INTERNATIONAL BACCALAUREATE
BACCALAURÉAT INTERNATIONAL
BACHILLERATO INTERNACIONAL

CHEMISTRY
STANDARD LEVEL
PAPER 2

Tuesday 7 November 2000 (afternoon)

1 hour

Name

Number

INSTRUCTIONS TO CANDIDATES

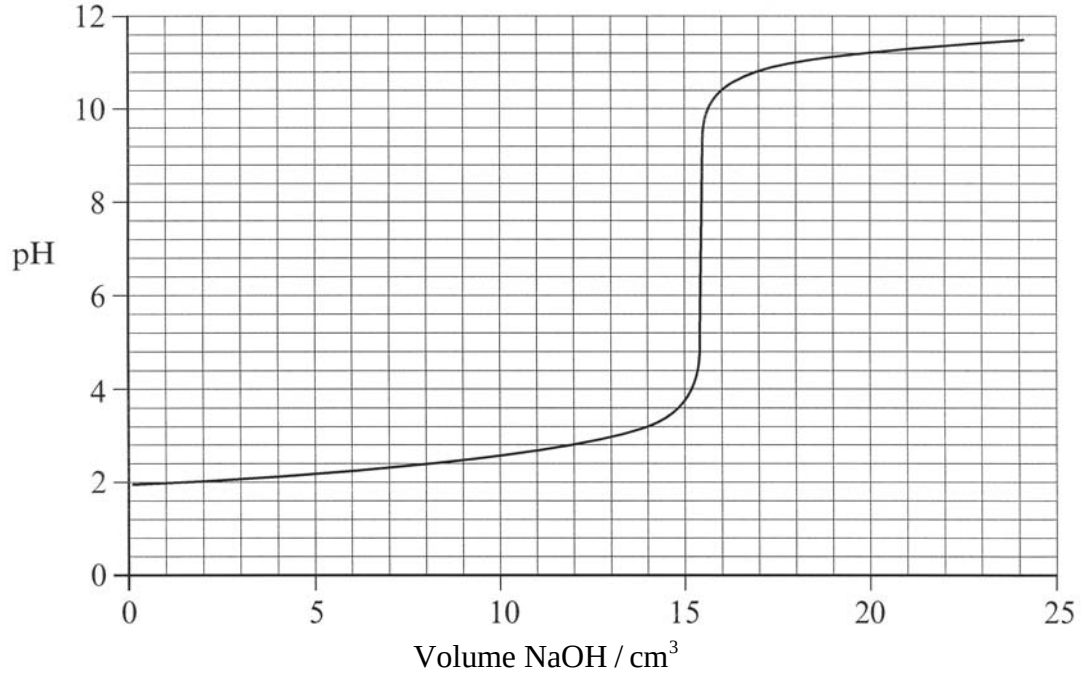
- Write your candidate name and number in the boxes above.
- Do not open this examination paper until instructed to do so.
- Section A: Answer all of Section A in the spaces provided.
- Section B: Answer one question from Section B. You may use the lined pages at the end of this paper or continue your 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. 25.0 cm^3 of hydrochloric acid of known concentration is titrated with a dilute sodium hydroxide solution. The pH of the mixture is measured continuously as shown in the graph below:



(a) (i) From the graph, determine the pH after 10.0 cm^3 of sodium hydroxide solution is added. *[1]*

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(ii) Determine the concentration of hydrochloric acid **before** titration and state its units. *[2]*

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(iii) From the graph, determine the volume of sodium hydroxide solution required to neutralise the hydrochloric acid. *[1]*

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(iv) Calculate the concentration of the sodium hydroxide solution and state its units. *[1]*

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(This question continues on the following page)

(Question 1 continued)

(b) (i) Hydrochloric acid is a strong acid, whereas ethanoic acid is a weak acid. What is the difference between a strong acid and a weak acid? *[1]*

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(ii) What mass of ethanoic acid would you use and how would you prepare 0.500 dm^3 of a 0.500 $mol\,dm^{-3}$ ethanoic acid solution? (M_r of ethanoic acid = 60.0) *[2]*

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2. For the following reaction:

$$2Cu^+ \rightarrow Cu + Cu^{2+}$$

(a) state the oxidation number of each species. *[1]*

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(b) write a balanced half-reaction for the oxidation process. *[1]*

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(c) write a balanced half-reaction for the reduction process. *[1]*

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3. For the reversible reaction:

$$H_2(g) + I_2(g) \rightleftharpoons 2HI(g) \qquad \Delta H > 0$$

the equilibrium constant $K_c = 60$ at a particular temperature.

(a) Give the equilibrium expression and explain why the equilibrium constant has no units. *[2]*

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(b) For this reaction, what information does the value of K_c provide about the **relative** concentrations of the product and reactants at equilibrium? *[1]*

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(c) What effect, if any, will an increase in pressure have on the **equilibrium position**? *[1]*

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(d) Explain why an increase in temperature increases the value of the **equilibrium constant** for the above reaction. *[1]*

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4. (a) Write structural formulas and the names of the two alkanol isomers of C_3H_8O. *[2]*

(b) Both isomers react with alkanoic acids. Give a balanced chemical equation for the reaction of **one** of the alkanols with ethanoic acid when heated in the presence of H^+ as a catalyst. Name the organic product. *[2]*

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SECTION B

*Answer **one** question. You may use the lined pages at the end of this paper or continue 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.*

5. (a) State the meaning of the term *mass number* (A). State the difference between mass number and *atomic number* (Z). Show how these numbers can be used to determine the number and types of particles in an atom. *[4]*

(b) State the electronic configuration for a carbon atom. Calculate the number of protons, electrons and neutrons in a carbide ion, $^{12}C^{4-}$, and state their relative positions in the ion. *[4]*

(c) Chlorine consists of ^{35}Cl and ^{37}Cl atoms. If the relative atomic mass, A_r, of chlorine is 35.5, calculate the percentage of ^{35}Cl in a sample, given $A_r(^{35}Cl) = 35.0$ and $A_r(^{37}Cl) = 37.0$. In terms of their electronic structure, state **two** ways in which atoms of ^{35}Cl are similar to ^{37}Cl. Besides the difference in the mass and the number of neutrons, state **one** way in which compounds containing ^{35}Cl differ from compounds containing ^{37}Cl atoms. *[4]*

(d) (i) Trends in atomic radii of elements are given in Table 8 of the Data Booklet. Account for the trend in atomic radii of the halogens ($F \rightarrow At$) and the period 2 elements ($Li \rightarrow Ne$). *[4]*

(ii) Write the equation for the first ionisation of magnesium, including the states. With reference to its electronic configuration, account for the ionisation energy values for magnesium in the table below:

Energy (kJ mol^{-1}) required to remove:		
1st electron	2nd electron	3rd electron
740	1450	7740

[4]

6. (a) Give an example of each of the following substances, and use **bonding theories** to describe the interactions between atoms, molecules and/or ions in each:

(i) a polar covalent substance *[5]*

(ii) a network (giant) covalent solid *[3]*

(iii) a solid that contains both covalent and ionic bonds. *[4]*

(b) Draw the molecular shape of aminomethane (CH_3NH_2), and predict the bond angles around the carbon and nitrogen atoms using the Valence Shell Electron Pair Repulsion (VSEPR) theory. *[4]*

(c) Aminomethane and ethane have similar molar masses. Explain why aminomethane has a boiling point of $-6\,^{\circ}C$ whereas that of ethane is $-89\,^{\circ}C$. *[4]*

7. When dilute hydrochloric acid is added to a solution of sodium thiosulfate, a white precipitate of sulfur is formed.

(a) Describe the effect of the following changes on the rate of the reaction between hydrochloric acid and sodium thiosulfate and explain each of your answers using the kinetic molecular theory:

(i) the concentration of the hydrochloric acid is decreased. *[2]*

(ii) the volume of the hydrochloric acid used is increased. *[3]*

(iii) the temperature is raised from 20 °C to 30 °C. *[4]*

(iv) the solution of sodium thiosulfate is made from a fine powder instead of from crystals. *[2]*

(b) Explain why a small increase in temperature has a much greater effect on the rate of reaction than a small increase in concentration. *[2]*

(c) A series of reactions is carried out where a fixed volume of 1.0 mol dm^{-3} hydrochloric acid is added to a fixed volume of sodium thiosulfate solution of different concentrations. The time taken to form a visible precipitate of sulfur is noted.

(i) Sketch a graph of sodium thiosulfate concentration (vertical axis) against time to form the visible precipitate (horizontal axis). *[2]*

(ii) How would you calculate the rate of the reaction at different times from the above graph? *[2]*

(iii) List the laboratory apparatus you would need to carry out the experiments described in (c) above. What precautions would you take to make sure that the results from the series of reactions are comparable? *[3]*