Centre Number

Student Number

CATHOLIC SECONDARY SCHOOLS
ASSOCIATION OF NEW SOUTH WALES

2009
TRIAL HIGHER SCHOOL CERTIFICATE EXAMINATION

Chemistry

Morning Session
Thursday, 13 August 2009

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
- 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 page 9

Total marks – 100

Section I Pages 2–23

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 16–28
- Allow about 1 hour and 45 minutes for this part

Section II Pages 25–34

25 marks
- Attempt ONE question from Questions 29–33
- 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

Use the Multiple Choice Answer Sheet provided.

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1 Which of the following is an example of a synthetic biopolymer?

(A) Biopol
(B) Cellulose
(C) Crude oil
(D) Ethanol

2 Polystyrene is suitable for the manufacture of

(A) shopping bags because of its biodegradability.
(B) garden hoses because of its high melting point.
(C) tool handles because of its rigidity.
(D) carpets because of its ability to stretch and return to its original position.

3 Copper metal will form on the surface of an iron nail dropped into an aqueous solution of copper (II) sulfate because

(A) copper ions have a positive charge.
(B) iron atoms transfer electrons to copper ions.
(C) electrons move from copper ions to iron atoms.
(D) copper acts as an anode.

4 The table below lists the boiling points of some alkanols and their corresponding alkanoic acids.

Alkanols		*Alkanoic Acids*	
Substance	*BP (K)*	*Substance*	*BP (K)*
propan-1-ol	370	propanoic acid	414
butan-1-ol	390	butanoic acid	434
pentan-1-ol	411	pentanoic acid	459

What causes the alkanoic acids to have higher boiling points than their corresponding alkanols?

(A) The greater dispersion forces between the molecules of the alkanoic acids

(B) The ionic bonding that occurs in the alkanoic acids when they become ionised

(C) The stronger acidic properties of the alkanoic acids

(D) The greater extent of hydrogen bonding between the alkanoic acid molecules

5 Some radioisotopes used for medical purposes are produced on-site at the hospital by the decay of other unstable isotopes sourced from a nuclear reactor.

What is the main reason for producing the required isotope at a hospital rather than elsewhere?

(A) Transport of some radioisotopes is considered too dangerous.

(B) The short half-lives of these isotopes mean too much will decay during transport.

(C) Gamma ray emitters cannot be transported with other radioisotopes because they may cause the other isotopes to decay during the trip.

(D) Nuclear reactors cannot produce a variety of different isotopes all at the same time, so some need to be produced elsewhere.

6 A teacher found an old collection of indicators which she suspected were incorrectly labelled. She asked a student to check which indicators were correctly labelled by adding them to solutions of known pH.

The student's results are in the table below.

Label on bottle of indicator	*Colour of solutions of known pH after indicator added*			
	pH = 1	*pH = 4*	*pH = 7*	*pH = 11*
Methyl orange	red	yellow	yellow	blue
Bromothymol blue	yellow	yellow	green	blue
Litmus	blue	blue	purple	red

Which bottles of indicator were labelled correctly?

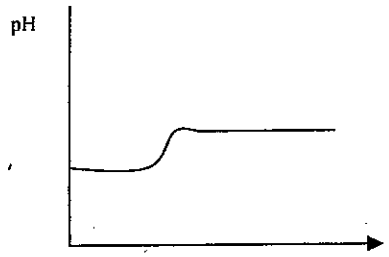
(A) The methyl orange and the litmus
(B) The litmus and the bromothymol blue
(C) Only the bromothymol blue
(D) Only the methyl orange

7 Which of the following is NOT classified as amphiprotic?

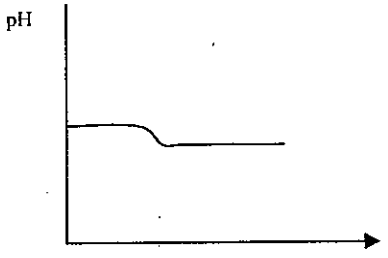
(A) HCO_3^-
(B) HSO_4^-
(C) H_3O^+
(D) H_2O

8 A warm unopened bottle of soda water was placed in a refrigerator. Which graph best shows the pH changes that occur in the bottle as a new equilibrium is established?

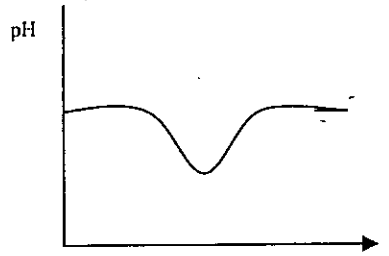
(A)



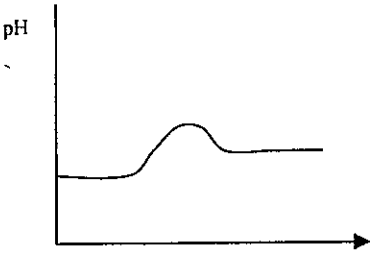
(B)



(C)



(D)



9 A titration was performed using 25.00 mL of a 0.100 mol L^{-1} ammonia solution and a 0.100 mol L^{-1} solution of a strong monoprotic acid. Which of the following will be required to observe a valid endpoint?

	Indicator	*Volume of Acid (mL)*
(A)	methyl orange	25.00
(B)	methyl orange	less than 25.00
(C)	phenolphthalein	25.00
(D)	phenolphthalein	less than 25.00

10 The pH of a 0.0541 mol L^{-1} solution of hydrochloric acid is most correctly expressed as

(A) 1.266803

(B) 1.267

(C) 1.27

(D) 1.3

11 The increase in atmospheric carbon dioxide has been linked to the burning of fossil fuels.

The combustion of octane produces 1.554 x10^7 kJ of energy per tonne of carbon dioxide produced.

Ethanol has been proposed as a more environmentally sound source of energy. The heat of combustion for ethanol is 1367 kJ mol^{-1}. The energy produced per tonne of carbon dioxide from the combustion of ethanol is

(A) 8.311 kJ

(B) 2.272 x 10^4 kJ

(C) 1.553 x 10^7 kJ

(D) 3.106 x 10^7 kJ

12 In the Haber process, iron on the surface of iron oxide (magnetite) is used because it

(A) shifts the equilibrium in the preferred direction.

(B) decreases the formation of unwanted waste products.

(C) removes unwanted oxygen and so prevents dangerous explosions.

(D) allows a lower temperature to be used.

13 Which reagent would be most suitable to use when testing for the presence of chloride ions in a sample?

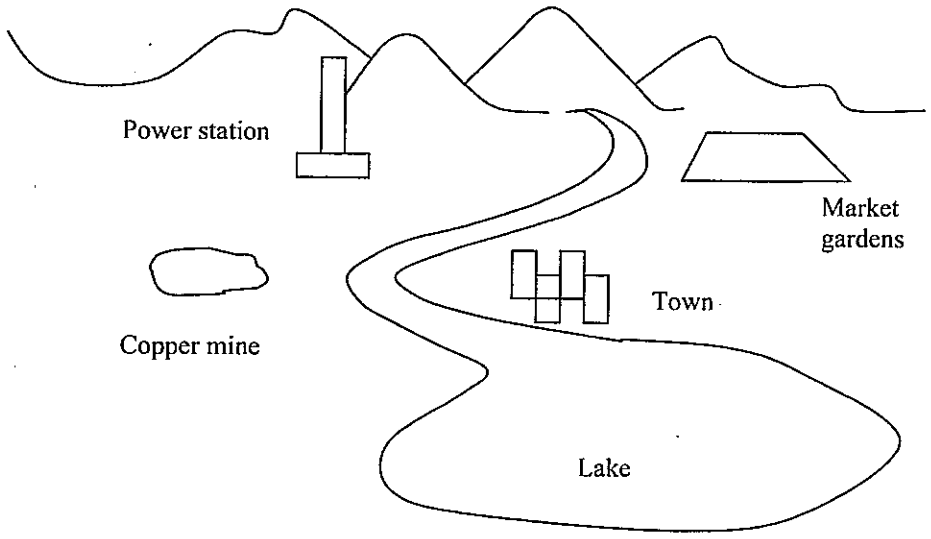
(A) $AgNO_3$

(B) $Ba(NO_3)_2$

(C) $NaNO_3$

(D) $Cu(NO_3)_2$

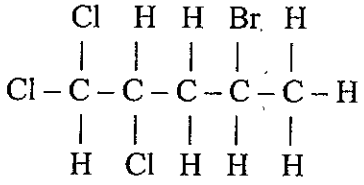
14 The lake indicated in the diagram below is showing signs of eutrophication.



Which is the most likely source of contaminants that would result in this problem?

(A) Copper mine
(B) Power station
(C) Town
(D) Market gardens

15 What is the correct systematic name for the compound having the structure shown below?



(A) 4-bromo-1,1,2-trichloropentane
(B) 4,5,5-trichloro-2-bromopentane
(C) 2-bromo-4,5,5-trichloropentane
(D) 1,1,2-trichloro-4-bromopentane

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Chemistry

Centre Number

Student Number

Section I (continued)

Part B – 60 marks
Attempt Questions 16-28
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.

Marks

Question 16 (2 marks)

Describe the steps in the formation of the addition polymer poly(vinyl chloride). **2**

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Marks

Question 17 (9 marks)

Many cosmetics and pharmaceutical preparations require the use of a solvent such as ethanol, which can be produced by the fermentation of sugars or can be derived from crude oil.

(a) Describe the conditions required to produce ethanol by the fermentation of sugars. **2**

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(b) Explain how mass changes can be used to monitor the fermentation reaction. Include a suitable equation in your answer. **2**

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Question 17 continues on page 11

Marks

Question 17 (continued)

(c) Justify the use of ethanol as a solvent, by referring to the structure of the ethanol molecule. 3

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(d) Identify the steps in the production of ethanol from crude oil. 2

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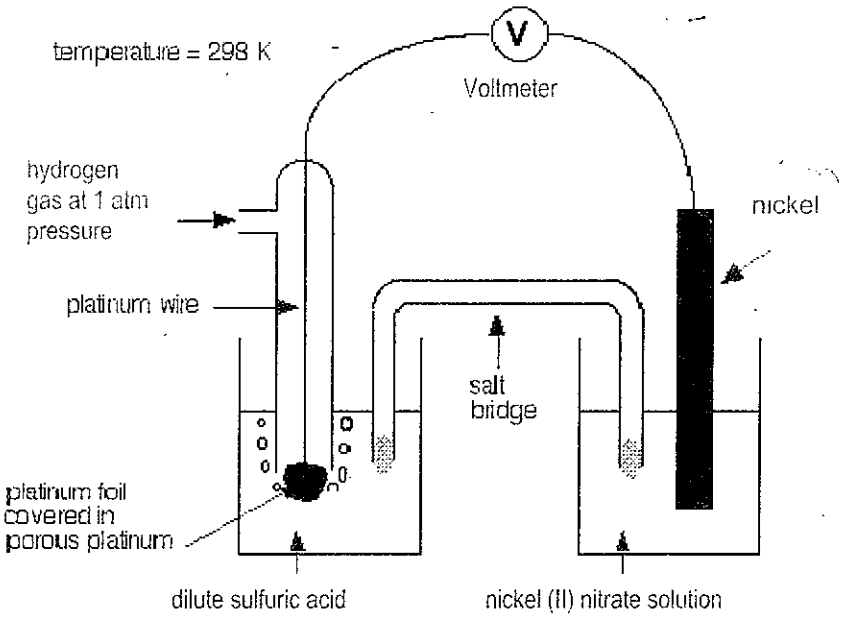
End of Question 17

Marks

Question 18 (5 marks)

A group of students constructed the galvanic cell below.



(a) Write the half-equations for this galvanic cell and, on the diagram above, clearly show the direction of electron flow. **2**

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(b) Label the anode and cathode on the diagram of the galvanic cell above. **1**

(c) Suggest TWO reasons why this particular galvanic process is unsuitable as the basis for development of a commercial cell. **2**

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Marks

Question 19 (4 marks)

A scientist placed a rock on top of a few sheets of newspaper, under which was an envelope containing photographic film. After only 5 minutes he removed the photographic film and found that an image in the shape of the rock had developed on the film.

After 28 days, he demonstrated this phenomenon to his colleagues with the same rock, but this time it took 20 minutes for the image to develop to the same intensity.

The table shows properties of some radioactive isotopes.

Name of isotope	*Radiation emitted*	*Approximate half-life*
Sodium-24	beta, gamma	15 hours
Bismuth-210	beta	5 days
Iodine-131	beta	7 days
Phosphorus-32	beta	14 days
Radium-225	alpha	14 days
Thorium-227	alpha	28 days
Protactinium-234	beta	28 days

(a) Use the information about the scientist's experiment and that in the table above to deduce which of these radioactive isotopes the rock may have contained. Explain your choice. **2**

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(b) Identify ONE instrument or process, other than the use of a photographic film, which can be used to detect radiation. **1**

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(c) Name the isotope which undergoes beta decay to form thorium-227. **1**

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Marks

Question 20 (6 marks)

The role of the solvent is important to our understanding of acids and bases.

(a) Identify the scientist(s) whose theory of acids first considered solvents other than water. **1**

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(b) Nitrogen dioxide is an acidic oxide that produces acid rain.

(i) Identify an industrial source of nitrogen dioxide. **1**

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(ii) Explain, using a balanced equation, the formation of acid rain from nitrogen dioxide. **2**

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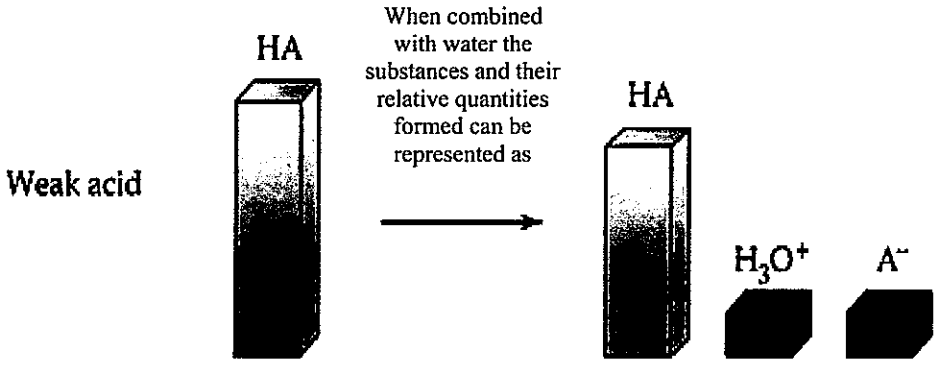
Question 20 continues on page 15

Question 20 (continued)

(c) A secondary source modelled the ionisation of a weak acid in water using the following diagram. **2**



In the space below, show how the diagram would be redrawn to model the change when a strong acid ionises in water.

End of Question 20

Marks

Question 21 (5 marks)

A student weighed out a solid sample from a reagent bottle labelled sodium hydroxide. The sample was dissolved in a volumetric flask using deionised water. This primary standard was then used in a series of titrations to determine the concentration of a sample of vinegar.

(a) Calculate the mass of pure sodium hydroxide required to make 100.0 mL of a 0.100 mol L^{-1} solution. **2**

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(b) Evaluate the appropriateness of the student's method. **3**

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Question 22 (5 marks) **Marks**

A student conducted the following experiment using a solution of acetic acid and a solution of hydrochloric acid. After measuring the pH, a salt was dissolved into each sample and the pH measured again. The results are summarised in the table below.

	acetic acid	*hydrochloric acid*
Concentration of acid (mol L^{-1})	1.0	0.0040
Initial pH	2.4	2.4
Substance added	1.0 g solid sodium acetate	1.0 g solid sodium chloride
Final pH	2.6	2.4

Analyse and explain all concentration and pH readings recorded during this investigation. **5**

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Question 23 (4 marks) **Marks**

Consider the following reaction:

ethanol + propanoic acid $\overset{\text{conc. } H_2SO_4}{\rightleftharpoons}$ compound X + compound Y

(a) Name and write structural formulae for compounds X and Y. **2**

X = ...

Structural formula for X:

Y= .....

Structural formula for Y:

(b) Draw a labelled diagram of the apparatus used to carry out this reaction in the laboratory. **2**

Marks

Question 24 (4 marks)

"The Haber process is based on a delicate balancing act involving reaction energy, reaction rate and equilibrium." **4**

Analyse this statement.

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Marks

Question 25 (4 marks)

(a) Write a balanced equation for INCOMPLETE combustion of propane. **1**

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(b) "Incomplete combustion of fuels is an issue for society. As a result, combustion reactions require monitoring and management." **3**

Discuss these statements.

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Marks

Question 26 (5 marks)

Human activity has caused changes in the composition and structure of the atmosphere. Chemists monitor changes in the concentration of ozone so that further damage can be limited.

(a) Outline how the measurements which show the depletion of ozone in the stratosphere are obtained. **2**

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(b) Outline a step taken to reduce the effects of ozone-destroying chemicals in the stratosphere. **1**

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(c) Explain how ozone is destroyed by chemicals such as CFCs in the stratosphere. Include equations in your response. **2**

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Marks

Question 27 (3 marks)

Discuss the use of chemical additives and membrane filters in the treatment of mass water supplies. **3**

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Marks

Question 28 (4 marks)

A chemistry student determined the percentage of sulfate in a lawn fertiliser using the following procedure. He ground the fertiliser into a powder, weighed out 1.03 g of the powder, added it to 250 mL of dilute hydrochloric acid and stirred to dissolve as much as possible of the fertiliser. The insoluble material was then removed by filtration. The filtrate was warmed and a solution of barium chloride was slowly added until no more precipitate formed. The precipitate was allowed to settle. After 30 minutes, the precipitate was filtered through a weighed sintered glass filter, washed, dried and the mass of the precipitate determined.
The precipitate was found to have a mass of 1.80 g.

(a) Use the above data to calculate the percentage of sulfate in the lawn fertiliser. **2**

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(b) The teacher told the student that his answer was not correct and suggested that the washing and drying stages of the experiment might not have been performed adequately. Explain how incorrect techniques during the washing and drying stages could impact on the accuracy of the result. **2**

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Chemistry

Section II

25 marks
Attempt ONE question from Questions 29–33
Allow about 45 minutes for this section

Answer the question in a SEPARATE writing booklet.

Show all relevant working in questions involving calculations.

Marks

Question 29 – Industrial Chemistry (25 marks)

(a) Describe the issues associated with the shrinking world resources of ONE identified natural product that is not a fossil fuel and identify a replacement material used. **2**

(b) The Contact process in the production of sulfuric acid involves the conversion of SO_2 *(g)* into SO_3 *(g)*.

(i) Initially (before any sulfur trioxide had been produced) the concentration of sulfur dioxide was found to be 0.360 mol L^{-1} and the concentration of oxygen was found to be 0.300 mol L^{-1} in a 1.00 L vessel. At equilibrium, the concentration of sulfur trioxide was found to be 0.240 mol L^{-1}. **4**

Calculate the equilibrium constant for the reaction.

(ii) Sketch a graph to show the changes in concentration of sulfur dioxide, oxygen and sulfur trioxide as reaction proceeded until some time after equilibrium had been achieved. **2**

(c) During your practical work you performed a first-hand investigation to gather information about, and to carry out, the process of saponification.

(i) Define the term saponification. **1**

(ii) Outline the procedure used in your investigation and outline how you identified your product. **3**

(iii) Account for the cleaning action of soap. **3**

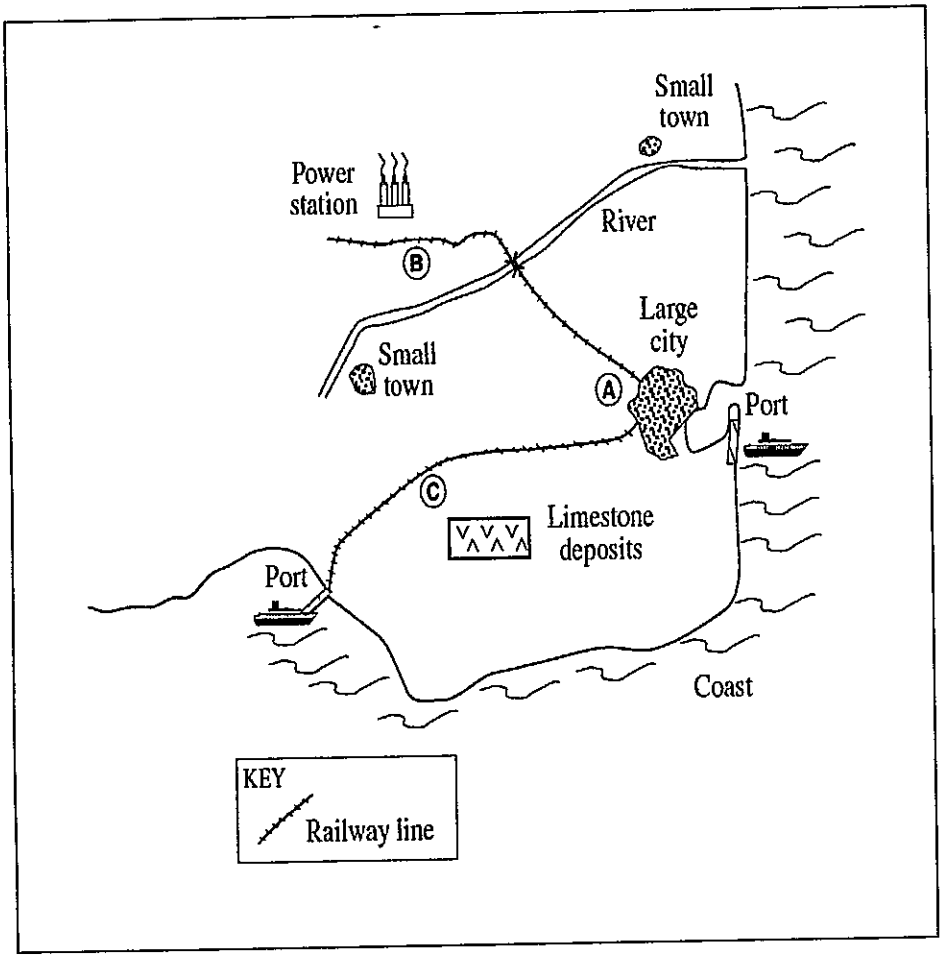
(d) Evaluate the THREE industrial methods for production of sodium hydroxide over the past century, by considering their impact on society and the environment and the chemical reactions and technologies involved. **6**

Question 29 continues on page 27

Marks

Question 29 (continued)

(e) Solvay Solutions Pty Ltd wishes to build a new industrial plant to be used for the production of sodium carbonate. The map shows THREE proposed sites (A, B and C) for the new plant. **4**



Critically assess the suitability of each of the proposed sites, A, B and C, for locating the new plant.

End of Question 29

Marks

Question 30 – Shipwrecks, Corrosion and Conservation (25 marks)

(a) (i) Identify the type of corrosion prevention provided by a zinc bar attached to the hull of an iron ship. **1**

(ii) Explain why the presence of a passivating layer on the zinc would make it unsuitable as a means of corrosion prevention for the ship. **2**

(b) Explain the key steps in the process of rusting. Include appropriate equations in your response. **3**

(c) Acidic environments accelerate corrosion.

(i) Identify a source of acidity in the ocean. **1**

(ii) In your course you performed a first-hand investigation of corrosion in different acidic and neutral solutions. Explain how your method allowed a valid comparison of rates of corrosion to be made. **4**

(d) Sir Humphrey Davy was able to produce pure sodium by passing an electric current through molten samples of common salt.

(i) Identify the source of the electricity used in Davy's experiment. **1**

(ii) Explain why the production of sodium metal in Davy's experiment required an electrolyte of molten sodium chloride rather than an aqueous solution of sodium chloride. **2**

Question 30 continues on page 29

Question 30 (continued)

(e) The table below lists details relating to TWO submerged artefacts that are to be recovered for cleaning and preservation. **6**

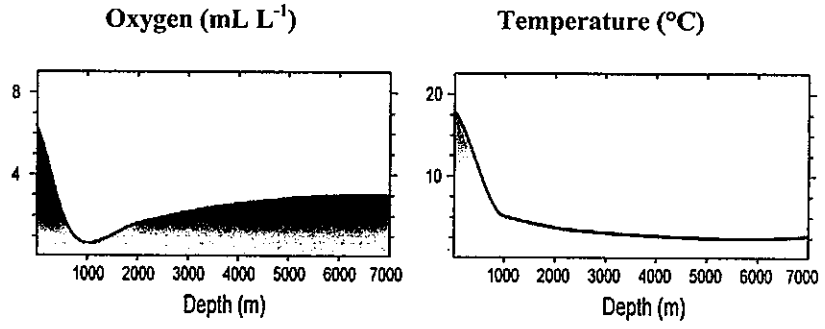
	Artefact 1 ***boiler and engine***	***Artefact 2*** ***anchor***
location	Murray River	Great Barrier Reef
water	fresh water	marine
average depth	8 m	12 m
composition	iron	iron
approximate age	110 years	115 years
average water temperature	18°C	26°C

Discuss the range of procedures that should be used to clean and stabilise EACH artefact, explaining any differences in the treatments required.

(f) (i) Identify the relationship between temperature of water and oxygen solubility. **1**

(ii) Examine the following graphs:

Depth of the Ocean versus Oxygen Concentration and Temperature



Graph A **Graph B**

Adapted from: http://www.rsbs.anu.edu.au/O2/O2_2_Aqua.htm

Explain the shape of Graph A. **3**

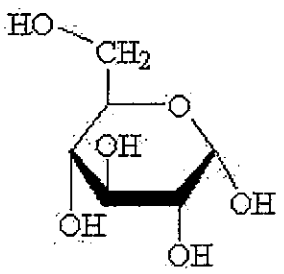
(iii) In your answer booklet, sketch a graph to show the relationship that *would be expected* between depth of ocean and oxygen concentration, *if* temperature were the only factor determining the relationship. **1**

End of Question 30

Marks

Question 31 – The Biochemistry of Movement (25 marks)

(a)



(i) To what class of compounds does this molecule belong? **1**

(ii) You performed a first-hand investigation, using models, computer simulations or diagrams, to compare the molecule shown above with glycogen. **2**

Outline the results of your investigation.

(b) "Protein molecules are very complex structures, determined by their sequence of amino acids." **4**

Analyse this statement, making reference to the nature of bonding and the various levels of protein structure.

(c) During your practical work you performed a first-hand investigation to demonstrate the effect of various factors on the reaction of a named enzyme.

(i) Outline the procedure used in the investigation and one safety precaution used. **3**

(ii) Describe the results obtained in the investigation. **2**

(iii) Outline any conclusions reached. **1**

Question 31 continues on page 31

Question 31 (continued)

(d) (i) Compare the appearance of Type 1 and Type 2 muscle fibres and relate their appearance to the types of exercise for which they are used. **3**

(ii) During vigorous exercise, athletes are not capable of maintaining an adequate supply of oxygen to their muscle tissue. Describe the way in which muscles meet their energy needs in an oxygen-deprived environment. **2**

(iii) Compare the energy output in an oxygen-deprived environment with that during aerobic respiration. **1**

(iv) Describe and account for the symptoms felt by athletes in oxygen-deprived conditions. **1**

(e) (i) Draw a structural formula for glycerol. **1**

(ii) Explain the high viscosity of glycerol. **2**

(iii) Use an equation to explain how glycerol is involved in the formation of fats (TAGs) in living tissues. **2**

End of Question 31

Marks

Question 32 – The Chemistry of Art (25 marks)

(a) Explain how pigments present in a painting can be identified using reflectance spectra. **2**

(b) Discuss how pigments have changed over time in response to recognition of health risks and discoveries of new pigments. Make reference to specific pigments and their colours in your answer. **3**

(c) You performed an experiment to investigate the oxidising strength of potassium permanganate ($KMnO_4$).

(i) Explain how the oxidising strength of potassium permanganate relates to the position of the permanganate ion (MnO_4^-) on the table of standard reduction potentials. **2**

(ii) Explain how the oxidising strength of potassium permanganate relates to its oxidation state. **2**

(iii) When potassium permanganate is reduced to manganese (II) ions, a colour change is observed and the oxidation state of the metal changes.
Relate this change in colour to change in electron configuration of transition metal ions. **4**

(iv) State a safety precaution that was taken during the experiment and explain how it lowered risk. **1**

(d) Outline the relationship between the trend in the successive ionisation energies of an aluminium atom and its electron configuration. **2**

(e) "While almost all the 3d transition metals exhibit variable valency, they usually exhibit a +2 oxidation state. However, one of the metals of the first transition series does not exhibit variable valency and only exists in the 0 and +2 oxidation states." **6**

Analyse these statements, using examples of transition metals as appropriate, and referring to electron configurations of these metals.

(f) "Hydrated ions are examples of co-ordination complexes." **3**

Explain this statement. Include a Lewis formula for a hydrated ion in your response.

Marks

Question 33 – Forensic Chemistry (25 marks)

(a) Outline TWO precautions that are used by forensic chemists when collecting samples and performing analyses and explain why these precautions are important. **2**

(b) The origin of a polysaccharide can be useful information when conducting forensic investigations.

(i) Identify the difference in structure between a named polysaccharide from a plant and a named polysaccharide from an animal. **2**

(ii) Identify the reagents that could be used to distinguish between the two polysaccharides you identified in (i). Describe the positive results you would expect. **2**

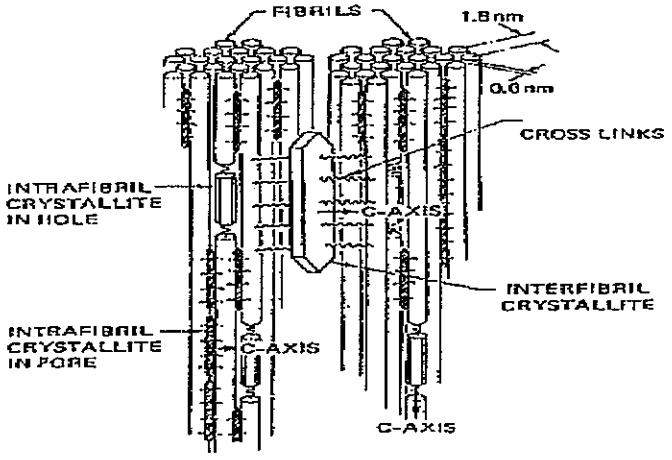
(c) As part of your course you performed a first-hand investigation to separate a mixture of organic materials by chromatography.

(i) Describe the procedure that you used in your investigation. **3**

(ii) Identify the safety precautions that you used. **1**

(iii) Explain how chromatography can be used to separate biological samples. **2**

(d) (i) Identify an example of the type of protein indicated in the diagram below. **1**



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(ii) Explain how a peptide bond is formed and write an equation, using structural formulae, to show the condensation reaction between two amino acids. **2**

Question 33 continues on page 34

Marks

Question 33 (continued)

(e) "DNA analysis is not infallible in forensic cases." **4**

Discuss this statement.

(f) Sensitive instrumental techniques have been used in recent years to provide forensic evidence about samples. For example, forensic chemists use analytical techniques in providing evidence to convict drug cheats in professional sport. Using this example, or another of your choosing, evaluate the use of TWO instrumental techniques (other than DNA analysis) in providing evidence for forensic investigations. **6**

End of Paper

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