INTERNATIONAL BACCALAUREATE
BACCALAURÉAT INTERNATIONAL
BACHILLERATO INTERNACIONAL

M99/420/S(3)

CHEMISTRY

Standard Level

Friday 7 May 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 question 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 with the letters of the options answered.

B

QUESTIONS ANSWERED

C

EXAMINER	MODERATOR
/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. (a) Use the Valence Shell Electron Pair Repulsion theory to predict the shapes of the following species. Explain your reasoning for **one** of these species.

$$CH_3Cl, \quad C_2H_2, \quad CH_3^+$$ *[4]*

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(b) The carbon–oxygen bond lengths in methanoic acid, HCOOH, and in the methanoate ion, $HCOO^-$, are shown in the table below. Discuss these values.

Species	carbon–oxygen bond lengths / nm
HCOOH	0.123 ; 0.136
$HCOO^-$	0.130

[3]

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A2. (a) Compound **A**, 2-bromo-2-methylpropane, is hydrolysed by aqueous alkali to yield **B**. Give the structural formulae of **A** and **B**. Write a mechanism by which **A** is converted into **B**. *[5]*

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(b) Ethanol is a much weaker acid than ethanoic acid. State what is meant by a weak acid and explain the difference in acidity between ethanol and ethanoic acid. *[3]*

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Option B – Higher Physical Chemistry

B1. This question relates to an aqueous solution of propanoic acid, CH_3CH_2COOH.

(a) Write an equation to represent the equilibrium reaction in solution. *[1]*

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(b) Give an expression for the equilibrium constant, K_a. *[1]*

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(c) K_a for propanoic acid is 1.34×10^{-5} mol dm^{-3}.

(i) Calculate pK_a. *[1]*

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(ii) Calculate the pH of a 0.050 mol dm^{-3} solution of propanoic acid. *[3]*

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(d) 50.00 cm^3 of 0.050 mol dm^{-3} aqueous propanoic acid is titrated with 0.050 mol dm^{-3} aqueous sodium hydroxide, NaOH. Sketch a graph showing the initial pH, the variation in pH with the volume of NaOH added up to and beyond the equivalence point, and the volume of NaOH at the equivalence point. *[4]*

B2. For the reaction:

$$C(s) + 2H_2(g) \rightarrow CH_4(g)$$

(a) Calculate ΔS° using the data below and any other necessary data from the Data Booklet. *[4]*

S° $C(s) = 5.73\ J\,K^{-1}\,mol^{-1}$

S° $H_2(g) = 130.6\ J\,K^{-1}\,mol^{-1}$

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(b) Explain the significance of the sign of ΔS° calculated in (a). *[1]*

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Option C – Human Biochemistry

C1. Iodine index (iodine number) is defined as the number of grams of iodine able to react with 100 grams of a fat or an oil in an addition reaction. The table below contains the values of iodine indexes for three fats/oils.

Fat/Oil	Iodine index
Coconut	8–10
Butter	26–45
Olive	74–94

(a) Explain the relationship between the iodine index and unsaturation, and select the most ***saturated*** fat/oil. *[2]*

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(b) Oleic acid [$CH_3(CH_2)_7CH{=}CH(CH_2)_7COOH$] is commonly present in fats and oils. Calculate the iodine index of this acid according to the above definition. *[3]*

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(c) Which of the above fats or oils would you recommend to be part of a healthy diet? Justify your answer. *[2]*

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(d) State **three** functions of fats and oils in the human body. *[3]*

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C2. (a) What is a vitamin? *[1]*

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(b) Name **two** vitamins and the diseases/conditions they reduce. *[2]*

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(c) Using the structures of vitamin C and vitamin A, which may be found in the Data Booklet, explain why vitamin C is water soluble whereas vitamin A is not. *[2]*

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Option D – Environmental Chemistry

D1. This question relates to 'acid rain'.

(a) Account for the fact that natural rain has a pH of around 5.6. Give a chemical equation to support your answer. *[2]*

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(b) Because of pollution, acid rain may be 50 times more acidic than natural rain. Identify the **two** acids that cause this high acidity and indicate their origins. Show by means of an equation how **one** of these acids is produced. *[5]*

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(c) State **two** consequences of acid rain. *[1]*

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D2. (a) Write equations to show how ozone is produced in the upper atmosphere. *[3]*

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(b) Give **two** pieces of evidence supporting the fact that the ozone layer is being depleted. *[2]*

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(c) Identify a pollutant that destroys ozone in the upper atmosphere and explain why a small amount of pollutant has such a big effect. *[2]*

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Option E – Chemical Industries

E1. (a) Aluminium is manufactured by the electrolysis of alumina dissolved in molten cryolite.

(i) Explain the function of the cryolite. *[1]*

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(ii) Give an ionic equation for the reaction at the anode during the electrolysis. *[1]*

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(iii) Explain why the anode slowly disappears. *[1]*

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(b) Explain how the production of pure alumina from bauxite takes advantage of the amphoteric nature of aluminium oxide. *[2]*

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(c) State the main reason, other than cost, why aluminium is preferred to copper in overhead electricity cables. *[1]*

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E2. Oil is used as an energy source and as a chemical feedstock.

(a) Name **one** compound obtained from oil which is used as a fuel, and give an equation for its complete combustion. *[2]*

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(b) Decane has been used as an energy source but has greater value as a source of other chemicals. Use an equation to show the formation of **two** organic products from the cracking of decane, $C_{10}H_{22}$. *[2]*

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(c) Name the processes by which polythene is obtained from oil. *[3]*

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(d) Briefly describe **two** environmental problems associated with the use of polymers. *[2]*

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Option F – Fuels and Energy

F1. Coal is a fossil fuel that is mostly carbon.

(a) How much heat could be obtained by burning 1 kilogram of carbon? ($\Delta H_c^\circ = -393.5\,\text{kJ mol}^{-1}$.) *[2]*

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(b) When coal is burned several gases are produced in addition to carbon dioxide. Write an equation for the combustion of an ***element*** in coal to form **one** of these gases. *[1]*

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(c) State how the emissions of the gas identified in (b) could be minimised. *[1]*

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(d) In countries lacking natural gas reserves, coal is sometimes converted into synthesis gas, a mixture of carbon monoxide and hydrogen. Name the other raw material used and write an equation for the reaction. *[2]*

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(e) Give **two** advantages of a liquid fuel compared with a solid fuel. *[2]*

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F2. (a) State the main difference between a chemical reaction and a nuclear reaction. *[1]*

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(b) List **three** components of a nuclear reactor, other than the fuel, and describe the role of each. *[6]*

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