IB DIPLOMA PROGRAMME
PROGRAMME DU DIPLÔME DU BI
PROGRAMA DEL DIPLOMA DEL BI

N02/420/S(2)+

CHEMISTRY
STANDARD LEVEL
PAPER 2

Name

Number

Monday 18 November 2002 (afternoon)

1 hour

INSTRUCTIONS TO CANDIDATES

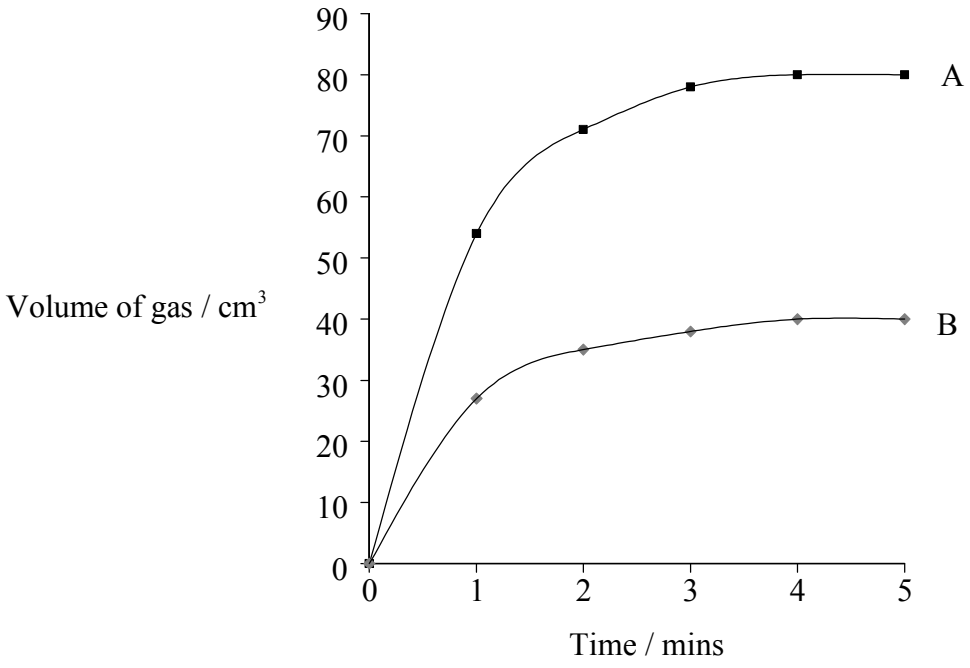
- Write your candidate name and number in the boxes above.
- Do not open this examination paper until instructed to do so.
- Section A: Answer all of Section A in the spaces provided.
- Section B: Answer one question from Section B. Write your answers in a continuation answer booklet, and indicate the 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. The graph below was obtained when copper(II) carbonate reacted with dilute hydrochloric acid under two different conditions, A and B.



(a) (i) Name the gas produced in the reaction. *[1]*

. . . . . .

(ii) Write a balanced equation for the reaction occurring. *[2]*

. . . . . .

(b) Identify the volume of gas produced and the time taken for the reaction under condition A to be complete. *[1]*

Volume of gas . . . . . .

Time taken . . . . . .

(This question continues on the following page)

(Question 1 continued)

(c) (i) Explain the shape of curve A in terms of the collision theory. *[2]*

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(ii) Suggest **two** possible reasons for the differences between curves A and B. *[2]*

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(d) On the graph opposite draw a line, labelled C, for the curve if the reaction were repeated under condition A but in the presence of a catalyst. *[2]*

2. Complete the following table. *[3]*

	Protons	**Neutrons**	**Electrons**
^{27}Al			
$^{24}Mg^{2+}$			
$^{16}O^{2-}$			

3. The table below gives information about the percentage yield of ammonia obtained in the Haber Process under different conditions.

	Temperature / °C			
Pressure / atm	**200**	**300**	**400**	**500**
10	50.7	14.7	3.9	1.2
100	81.7	52.5	25.2	10.6
200	89.1	66.7	38.8	18.3
300	89.9	71.1	47.1	24.4
400	94.6	79.7	55.4	31.9
600	95.4	84.2	65.2	42.3

(a) Deduce which combination of temperature and pressure gives the highest yield of ammonia. *[1]*

. . . . . .

(b) The equation for the main reaction in the Haber Process is shown below.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \qquad \Delta H = -92 \text{ kJ}$$

Use this information to state and explain, using Le Chatelier's Principle, the effect on the equilibrium yield of ammonia of

(i) an increase in pressure. *[2]*

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. . . . . .
. . . . . .
. . . . . .

(ii) an increase in temperature. *[2]*

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(c) In practice, the conditions used are typically 500 °C and 200 atm. Explain why the conditions that give the highest yield are not used. *[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) The first ionisation energies of the elements are given in Table 7 of the Data Booklet.

(i) Define the term *first ionisation energy*. *[1]*

(ii) State and explain the trend in first ionisation energy values across the period Li to F. *[3]*

(iii) State and explain the trend in first ionisation energy values down group 1, Li to Cs. *[3]*

(b) Give a formula for a stable oxide of each of the elements Na to S and comment on their acid-base nature. *[6]*

(c) Table 7 in the Data Booklet also gives the electronegativities of the elements.

(i) Define the term *electronegativity*. *[1]*

(ii) Predict the type of bonding formed between Ca and S and explain your answer with reference to electronegativity values. *[2]*

(d) Table 6 in the Data Booklet gives the melting points of the elements. State the type of bonding present and explain the difference in melting point in each of the following pairs. *[4]*

(i) Sodium and magnesium

(ii) Chlorine and argon

5. Carbonic acid (H_2CO_3) is described as a weak acid and hydrochloric acid (HCl) is described as a strong acid.

(a) Explain, with the help of equations, what is meant by *strong* and *weak* acid using the above acids as examples. *[4]*

(b) Outline **two** ways, other than using pH, in which you could distinguish between carbonic acid and hydrochloric acid of the same concentration. *[4]*

(c) A solution of hydrochloric acid, HCl(aq), has a pH of 1 and a solution of carbonic acid, $H_2CO_3(aq)$, has a pH of 5. Determine the ratio of the hydrogen ion concentrations in these solutions. *[2]*

(d) The relative strengths of acids can be illustrated by the following equation.

$$HCO_3^-(aq) + HCl(aq) \rightleftharpoons H_2CO_3(aq) + Cl^-(aq)$$

(i) Identify the acid and its conjugate base and the base and its conjugate acid in the above equation. *[2]*

(ii) Name the theory that is illustrated in (d) (i). *[1]*

(e) Give examples of both a strong base and a weak base, clearly indicating which is which. *[2]*

(f) Give an equation for the reaction between carbonic acid and **one** of the bases given in (e). *[2]*

(g) Carbonic acid can be used to treat wasp (an insect) stings.

(i) Suggest what this indicates about the nature of wasp stings.

(ii) Name the type of reaction that occurs.

(iii) Explain why hydrochloric acid is not used to treat wasp stings. *[3]*

6. Organic compounds are arranged as *homologous series* due to the presence of *functional groups*.

(a) Explain the meaning of the terms *homologous series* and *functional groups* using alkanols as examples. *[5]*

(b) Arrange the following homologous series in order of **increasing** acidity (least acidic first). Use the first members of each series as examples.

alkanoic acid, alkanol, amine, ester *[2]*

(c) Ethanoic acid and ethanol react together in the presence of concentrated sulfuric acid.

(i) Give an equation for the reaction. *[2]*

(ii) State how the organic product may be distinguished from the reactants and to which homologous series it belongs. *[2]*

(iii) State **two** reasons why concentrated sulfuric acid is used. *[2]*

(d) Under certain conditions ethene can be converted to ethanol.

(i) Give a chemical test to identify ethene and state what would be observed.

(ii) Give a balanced equation for the reaction to form ethanol from ethene.

(iii) State the conditions necessary for the reaction in (d) (ii). *[4]*

(e) Ethanol may be converted to ethanoic acid.

(i) Identify the reagent needed and state the type of reaction. *[2]*

(ii) State the colour change observed during the reaction. *[1]*