentration of ethanoic acid in white vinegar, a student took 25.0 mL of white vinegar and diluted it to 100 mL with distilled water. He then titrated the diluted vinegar with 0.0970 mol L^{-1} potassium hydroxide solution. He found that 20.0 mL of the diluted vinegar neutralised 35.1 mL of the KOH solution.

(a) Calculate the concentration of the ethanoic acid in the original vinegar sample. (Assume that ethanoic acid is the only component of vinegar that reacts with KOH). **4**

(b) What is the concentration of ethanoic acid in vinegar in %w/v? **1**

(c) If the student had mistakenly only rinsed the burette with water before filling it with the KOH solution, would the student's calculated concentration of vinegar be higher or lower compared to its real concentration? Explain your answer. **1**

(d) Suggest a suitable indicator for the titration. Justify your choice. **1**

Student Number: | | | | | | | | | |

Marks

Question 26 (6 marks)

Justify at least 3 tests that are used to determine the quality of a water sample suitable for drinking. **6**

Student Number: | | | | | | | | | |

Marks

Question 27 (3 marks)

Discuss the problems associated with the use of CFC's. **3**

Student Number: | | | | | | | | | |

Marks

Question 28 (8 marks)

O_2 and O_3 are allotropes of oxygen.

(a) Draw the electron dot formula for each allotrope and indicate any coordinate covalent bond that may be involved. **3**

O_2 O_3

(b) Write the equation to illustrate how O_3 is formed in the stratosphere from O_2. **1**

(c) Explain why, how and where O_3 acts as a pollutant. **4**

Student Number: | | | | | | | | | |

Marks

Question 29 (2 marks)

Explain how microscopic membrane filters purify contaminated water. **2**

Student Number: | | | | | | | | | |

Marks

Question 30 (2 marks)

To a 25 mL 1.0 mol L^{-1} NaOH solution in a styrofoam cup was added 25 mL 1.0 mol L^{-1} HCl solution. The maximum change in temperature for the neutralisation reaction was found to be 6.8 °C.

Calculate the molar heat of neutralisation for the reaction. **2**

Student Number: | | | | | | | | | |

Marks

Question 31 (4 marks)

Many reactions need monitoring. Discuss this statement in relation to the combustion of a specified compound. **4**

Student Number: | | | | | | | | | |

Marks

Question 32 (5 marks)

Discuss how the Haber Process is based on a delicate balancing act to obtain NH_3 in a short time yet with reasonable yields. Assess the impact of the catalyst that is used industrially in the Haber Process. **5**