INTERNATIONAL BACCALAUREATE
BACCALAURÉAT INTERNATIONAL
BACHILLERATO INTERNACIONAL

CHEMISTRY
HIGHER LEVEL
PAPER 3

Wednesday 17 May 2000 (morning)

1 hour 15 minutes

Name

Number

INSTRUCTIONS TO CANDIDATES

- Write your candidate name and number in the boxes above.
- Do not open this examination paper until instructed to do so.
- Answer all of the questions from two of the Options in the spaces provided. You may continue your answers in a continuation answer booklet, and indicate the number of booklets used in the box below. Write your name and candidate number on the front cover of the continuation answer booklets, and attach them to this question paper using the tag provided.
- At the end of the examination, indicate the letters of the Options answered in the boxes below.

OPTIONS ANSWERED		EXAMINER	TEAM LEADER	IBCA
		/25	/25	/25
		/25	/25	/25
NUMBER OF CONTINUATION BOOKLETS USED	. . . . .	TOTAL /50	TOTAL /50	TOTAL /50

Option C – Human Biochemistry

C1. (a) (i) Draw the straight-chain formula of glucose and circle a carbon atom in the structure which is **not** chiral. [2

(ii) Describe the structural difference between α-glucose and β-glucose. [2

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(b) Give the names of the monosaccharides which condense to form

(i) sucrose; [2

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(ii) starch. [1

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(c) State **one** major function of a polysaccharide in the body. [1

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C2. (a) How many different tripeptides can be formed using three α-amino acids, glycine, alanine and valine, if each amino acid is used only once in each tripeptide? *[1]*

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(b) (i) Name **two** methods by which an unknown tripeptide can be analysed. *[2]*

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(ii) For **one** of these methods outline the experimental procedure and give the information which would be needed to identify the individual amino acids. *[4]*

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(c) Alanine, $H_2N-CH(CH_3)-COOH$, has an isoelectric point of 6.0. Write the structural formulas of alanine at pH values 4.5, 6.0 and 7.5. *[3]*

C3. Describe and explain the way in which the activity of an enzyme is influenced by an increase in

(a) substrate concentration; *[3]*

(b) temperature. *[4]*

Labelled graphs, instead of descriptions, may be used to support your answer.

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(b)

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Option D – Environmental Chemistry

D1. (a) For **each** of the air pollutants listed below, state its source and **one** process in which its emission into the atmosphere could be reduced. State the product(s) formed from the pollutant in **one** of the processes. *[6]*

(i) Carbon monoxide:

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(ii) Sulphur dioxide:

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(iii) Nitrogen oxides:

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(b) Identify **one** gas, from the above list, which contributes to acid rain and write an equation for its reaction with water. *[2]*

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D2. (a) Explain what is meant by *Biological Oxygen Demand* (BOD) and describe the effect of a high BOD in water. *[2*

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(b) Identify the stage of sewage treatment which removes the substances responsible for BOD and explain how this is done. *[3*

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(c) Discuss how the addition of nitrates **or** phosphates to water can contribute to the BOD. *[2*

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D3. (a) (i) Explain the meaning of the term LD_{50}. *[2]*

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(ii) State **one** advantage and **one** disadvantage of the use of LD_{50}. *[2]*

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(b) Lead and nitrates represent a health hazard in polluted water. Identify a source of **each** of these pollutants, state a health hazard caused by **each** pollutant, and indicate a way by which the concentration of **each** can be reduced. *[6]*

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Option E – Chemical Industries

E1. (a) Complete the table below to show the conditions used in the Haber and Contact processes, for the manufacture of ammonia and sulphur trioxide, respectively.

	HABER	CONTACT
Temperature / °C		
Pressure / atm		
Identity of catalyst		

(b) Write a balanced equation for the manufacture of ammonia (ΔH is negative). Explain the choice of the temperature used.

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(c) The hydrogen used in the manufacture of ammonia can be obtained by the process of *reforming*. Give the raw material(s), the conditions and a possible equation for the process.

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E2. (a) List **two** important factors which should be considered when choosing a location for the manufacture of polythene. [2

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(b) Explain why polyvinyl chloride is less flexible than polythene. [2

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(c) Write an equation for the combustion of polythene and polyvinyl chloride and explain why these polymers are first separated **before** combustion. [3

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(Question E2 continued)

(d) Discuss and compare the radical mechanism for the manufacture of low density polythene with the ionic mechanism for the manufacture of high density polythene.

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Option F – Fuels and Energy

F1. (a) Radium-223, ^{223}Ra, emits α-particles when it decays.

(i) Write the mass number and atomic number of the heavier product formed by this decay. *[2*

Mass number: .....

Atomic number: .....

(ii) What happens to the mass number and the atomic number of an element if it undergoes β-decay? *[2*

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(b) The intensity of radiation emitted by a certain mass of ^{223}Ra falls to $\frac{1}{8}$ of its original value after 35.1 days.

(i) Define *half-life*. *[1*

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(ii) Calculate, showing your working, the half-life of ^{223}Ra. *[2*

(iii) Calculate the fraction of ^{223}Ra which has decayed after 35.1 days. *[1*

(iv) Calculate the fraction of ^{223}Ra **remaining** at this time if the original mass had been twice as great. *[1*

F2. (a) Identify the two electrodes in the Leclanché dry cell. [

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(b) Describe the difference between *voltage* and *power* for such a cell **and** identify the factors that affect the voltage and the power. [

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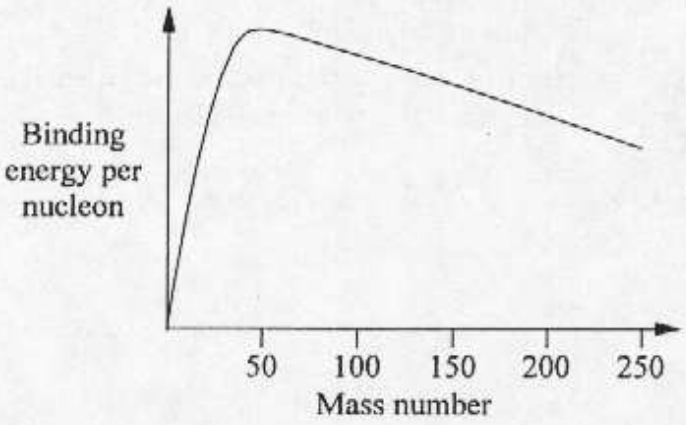
F3. (a)



Define the term *nuclear binding energy*. By using the above curve, explain why ^{223}Ra undergoes the loss of an α-particle as stated in **F1.** (a). *[3]*

(b) Nuclear waste is often divided into low-level and high-level waste. Discuss the differences between these types with regard to their sources, characteristics and appropriate methods of storage. *[7]*

Option G – Modern Analytical Chemistry

G1. (a) Draw a simple diagram of a mass spectrometer. State briefly how its use could show the existence of isotopes in a gaseous sample of an element. *[6*

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(b) Chlorine exists as a mixture of two stable isotopes ^{35}Cl and ^{37}Cl, present in the approximate ratio 3:1.

(i) Calculate the relative atomic mass of chlorine. *[2]*

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(ii) Sketch and label a diagram of the mass spectrum of **molecular** chlorine. *[3]*

G2. (a) In the use of paper chromatography, a retention factor, R_f, is determined. Define R_f. *[1]*

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(b) A drop of green dye is placed 2 cm from the bottom of a strip of filter paper. The filter paper is suspended in a graduated cylinder with 1 cm of the paper immersed in a water–alcohol solvent. After 30 minutes, the green spot is no longer present and there is a yellow spot and a blue spot.

(i) Describe how the R_f value of the blue spot could be determined. *[2]*

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(ii) Account for the difference in the R_f values of the yellow and blue dyes. *[2]*

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(iii) What is the significance of an R_f value of 1.0? *[2]*

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G3. (a) A compound of nitrogen has a molecular formula NH_3O which could have two structures, ONH_3 and $HONH_2$. Draw the Lewis structure of **each** species. *[2]*

(b) State and explain the number and relative areas of the peaks in the ^1H NMR spectra of ONH_3 and $HONH_2$. *[5]*

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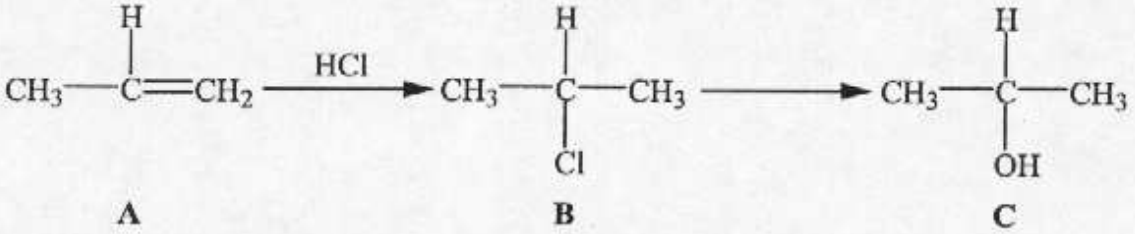
Option H – Further Organic Chemistry

*Below is a reaction scheme involving compounds **A**, **B** and **C** (referred to in question H1 below):*



A **B** **C**

H1. (a) Name and outline the mechanism for the conversion of **A** into **B**. *[4]*

(b) As well as compound **B**, another product is formed. Write down the structural formula of this compound, and explain why it is only produced in small amounts. *[3]*

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(Question H1 continued)

(c) The conversion of **B** into **C** is a *nucleophilic substitution* reaction. Define what is meant by **nucleophilic** substitution. *[1]*

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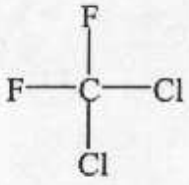
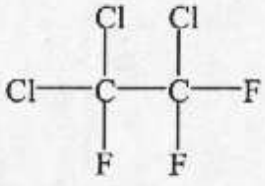
(d) Outline the mechanism involved in this nucleophilic substitution, showing clearly the reacting species. *[3]*

H2. The two compounds **V** and **W**, shown below, are known as Freons or CFCs. These compounds are usually inert but are quite reactive in the upper atmosphere contributing to ozone depletion. This depletion reaction follows a free-radical mechanism involving a chlorine free radical Cl·, generated from the CFCs.



V



W

(a) Write down the systematic name of each compound. *[2]*

V: .....

W: .....

(b) State briefly the importance of ozone in the atmosphere. *[1]*

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(c) With reference to Table 10 of the Data Booklet;

(i) explain why CFCs are generally inert compounds. *[1]*

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(ii) account for the fact that a chlorine radical Cl·, rather than a fluorine radical F·, is produced from compounds **V** and **W**. *[2]*

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(d) Write an equation for the reaction between Cl· and ozone, O_3. *[1]*

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H3. (a) State the structural feature of a molecule needed for optical activity to occur, illustrating your answer with appropriate drawings. *[3]*

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(b) One way of studying optically active compounds is using plane-polarised light. State what is meant by *plane-polarised light* and how it is affected by optically active compounds. Under what conditions would this effect **not** be observed? *[4]*

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