INTERNATIONAL BACCALAUREATE
BACCALAURÉAT INTERNATIONAL
BACHILLERATO INTERNACIONAL

N01/420/S(2) A

CHEMISTRY
STANDARD LEVEL
PAPER 2

Tuesday 13 November 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) Use average bond enthalpies in Table 10 of the Data Booklet to calculate the change in enthalpy for the hydrogenation of ethene:

$$C_2H_4(g) + H_2(g) \rightarrow C_2H_6(g)$$ *[3]*

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(b) Using your answer to (a), predict the change in enthalpy for the hydrogenation of 1,3-butadiene, $CH_2{=}CH-CH{=}CH_2$. Give a reason for your answer. *[2]*

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2. An organic compound **X** contains 40.00 % carbon, 6.72 % hydrogen and 53.28 % oxygen by mass.

(a) Determine the empirical formula of compound **X**. *[2]*

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(This question continues on the following page)

(Question 2 continued)

(b) Compound **X** has a relative molecular mass of 60.0. Deduce its molecular formula. *[2]*

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(c) Draw **two** possible functional group isomers for **X**. *[2]*

(d) State **two** physical tests to distinguish between the two isomers and state the result of each test. *[4]*

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3. (a) Given the equation:

$$Mg(s) + CuSO_4(aq) \rightarrow Cu(s) + MgSO_4(aq)$$

determine the oxidation number of magnesium and of copper in the reactants. *[1]*

Mg: . . . . . Cu: . . . . . .

(b) Identify the oxidising agent in the reaction given in (a). *[1]*

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(c) In order to determine the position of titanium, Ti, in the activity series:

Mg
Ni
Cu

a student added a piece of Ti to separate solutions of $CuSO_4$, $MgSO_4$ and $NiSO_4$. It was found that Ti reacts with $NiSO_4$ and $CuSO_4$, but not with $MgSO_4$. Based on this information, place Ti in the activity series and explain your answer in terms of the reducing ability of the elements. *[3]*

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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) (i) Define an *acid* and a *base* according to the Brønsted-Lowry theory. *[2]*

(ii) State, with an example, what is meant by the term *conjugate acid-base pair*. *[2]*

(iii) Predict whether the hydrogencarbonate ion, HCO_3^-, can act as an acid, a base, both or neither. Illustrate your answer using balanced equation(s). *[3]*

(iv) Explain, with the aid of a balanced equation, why the carbonate ion, CO_3^{2-}, is basic in aqueous solution. *[2]*

(b) Outline **two** tests that can distinguish between aqueous solutions of ethanoic acid and hydrochloric acid of the same concentration. Explain how the results would distinguish between the acids. *[6]*

(c) The following table lists four bases and the corresponding numerical values of the equilibrium constant, K_c, at 298 *K*.

Base	Ammonia	Caffeine	Sodium Hydroxide	Urea
K_c	1.8×10^{-5}	4.1×10^{-4}	Very large	1.5×10^{-14}

(i) List the bases in order of **increasing** strength. *[2]*

(ii) The pH of an aqueous caffeine solution is 12. An aqueous urea solution is 100,000 times more acidic than the caffeine solution. Estimate the pH of the urea solution and explain your answer. *[3]*

5. (a) The equilibrium constant values for water at different temperatures are given below:

T / ºC	10	25	50
Equilibrium constant	3.00×10^{-15}	1.00×10^{-14}	5.47×10^{-14}

(i) Write a balanced equation for the dissociation of water, and specify the states. *[2]*

(ii) Based on bonding considerations, explain whether the forward reaction is exothermic or endothermic. *[2]*

(iii) Explain whether an increase in temperature favours the forward or the reverse reaction. *[2]*

(b) The reaction:

$$H_2(g) + I_2(g) \rightleftharpoons 2HI(g) \qquad \Delta H = +53 \text{ kJ}$$

is a homogeneous equilibrium.

(i) State what is meant by the term *homogeneous*. *[1]*

(ii) Suggest what evidence would show that the reaction has reached equilibrium. *[1]*

(iii) Deduce the extent of the reaction when $K_c > 1$ and when $K_c << 1$. *[2]*

(iv) The volume of the reaction mixture is decreased. State and explain what happens to the pressure and the position of equilibrium. *[3]*

(v) Explain the effect of a catalyst on the position of equilibrium and on the value of the equilibrium constant. *[4]*

(c) The concentrations of hydrogen, iodine and hydrogen iodide at equilibrium are found to be 0.15, 0.05 and 0.50 mol dm^{-3} respectively. Calculate the initial concentrations of hydrogen and iodine if there was no hydrogen iodide present at the start of the reaction. *[3]*

6. (a) In the following examples, state the type of interparticle forces and describe how these arise. *[8]*

(i) Methanol and water molecules

(ii) Two neon atoms in solid neon

(iii) Solid sodium chloride

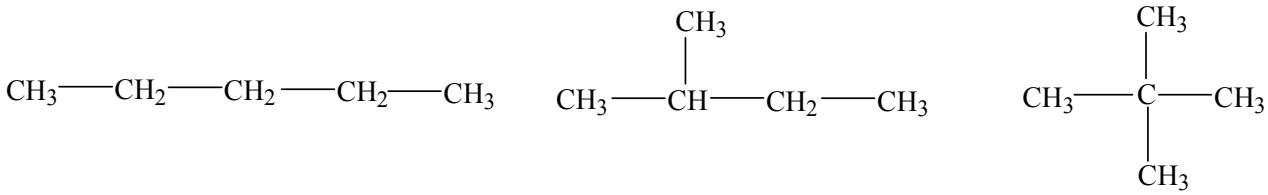
(b) For each of the species:

$$PCl_3\,,\ NH_2^-\ \text{and}\ NH_4^+$$

(i) Draw the Lewis structures showing all the valence electrons. *[3]*

(ii) Deduce the shape of each species and state the bond angle around the central atom. *[6]*

(c) Three isomers exist for the molecular formula C_5H_{12}



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List the isomers in order of **increasing** boiling point and explain your answer. *[3]*