INTERNATIONAL BACCALAUREATE
BACCALAURÉAT INTERNATIONAL
BACHILLERATO INTERNACIONAL

CHEMISTRY

Standard Level

Wednesday 17 November 1999 (morning)

Paper 3 — 1 hour 15 minutes

A

Candidate name:	Candidate Category and Number:

This examination paper consists of 6 Options.
The maximum mark for each option is 15.
The maximum mark for this paper is 45.

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 THREE of the options in the spaces provided.

At the end of the examination, complete box B below with the letters of the options answered.

B

OPTIONS ANSWERED

C

EXAMINER	TEAM LEADER
/15	/15
/15	/15
/15	/15
TOTAL /45	TOTAL /45

D

IBCA
/15
/15
/15
TOTAL /45

EXAMINATION MATERIALS

Required:
Calculator
Chemistry Data Booklet

Allowed:
A simple translating dictionary for candidates not working in their own language

Option A – Higher Organic Chemistry

A1. Draw the Lewis structures of the following species. For each one predict the shape of the species and the angle between the atoms: *[6]*

(a) CH_4, methane

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(b) CH_3^-, methyl anion

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(c) CH_3^+, methyl cation

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A2. (a) The mass spectrum of a saturated hydrocarbon gives a peak corresponding to the parent ion at $M_r = 72$. Draw the structural formulas of the three isomers of the compound. *[2]*

(b) The mass spectrum does not contain a peak at $M_r = 29$. Explain which **two** of the isomers can definitely be eliminated on the basis of this information. *[2]*

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(c) State how the ^{1}H NMR spectrum could be used to confirm the identity of the compound. *[1]*

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(d) Give the characteristic range of wave numbers of **one** absorption peak that should be present in the infrared spectrum of the compound. *[1]*

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A3. Propanal can be oxidised using acidic dichromate(VI) solution or it can be reduced with $LiAlH_4$. Give the structural formula of propanal, and of the product formed in each case. *[3]*

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Option B – Higher Physical Chemistry

B1. (a) Explain the difference between a strong base and a weak base. *[1]*

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(b) Write the ionisation constant expression for the reaction between ammonia and water. Calculate the hydroxide ion concentration of $0.10\ \text{mol dm}^{-3}$ ammonia ($K_b = 1.8 \times 10^{-5}$) and compare it to the hydroxide ion concentration of $0.10\ \text{mol dm}^{-3}$ sodium hydroxide solution. *[4]*

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(c) Calculate the pH of a $1.0\ \text{dm}^3$ solution that contains 0.10 mol ammonia and 0.50 mol ammonium chloride. *[3]*

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(d) Explain with equations why the pH of the solution in (c) remains relatively constant if small amounts of a strong acid or a strong base are added to it. *[2]*

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B2. For the reaction:

$$2ICl + H_2 \rightarrow I_2 + 2HCl$$

it has been shown experimentally that the initial rate of the reaction doubles when the ICl concentration is constant and the H_2 concentration is doubled. It is also found that the initial rate of the reaction becomes three times as fast when the concentration of ICl is tripled, and the concentration of H_2 is kept constant.

(a) Write the rate law (rate expression) for the reaction. *[2]*

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(b) State the units of the rate constant. *[1]*

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(c) The following mechanism has been proposed for this reaction:

$$ICl + H_2 \rightarrow HI + HCl$$
$$HI + ICl \rightarrow I_2 + HCl$$

Identify the rate determining step in the mechanism and outline your reasoning. *[2]*

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Option C – Human Biochemistry

C1. The structures of vitamin A (retinol) and vitamin C (ascorbic acid) are given in Table 21 of the Data Booklet.

(a) Name **two** functional groups which are present in retinol. *[2]*

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(b) By referring to the structures, classify vitamin A and vitamin C as water or fat soluble and account for the difference on the molecular level. *[3]*

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C2. (a) List **two** major functions of fats in the body. Write a general formula for a fat or an oil and describe the structural similarity between the two. State how the molecular structures of a fat and an oil differ and explain why one is a solid at room temperature and the other a liquid. *[7]*

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(b) 0.014 moles of a particular oil were found to react exactly with 14.2 g of iodine. Calculate the number of moles of iodine that reacted and state what can be deduced about the structure of the oil from this information. *[3]*

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Option D – Environmental Chemistry

D1. Carbon dioxide is perhaps the best known greenhouse gas. What is the greenhouse effect? Identify **one** other greenhouse gas and explain how these gases contribute to this effect. Explain how particulates can counteract this effect. *[5]*

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D2. (a) Apart from removing disease-causing agents, state **two** types of impurities which are removed during the treatment of fresh water for drinking purposes. *[2]*

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(b) Describe the primary, secondary and tertiary stages of sewage treatment. State the pollutants removed at each stage, discuss the effectiveness of each stage of sewage treatment and state why there is an increasing need for tertiary treatment. *[8]*

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Option E – Chemical Industries

E1. For each of the classes of manufactured chemicals listed below, name **one** of the chemicals and give an example of its use. *[4]*

Example:

Acids: Sulphuric acid is used in the manufacture of detergents.

(a) Alloys: . . . .

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(b) Polymers: . . . .

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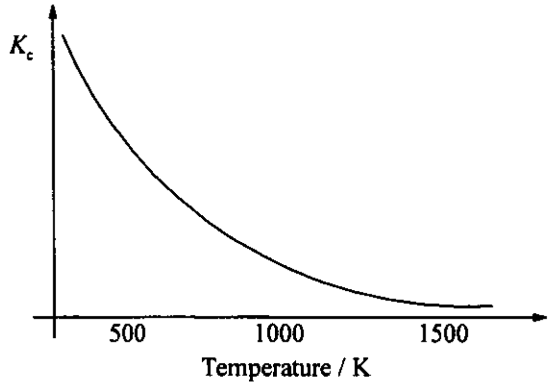
E2. The graph below (not to scale) indicates the variation of K_c with temperature for an industrial process:



(a) Based on the graph, explain whether the reaction is exothermic or endothermic. *[2]*

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(b) Industrially, this process is carried out at 750 K. Explain why it is not carried out at a much higher or much lower temperature. State how a catalyst could increase the rate of this reaction at 750 K. *[3]*

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E3. Catalytic cracking is one of the processes that takes place in an oil refinery. Explain the purpose of this process and state why it is important. Write a balanced equation using molecular formulas to represent a typical example of the process. In addition to a catalyst, state what other condition is necessary for the process. *[6]*

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Option F – Fuels and Energy

F1. (a) Describe how coal and oil were formed. *[2]*

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(b) Two possible reactions of coal are given below with their associated enthalpy changes per mole of product:

$$C(s) + \tfrac{1}{2}O_2(g) \rightarrow CO(g) \qquad \Delta H = -111 \text{ kJ}$$
$$C(s) + 2H_2(g) + \tfrac{1}{2}O_2(g) \rightarrow CH_3OH(l) \qquad \Delta H = -239 \text{ kJ}$$

(i) From this information, calculate the heat of reaction for:

$$CO(g) + 2H_2(g) \rightarrow CH_3OH(l)$$ *[2]*

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(ii) Give a balanced equation for the complete combustion of methanol. *[1]*

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(iii) Use information provided in Table 2 of the Data Booklet to calculate the amount of heat required to raise the temperature of 500 kg of water at 25.0° C to water at 100.0° C. *[1]*

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(iv) Use information provided in Table 13 of the Data Booklet to calculate the mass of methanol that must be burnt completely to produce the amount of heat required in (iii). *[2]*

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F2. (a) ^{234}Pa decays by beta emission. Give a balanced equation for the nuclear reaction. *[1]*

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(b) The half-life of ^{234}Pa is approximately 70 s. What fraction of a sample's initial activity will be present after 350 s? *[1]*

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F3. List **three** possible stages at which radioactive materials might escape from a nuclear power plant, and **two** ways in which such escapes might be prevented. *[5]*

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