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

M05/4/CHEMI/SP2/ENG/TZ0/XX

22056105

CHEMISTRY
STANDARD LEVEL
PAPER 2

Wednesday 4 May 2005 (afternoon)

1 hour 15 minutes

Candidate session number

0	0							

INSTRUCTIONS TO CANDIDATES

- Write your session 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 on answer sheets. Write your session number on each answer sheet, and attach them to this examination paper and your cover sheet using the tag provided.
- At the end of the examination, indicate the number of the question answered in the candidate box on your cover sheet and indicate the number of sheets used in the appropriate box on your cover sheet.

SECTION A

*Answer **all** the questions in the spaces provided.*

1. In aqueous solution, potassium hydroxide and hydrochloric acid react as follows.

$$KOH(aq) + HCl(aq) \rightarrow KCl(aq) + H_2O(l)$$

The data below is from an experiment to determine the enthalpy change of this reaction.

$50.0\ cm^3$ of a $0.500\ mol\ dm^{-3}$ solution of KOH was mixed rapidly in a glass beaker with $50.0\ cm^3$ of a $0.500\ mol\ dm^{-3}$ solution of HCl.
Initial temperature of each solution $= 19.6\ °C$
Final temperature of the mixture $= 23.1\ °C$

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

. . . . . .

. . . . . .

(b) Explain why the solutions were mixed rapidly. *[1]*

. . . . . .

. . . . . .

(c) Calculate the enthalpy change of this reaction in $kJ\ mol^{-1}$. Assume that the specific heat capacity of the solution is the same as that of water. *[4]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

(This question continues on the following page)

(Question 1 continued)

(d) Identify the **major** source of error in the experimental procedure described above. Explain how it could be minimized. *[2]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

(e) The experiment was repeated but with an HCl concentration of $0.510\ \text{mol dm}^{-3}$ instead of $0.500\ \text{mol dm}^{-3}$. State and explain what the temperature change would be. *[2]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

2. The percentage composition by mass of a hydrocarbon is C = 85.6 % and H = 14.4 %.

(a) Calculate the empirical formula of the hydrocarbon. *[2]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

(b) A 1.00 g sample of the hydrocarbon at a temperature of 273 K and a pressure of 1.01×10^5 Pa (1.00 atm) has a volume of 0.399 dm^3.

(i) Calculate the molar mass of the hydrocarbon. *[2]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

(ii) Deduce the molecular formula of the hydrocarbon. *[1]*

(c) Explain why the **incomplete** combustion of hydrocarbons is harmful to humans. *[2]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

3. When a small quantity of a strongly smelling gas such as ammonia is released into the air, it can be detected several metres away in a short time.

(a) Use the kinetic molecular theory to explain why this happens. *[2]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

(b) State and explain how the time taken to detect the gas changes when the temperature is increased. *[2]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

4. (a) Identify **two** features of colliding molecules that react together in the gas phase. *[2]*

. . . . . .

. . . . . .

. . . . . .

(b) For many reactions, the rate approximately doubles for a 10 °C rise in temperature. State **two** reasons for this increase and identify which of the two is the more important. *[3]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

5. Give the structural formulas for the isomers of molecular formula C_4H_{10} and state the name of each one. *[4]*

SECTION B

*Answer **one** question. Write your answers on the answer sheets provided. Write your session number on each answer sheet, and attach them to this examination paper and your cover sheet using the tag provided.*

6. (a) The letters **W**, **X**, **Y** and **Z** represent four consecutive elements in the periodic table. The number of electrons in the highest occupied energy levels are:

W: 3, **X**: 4, **Y**: 5, **Z**: 6

Write the formula for

(i) an ionic compound formed from **W** and **Y**, showing the charges. *[2]*

(ii) a covalent compound containing **X** and **Z**. *[1]*

(b) State the number of protons, electrons and neutrons in the ion $^{15}_{7}N^{3-}$. *[2]*

(c) State the type of bonding in the compound $SiCl_4$. Draw the Lewis structure for this compound. *[3]*

(d) Outline the principles of the valence shell electron pair repulsion (VSEPR) theory. *[3]*

(e) (i) Use the VSEPR theory to predict and explain the shape and the bond angle of each of the molecules SCl_2 and C_2Cl_2. *[6]*

(ii) Deduce whether or not each molecule is polar, giving a reason for your answer. *[3]*

7. (a) State and explain the trends in the atomic radius and the ionization energy

(i) for the alkali metals Li to Cs. *[4]*

(ii) for the period 3 elements Na to Cl. *[4]*

(b) (i) Describe **three** similarities and **one** difference in the reactions of lithium and potassium with water. *[4]*

(ii) Give an equation for **one** of these reactions. Suggest a pH value for the resulting solution, and give a reason for your answer. *[3]*

(c) Classify each of the following oxides as acidic, basic or amphoteric.

(i) aluminium oxide *[1]*
(ii) sodium oxide *[1]*
(iii) sulfur dioxide *[1]*

(d) Write an equation for each reaction between water and

(i) sodium oxide. *[1]*
(ii) sulfur dioxide. *[1]*

8. Several compounds have the molecular formula $C_3H_6O_2$.
Three of them, **A**, **B** and **C**, have the following properties:

A is soluble in water and is acidic

B and **C** are neutral and do not react with bromine.

(a) Give a structural formula for each of these compounds and name them. *[6]*

(b) (i) Explain the solubility and acidity of **A** in water. *[2]*

(ii) Write an equation for the reaction of **A** with sodium hydroxide solution. *[1]*

(iii) Explain why **B** and **C** do not react with bromine. *[1]*

(c) State and explain which one of **A**, **B** or **C** has the highest boiling point. *[2]*

(d) (i) Name the class of compounds to which **B** and **C** belong and state a use of this class of compounds. *[2]*

(ii) Name the **two** classes of compounds used to form **B** or **C**, and state the other product formed in this reaction. *[3]*

(e) Suggest the structural formula of an isomer of $C_3H_6O_2$ which does react rapidly with bromine. Name this type of reaction, and describe an observation that can be made during the reaction. *[3]*