Centre Number

Student Number

CATHOLIC SECONDARY SCHOOLS
ASSOCIATION OF NEW SOUTH WALES

2002
TRIAL HIGHER SCHOOL CERTIFICATE EXAMINATION

Chemistry

Afternoon Session
Tuesday 13 August 2002

Total marks – 100

General Instructions

- Reading time – 5 minutes
- Working time – 3 hours
- Write using blue or black pen
- Board-approved calculators may be used
- Draw diagrams using pencil
- Use the Multiple Choice Answer Sheet provided
- Write your answers for Part B in the spaces provided
- A Data Sheet and Periodic Table are provided separately

Section I Pages 3–17

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 16–27
- Allow about 1 hour 45 minutes for this part

Section II Pages 19–24

Marks **(25)**
- Attempt ONE question from Questions 28–32
- Allow about 45 minutes for this section

EXAMINERS

Anna Davis (convenor)	Casimir Catholic College, Marrickville
Gillian Giesajtis	Casimir Catholic College, Marrickville
Karen Bertinshaw	Gilroy College, Castle Hill
Luke Hanson	SCEGGS, Darlinghurst
Renee Tennant	Aquinas College, Menai
Chris Warren	St Vincent's College, Potts Point

Sources:

Winfield, A (1995) *Environmental Chemistry,* Cambridge University Press, Great Britain, p.46: Page 15

Thickett, G (2000) *Chemistry Pathways 2*, Macmillan Education Australia Pty Ltd, South Yarra: Page 20

Irwin, D et al (2001) *Chemistry Contexts 2 CD-ROM*, Pearson Education Australia: Page 21

Smith, R (2000) *HSC Course Conquering Chemistry* (3rd ed), McGraw Hill Book Company Australia Pty Limited, Sydney): Page 4 & 23

Brown,W H (1988) *Introduction to Organic Chemistry* (4th Ed) Wadsworth Inc, California: Page 24

2001 HSC Chemistry examination

Section I
Marks (75)

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

Use the Multiple Choice Answer Sheet provided

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1 The reaction of ethene with bromine is:

(A) a substitution reaction that occurs spontaneously

(B) a substitution reaction that occurs in the presence of a catalyst

(C) an addition reaction that occurs spontaneously

(D) an addition reaction that occurs in the presence of a catalyst

2 Which of the following does NOT usually occur during the cracking of high boiling fractions of crude oil?

(A) a decrease in the pressure of the reaction vessel

(B) the formation of products with a higher total chemical potential energy than the reactants

(C) the production of smaller saturated hydrocarbons

(D) the formation of unsaturated hydrocarbons, eg ethene

3 Wine is formed from the fermentation of grape juice.

The fermentation of grapes is NOT promoted by:

(A) excluding air

(B) adding yeast

(C) storage in a cold cellar

(D) crushing the grapes and adding some water.

4 A student was asked to distinguish between two white powders, one of which was glucose and the other sodium chloride.

Which physical property would be the best to test?

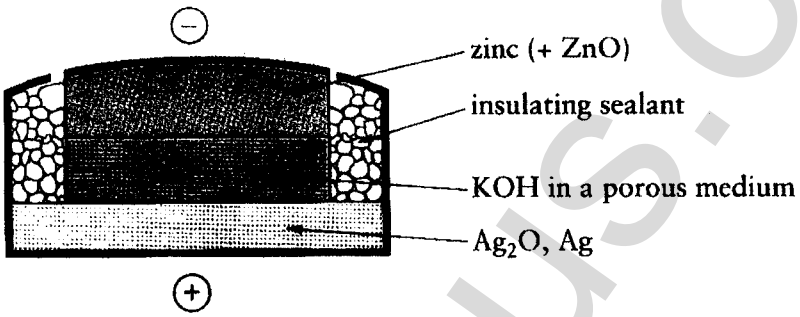
(A) solubility in water

(B) hardness

(C) thermal conductivity

(D) electrical conductivity in aqueous solution

5 The diagram below shows a silver oxide 'button' cell.



Choose the TRUE statement:

(A) The Ag_2O and Ag layer is the electrolyte

(B) The cathode is the negative electrode shown at the top of the cell

(C) Zinc is oxidised to zinc (II) at the anode

(D) The conventional notation for this cell is

$$KOH \mid Zn \mid Ag_2O, Ag$$

6 The pH of 0.0015 mol L^{-1} nitric acid is closest to:

(A) 2

(B) 3

(C) – 2

(D) 1.5

7 Swimming pools are sterilised by adding calcium hypochlorite, $Ca(OCl)_2$, or sodium hypochlorite, NaOCl.

The equilibrium involved is:

$$OCl^-(aq) + H_2O(l) \rightleftharpoons HOCl(aq) + OH^-(aq)$$

The species that is best at destroying bacteria and at resisting decomposition by sunlight is HOCl.

Identify the reaction conditions that will favour the formation of HOCl:

(A) adding NaOH

(B) adding HCl

(C) adding water

(D) both (B) and (C)

8 When using a pipette, you should always:

(A) rinse it with distilled water before use

(B) ensure it is clamped vertically

(C) rinse it with the solution to be used

(D) ensure that the last drops are drained by shaking or blowing it

9 The conjugate base of the HSO_4^- is:

(A) SO_4^{2-}

(B) H_2SO_4

(C) SO^{4-}

(D) SO_3^{2-}

10 Zinc metal can be formed by extracting it from its ore. The first step in this extraction process is to roast the sulfide ore in air.

$$2\ ZnS(s) + 3\ O_2(g) \rightarrow 2\ ZnO(s) + 2\ SO_2(g)$$

300 kg of zinc sulfide is roasted with air.

The volume of sulfur dioxide released into the atmosphere at 101.3 kPa and 298 K is closest to:

(A) 130 mL

(B) 75 L

(C) 130 L

(D) 75 000 L

11 The total dissolved solids in a water sample are best determined using:

(A) AAS

(B) electrical conductivity

(C) a pH meter

(D) a flame test

12 The following steps were taken to determine the citric acid concentration in orange juice:

- the orange juice was strained to remove pulp
- the concentration of a sodium hydroxide solution was determined by titrating with a primary standard
- 25 mL of orange juice was measured into a conical flask using a bulb pipette
- 5 drops of phenolphthalein was added
- the standardised NaOH was added from a burette until the endpoint was reached
- the titration was repeated two more times
- the results of the last two titrations were averaged

Which of the following would improve the reliability of this experiment?

(A) diluting the orange juice to obtain a more visible endpoint

(B) using a graduated pipette to measure the orange juice

(C) standardising the NaOH with a strong acid such as HCl

(D) averaging all of the results to calculate the citric acid concentration

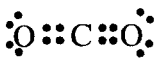
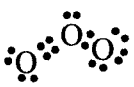
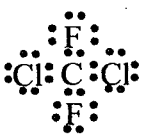
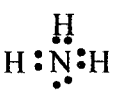
13 Ozone is found in highest concentrations in the layer of the atmosphere known as the:

(A) troposphere
(B) stratosphere
(C) mesosphere
(D) thermosphere

14 An iron-based chemical is required in the Haber process for the purposes of:

(A) increasing the yield of ammonia which is produced
(B) increasing the activation energy of the reaction
(C) increasing the quality of the ammonia which is produced
(D) increasing the rate at which ammonia is produced

15 Which of the following molecules is formed through a co-ordinate covalent bond?

(A) 
(B) 
(C) 
(D) 

Section I
Part B

Total marks (60)
Attempt Questions 16–27
Allow 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) **Marks**

Polvyinylchloride (PVC) is a widely used polymer.

(a) Identify the systematic name for the monomer used to manufacture PVC. **1**

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(b) Identify ONE use of PVC and account for its use in terms of its properties. **2**

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(c) Explain why the recycling of plastics is an important means of conserving our fossil fuel resources. **2**

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Question 17 (6 marks) **Marks**

One method of identifying cellulose is to:

- test for the presence of starch using iodine
  THEN
- if positive, starch was originally present
  OR
- if negative, decompose cellulose with 18 mol L^{-1} H_2SO_4 and $ZnCl_2$/KI solution (Schultze's reagent) and test for starch using iodine. If this test is positive, then cellulose is present.

A student performed an experiment to show that bacteria containing cellulase can be used to breakdown the cellulose in wood. The following results were recorded:

	Test for starch using iodine solution	Test for cellulose using Schultze's reagent followed by iodine
Bacterial solution	Remained orange / brown	Remained orange / brown
Wood samples treated with the bacterial solution	Turned blue / black	Turned blue / black
Untreated wood samples	Turned blue / black	Turned blue / black

For the experimental method outlined above:

(a) Identify ONE hazard. **1**

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(b) Outline safety precautions to minimise this hazard. **2**

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(c) Justify the conclusions that can be drawn from this experiment. **3**

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Question 18 (3 marks) **Marks**

Sodium-24 (a beta emitter), in the form of radioactive sodium chloride, is used by plumbers to trace water flow in underground pipes. **3**

Describe how beta emitters, such as sodium-24, are manufactured.

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Question 19 (6 marks)

Discuss the advantages and disadvantages of using models in chemistry. Use examples to illustrate your answer. **6**

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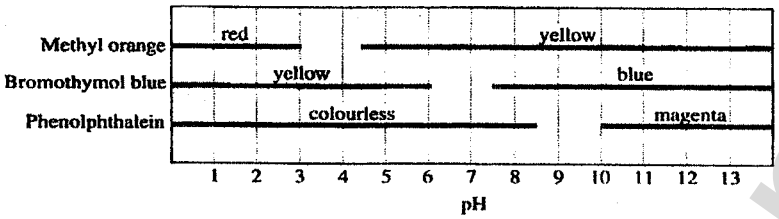
Question 20 (6 marks) **Marks**

The graph shows the colour changes of the acid-base indicators methyl orange, bromothymol blue and phenolphthalein. **6**



A student used a pH meter and bromothymol blue indicator to test 0.1 mol L^{-1} solutions of hydrochloric acid and acetic acid.

Use the above example to distinguish between destructive and non-destructive testing procedures and analyse the different results that will be obtained using these two procedures.

Question 21 (4 marks)

Use net ionic equations to explain the amphiprotic nature of sodium hydrogen carbonate in acidic and basic conditions. **4**

Question 22 (5 marks)

Marks

The procedure below was carried out to decarbonate a soft drink.

- Weigh an unopened can of soft drink using an electronic balance
- Open the can
- Place the can on a hot plate until it just begins to boil
- When cool, reweigh the can to determine the mass loss

(a) Explain why heating the soft drink will cause the carbon dioxide to be lost. **3**

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(b) Describe a modification required to make the results valid for calculating the mass loss of carbon dioxide. **2**

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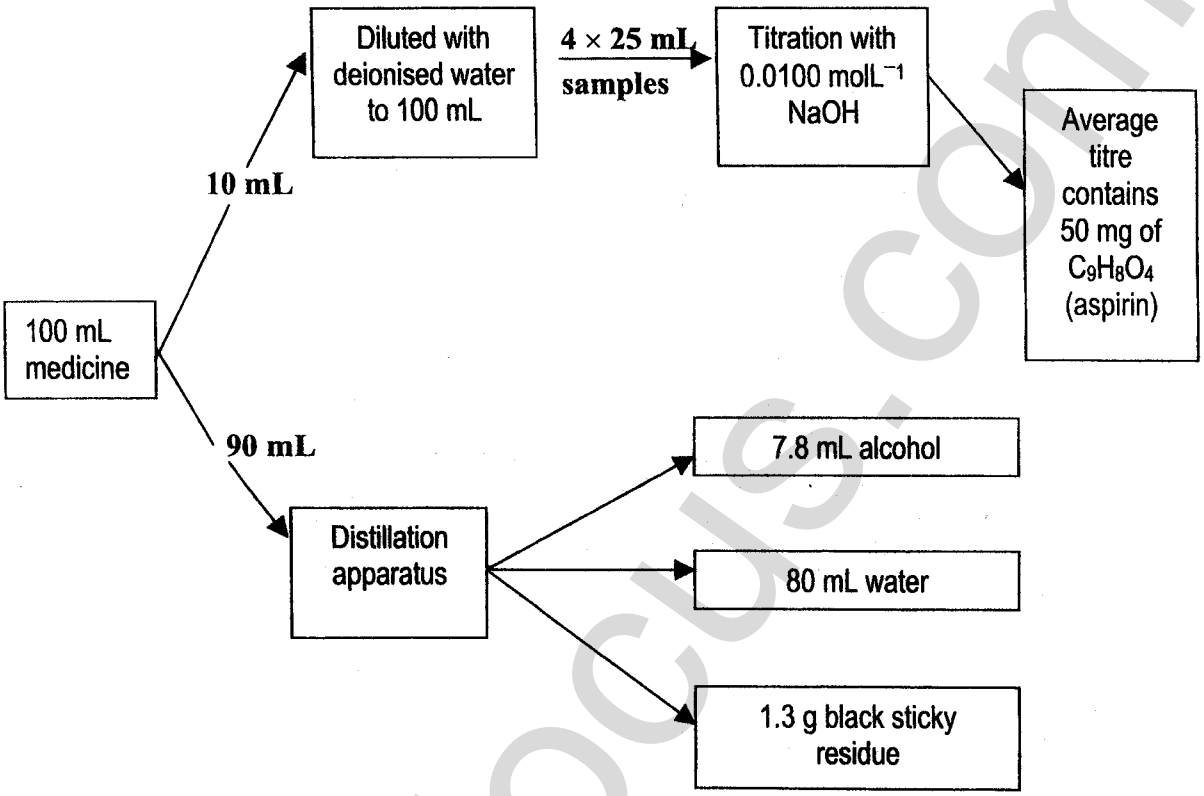
Question 23 (4 marks) **Marks**

A student analysed a medicine using the following process.

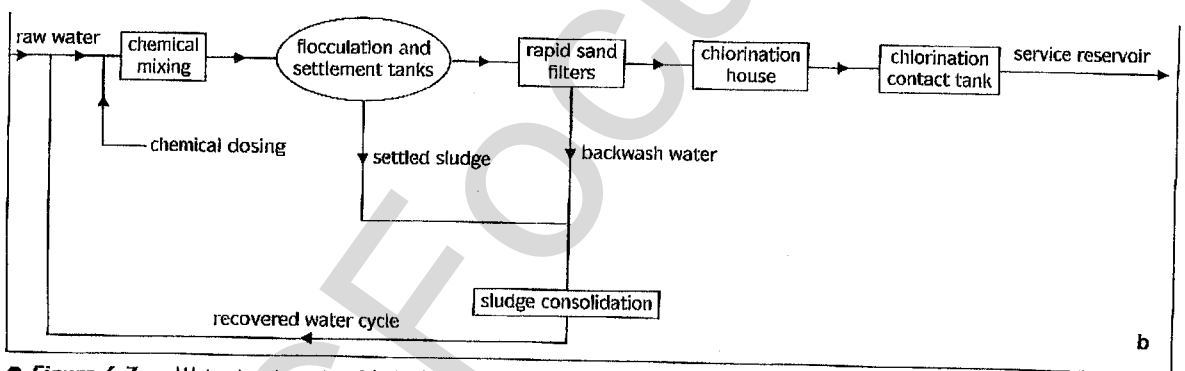


Calculate the concentration of aspirin ($C_9H_8O_4$), in mol L^{-1}, in the original sample of medicine. Show *all* working. **4**

Question 24 (5 marks)

Marks

A student investigating the physical and chemical processes used to purify and sanitise their local town water supply found the following photograph and diagram.



● ***Figure 4.7*** **a** Water treatment at Mythe Water Works, Tewkesbury, England.
b Layout of typical water treatment plant for public supply.

(a) Describe the relevance of this source material to the area of investigation. **3**

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Question 24 continues on page 15

Question 24 (continued) **Marks**

(b) Outline how you would assess the reliability of this source material. **2**

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Question 25 (7 marks)

Describe a procedure that could be used to determine the nitrogen content of fertiliser. In your answer, include relevant chemical equations and justify any assumptions that are made. **7**

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Question 26 (6 marks) **Marks**

Assess the significance of the industrial development of the Haber process to society at the beginning on the 1900s. Include a relevant chemical equation in your answer. **6**

Question 27 (3 marks) **Marks**

Chlorofluorocarbons (CFCs) are a family of organic compounds consisting of carbon, chlorine and fluorine. **3**

Although CFCs have properties that make them useful for a variety of applications, such as refrigerant coolants and aerosol propellants, they have largely been replaced in these applications by another family of compounds, known as hydrofluorocarbons (HFCs).

Account for the replacement of CFCs with hydrofluorocarbons.

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Section II - Options

Total marks (25)
Attempt ONE question from Questions 28–32
Allow about 45 minutes for this section

Answer the question in a SEPARATE writing book.

Show all relevant working in questions involving calculations.

Question 28 – Industrial Chemistry (25 marks) **Marks**

(a) (i) Identify the raw materials used in the Solvay process. **1**

(ii) Describe a current use of sodium carbonate. **2**

(b) Explain why the electrolysis of aqueous sodium chloride produces different products to the electrolysis of molten sodium chloride. Include relevant equations in your answer. **5**

(c) The second stage in the industrial production of H_2SO_4 involves the conversion of sulfur dioxide to sulfur trioxide.

(i) Write a balanced equation, including states, for this reaction. **1**

(ii) The reaction conditions in this second stage involve the use of vanadium oxide, 101.3 kPa pressure and a temperature of 400-500°C. **3**

Explain how these conditions contribute to the efficiency of this stage of this industrial process.

(d) Describe a first-hand investigation that involves sulfuric acid acting as an oxidising agent and describe ways in which the accuracy and reliability of your results could be improved. **6**

(e) Synthetic detergents are increasingly replacing soaps in both domestic and industrial situations. **7**

Analyse this trend using specific examples.

End of Question 28

Question 29 – Shipwrecks and Salvage (25 marks) **Marks**

(a) (i) Identify the type of reaction that occurs at the cathode. **1**

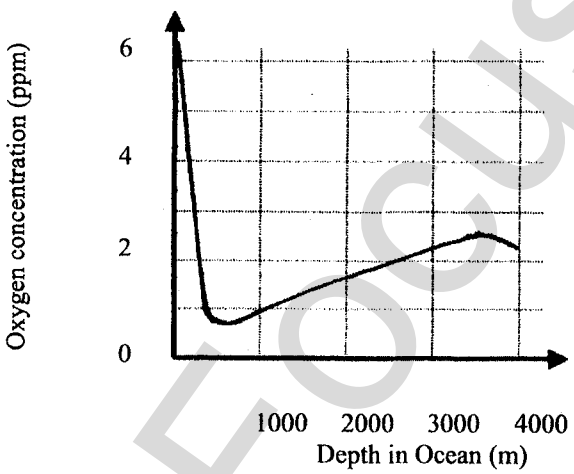
(ii) Using an example, outline the process of cathodic protection. **2**

(b) Shipwrecks often contain valuable and historically significant items. Much time is spent salvaging and restoring artefacts made from wood, glass, metal and leather.

(i) Describe named procedures that may be used to clean and preserve artifacts recovered from shipwrecks. **2**

(ii) Evaluate the impact of technology on the salvage of artefacts. **3**

(c)



(i) Describe the trend in oxygen concentration with increasing depth. **1**

(ii) Explain why the oxygen concentration changes with increasing depth. **3**

(d) Describe a first-hand investigation that examines the effects of acidic environments on corrosion and describe ways in which the accuracy and reliability of the procedure could be improved. **6**

(e) Outline and analyse the contributions of Galvani, Davy and Faraday in relation to electron transfer reactions. **7**

End of Question 29

Question 30 – The Biochemistry of Movement (25 marks) **Marks**

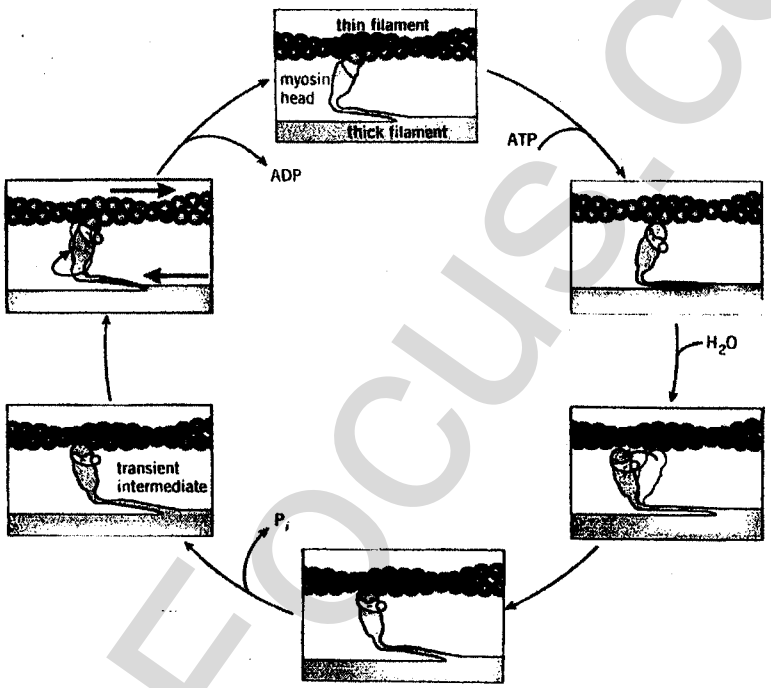
(a) (i) Define hydrophobic. **1**

(ii) Fatty acids are stored as esters of glycerol (TAGS). **2**

Account for the hydrophobic nature of these esters.

(b) Analyse the structure of the mitochondrion in terms of the efficiency of separation of organic chemical processes occurring. **5**

(c)



(i) Identify the cause of muscle cell contraction. **1**

(ii) Explain why ATP is consumed during muscle contraction. **3**

(d) Describe a first-hand investigation that shows the effect of temperature on a named enzyme reaction and describe ways in which the accuracy and reliability of the procedure could be improved. **6**

(e) Identify the muscle cells used for light or endurance exercise and justify how this type of muscle is used for this purpose. **7**

End of Question 30

Question 31 – The Chemistry of Art (25 marks) **Marks**

(a) Colours such as red, yellow, white and black feature predominantly in traditional Aboriginal cave paintings.

(i) Select and identify ONE of the colours listed above and state the name OR formula of a mineral used to produce the selected colour. **1**

(ii) Outline the basic steps that Aboriginal people would have followed to produce a paint from minerals such as the one identified in part (i). **2**

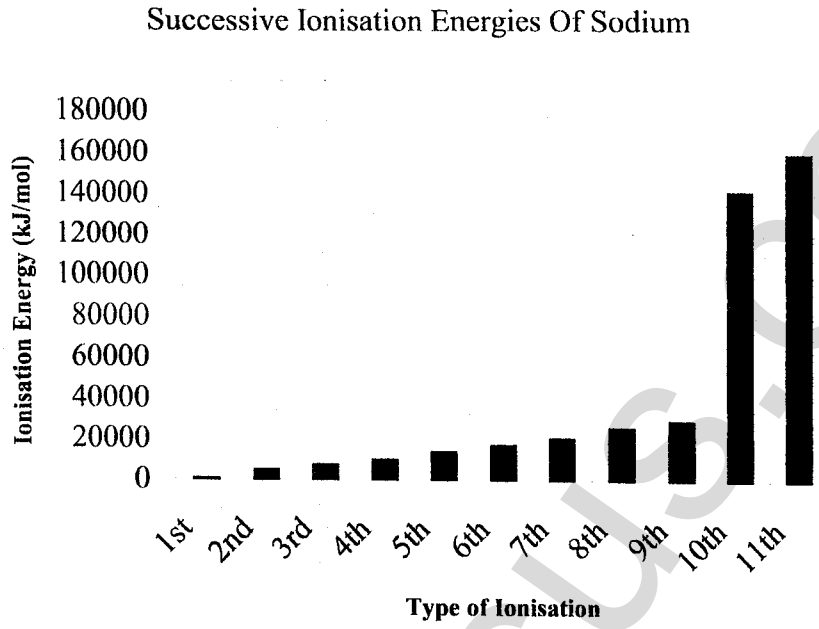
(b) An essential part of many art restoration processes is the identification of the materials used in the artwork. One method which can be employed to assist in the analysis of pigments is laser microspectral analysis.

(i) Describe the methodology involved in this form of analysis. **3**

(ii) Explain why an art restorer attempting to identify the composition of a pigment may prefer to observe the reflectance spectra of a painting rather than use laser microspectral analysis. **2**

Question 31 continues on page 23

(c) The following graph displays data on the successive ionisation energies of sodium.



(i) Write an equation to represent the 1st ionisation energy of sodium. **1**

(ii) Relate the data on the successive ionisation energies of sodium to the arrangement of electrons in the energy levels of its atoms. **3**

(d) During your studies of this Option, you performed a first-hand investigation to observe the colour changes in a transition element as it changes in oxidation state.

Identify the transition metal studied and outline the method you followed to carry out this investigation. Include observations of colour changes which occurred in the investigation and relate these to the changes in oxidation numbers of the metal. **6**

(e) Describe the main features of Bohr's atomic model and discuss the ability of the model to explain the phenomena of emission spectra of hydrogen and more complex elements. **7**

End of Question 31

Question 32 – Forensic Chemistry (25 marks) **Marks**

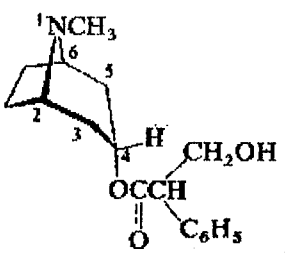
(a) (i) Define electron spectroscopy. **1**

(ii) Identify a sample that may be analysed by electron spectroscopy and describe the usefulness of this technique to a forensic scientist. **2**

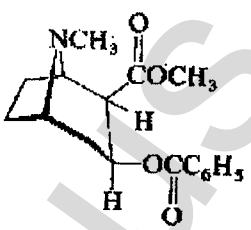
(b) (i) Use the appearance of line emission spectra to explain how the contents of a mixture can be determined from a mixed emission spectrum. **2**

(ii) Account for the fact that each element produces its signature line emission spectrum. **3**

(c)



atropine



cocaine

(i) Identify a functional group in these chemical structures and identify a class of organic compound in which this functional group is commonly found. **2**

(ii) Explain whether atropine and cocaine are isomers of each other. **2**

(d) Describe a technique you could perform to separate a mixture of amino acids and identify the properties of such a mixture which allow it to be separated. Justify your choice of technique. **6**

(e) Outline a range of community views on ethical issues associated with the use of DNA in forensic investigations, and justify the validity of concerns over sample contamination or other errors that may result in a false verdict. **7**

End of paper