INTERNATIONAL BACCALAUREATE
BACCALAURÉAT INTERNATIONAL
BACHILLERATO INTERNACIONAL

CHEMISTRY
STANDARD LEVEL
PAPER 2

Thursday 10 May 2001 (afternoon)

1 hour

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.
- Section A: Answer all of Section A in the spaces provided.
- Section B: Answer one question from Section B. Write 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 number of the Section B question answered in the box below.

QUESTIONS ANSWERED		EXAMINER	TEAM LEADER	IBCA
SECTION A	ALL	/20	/20	/20
SECTION B QUESTION	. . . . .	/20	/20	/20
NUMBER OF CONTINUATION BOOKLETS USED	. . . . .	TOTAL /40	TOTAL /40	TOTAL /40

SECTION A

*Candidates must answer **all** questions in the spaces provided.*

1. (a) Hess's law states that, whether a reaction occurs in one or several steps, the total enthalpy change is the same. Illustrate your understanding of this law by using the data below to calculate the enthalpy change (ΔH) when one mole of solid carbon is converted into carbon monoxide.

$$C(s) + O_2(g) \rightarrow CO_2(g) \qquad \Delta H = -393.5 \text{ kJ}$$
$$CO(g) + \tfrac{1}{2}O_2(g) \rightarrow CO_2(g) \qquad \Delta H = -283.0 \text{ kJ}$$ *[3]*

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(b) State what is meant by the term *endothermic reaction*. *[1]*

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(This question continues on the following page)

(Question 1 continued)

(c) Enthalpy changes may also be calculated by using bond enthalpies, some values of which (kJ mol^{-1}) are provided below:

$$C{=}C\ 612;\ C{-}H\ 412;\ O{-}H\ 463;\ C{=}O\ 743;\ O{=}O\ 496.$$

The balanced equation for the complete combustion of one mole of ethene, C_2H_4, in oxygen is shown below:

$$C_2H_4 + 3O_2 \rightarrow 2CO_2 + 2H_2O$$

(i) Use the equation and the bond enthalpy data above to calculate the enthalpy change for the complete combustion of one mole of ethene. *[4]*

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(ii) State, with a brief explanation, whether the reaction is endothermic or exothermic. *[1]*

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2. Sodium hydrogencarbonate dissolves in water forming an alkaline solution according to the following ionic equilibrium:

$$HCO_3^-(aq) + H_2O(l) \rightleftharpoons H_2CO_3(aq) + OH^-(aq)$$

(a) Why is the solution alkaline? *[1]*

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(b) Using the Brønsted–Lowry theory, state, with a brief explanation, whether the HCO_3^- ion is behaving as an acid or as a base. *[2]*

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(c) Identify the conjugate base of carbonic acid, H_2CO_3. *[1]*

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3. (a) Define the terms *atomic number* and *mass number*. *[2]*

Atomic number: . . . . . .

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Mass number: . . . . . .

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(b) For **each** of the species shown in the table, state the number of each sub-atomic particle present. *[3]*

Species	Protons	Neutrons	Electrons
$^{14}_{6}C$			
$^{19}_{9}F^{-}$			
$^{40}_{20}Ca^{2+}$			

(c) State, giving a reason, which reactant in the following equation is acting as an oxidising agent: *[2]*

$$Ca + F_2 \rightarrow CaF_2$$

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SECTION B

*Answer **one** question. Write your answers in a continuation answer booklet. 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.*

4. (a) Define the term *rate of reaction*. For a reaction of your choice, state the reactants and outline an experimental procedure by which you could obtain a value for the rate of reaction. *[5]*

(b) (i) State Le Chatelier's Principle. *[1]*

(ii) State the factors which affect the **position** of equilibrium in a reaction. Explain the influence of **one** of these factors using Le Chatelier's Principle. *[3]*

(iii) Outline the main features of the Collision Theory. *[4]*

(iv) State the factors which affect the **time** taken to reach equilibrium and explain briefly the influence of **one** of these factors. *[3]*

(c) Write an equation, including state symbols, for the synthesis of ammonia by the Haber process. Explain the use of high pressure and moderately-high temperatures in the production of ammonia. *[4]*

5. (a) Describe the appearance of the emission spectrum of hydrogen. Explain how this spectrum is related to the electron energy levels of hydrogen. *[5]*

(b) (i) Explain **each** of the terms *ionisation energy* and *electronegativity.* *[5]*

(ii) Give the equation for the reaction of potassium with water and explain why potassium is more reactive than lithium. *[4]*

(c) Describe and explain the trends in atomic radii **and** electronegativity on descending the halogen group and across Period 3. *[6]*

6. (a) The electronegativity value of carbon is 2.5 and that of oxygen is 3.5.

(i) Draw a Lewis (electron dot) structure for the carbon dioxide molecule, state its shape and give the bond angle. *[3]*

(ii) Using the concepts of molecular shape and bond polarity, predict, with an explanation, whether or not the carbon dioxide **molecule** is polar. *[3]*

(b) Explain at the molecular level why ethanol (C_2H_5OH) is soluble in water, but cholesterol $(C_{27}H_{45}OH)$ and ethane (C_2H_6) are not. *[4]*

(c) Give an equation for the complete combustion of methane, CH_4. Identify **two** products formed by the incomplete combustion of methane and identify **one** harmful effect caused by **one** of the products. *[3]*

(d) Polyunsaturated oils contain many $C=C$ bonds and react with hydrogen to yield fats. Using the simplified structure of an oil provided below, give the formula of the product formed by reacting this oil with *excess* hydrogen, **and** identify this type of reaction.

——C = C——C = C——C = C——C = C—— *[2]*

(e) The molecule HOOC—X—COOH (where X represents a hydrocarbon group) can be used to form both a polyamide and a polyester. Give the names **or** formulas of **two** monomers needed to produce the polyamide and the polyester. Draw the structures of **both** the polyamide and polyester linkages and draw the repeating unit in **either** the polyamide **or** the polyester. *[5]*