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

M06/4/CHEMI/SP2/ENG/TZ0/XX

22066105

CHEMISTRY
STANDARD LEVEL
PAPER 2

Thursday 18 May 2006 (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 numbers of the questions 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. But–1–ene gas, burns in oxygen to produce carbon dioxide and water vapour according to the following equation.

$$C_4H_8 + 6O_2 \rightarrow 4CO_2 + 4H_2O$$

(a) Use the data below to calculate the value of $\Delta H^{\ominus}$ for the combustion of but-1-ene. *[3]*

Bond	C–C	C=C	C–H	O=O	C=O	O–H
average bond enthalpy / kJ mol^{-1}	348	612	412	496	743	463

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

(b) State and explain whether the reaction above is endothermic or exothermic. *[1]*

. . . . . .

. . . . . .

(This question continues on the following page)

(Question 1 continued)

(c) Calculate the enthalpy change, ΔH_4 for the reaction *[4]*

$$C + 2H_2 + \tfrac{1}{2}O_2 \rightarrow CH_3OH \qquad \Delta H_4$$

using Hess's Law and the following information.

$$CH_3OH + 1\tfrac{1}{2}O_2 \rightarrow CO_2 + 2H_2O \qquad \Delta H_1 = -676 \text{ kJ mol}^{-1}$$
$$C + O_2 \rightarrow CO_2 \qquad \Delta H_2 = -394 \text{ kJ mol}^{-1}$$
$$H_2 + \tfrac{1}{2}O_2 \rightarrow H_2O \qquad \Delta H_3 = -242 \text{ kJ mol}^{-1}$$

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

2. (a) Define the following terms.

(i) *atomic number* *[1]*

. . . . . .

. . . . . .

(ii) *mass number* *[1]*

. . . . . .

. . . . . .

(b) Use the data below to calculate the relative molecular mass of thallium bromide, $TlBr_3$, to two decimal places. *[3]*

Isotope	Percentage Abundance
^{203}Tl	29.52
^{205}Tl	70.48
^{79}Br	50.69
^{81}Br	49.31

. . . . . .

. . . . . .

. . . . . .

. . . . . .

(c) Write the symbol for the ion with a 2+ charge which has the electron arrangement of 2, 8. *[1]*

. . . . . .

(d) Write the symbols for **three** other species, which also have the electron arrangement of 2, 8. *[2]*

. . . . . .

. . . . . .

. . . . . .

3. Copper metal may be produced by the reaction of copper(I) oxide and copper(I) sulfide according to the below equation.

$$2Cu_2O + Cu_2S \rightarrow 6Cu + SO_2$$

A mixture of 10.0 kg of copper(I) oxide and 5.00 kg of copper(I) sulfide was heated until no further reaction occurred.

(a) Determine the limiting reagent in this reaction, showing your working. *[3]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

(b) Calculate the maximum mass of copper that could be obtained from these masses of reactants. *[2]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

4. (a) In terms of electron transfer define:

(i) *oxidation* *[1]*

. . . . . .

. . . . . .

(ii) *oxidizing agent* *[1]*

. . . . . .

. . . . . .

(b) Deduce the **change** in oxidation number of chromium in the below reaction. State with a reason whether the chromium has been oxidized or reduced. *[2]*

$$Cr_2O_7^{2-} + 14H^+ + 6Fe^{2+} \rightarrow 2Cr^{3+} + 6Fe^{3+} + 7H_2O$$

. . . . . .

. . . . . .

. . . . . .

. . . . . .

5. (a) State **two** characteristics of a homologous series. *[2]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

(b) Describe a chemical test to distinguish between alkanes and alkenes, giving the result in each case. *[3]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

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. Consider the following reaction in the Contact process for the production of sulfuric acid for parts (a) to (f) in this question.

$$2SO_2 + O_2 \rightleftharpoons 2SO_3$$

(a) Write the equilibrium constant expression for the reaction. *[1]*

(b) (i) State the catalyst used in this reaction of the Contact process. *[1]*

(ii) State and explain the effect of the catalyst on the value of the equilibrium constant and on the rate of the reaction. *[4]*

(c) Use the collision theory to explain why increasing the temperature increases the rate of the reaction between sulfur dioxide and oxygen. *[2]*

(d) Using Le Chatelier's principle state and explain the effect on the position of equilibrium of

(i) increasing the pressure at constant temperature. *[2]*

(ii) removing of sulfur trioxide. *[2]*

(iii) using a catalyst. *[2]*

(e) Using the following data, explain whether the above reaction is exothermic or endothermic. *[2]*

Temperature / K	**Equilibrium constant K_c / $dm^3\ mol^{-1}$**
298	9.77×10^{25}
500	8.61×10^{11}
700	1.75×10^{6}

(This question continues on the following page)

(Question 6 continued)

(f) The value of $\Delta G^{\ominus}$ for the reaction is -140 kJ at 298 K.

(i) State the name of the term represented by $\Delta G^{\ominus}$. *[1]*

(ii) State what can be deduced from the sign of $\Delta G^{\ominus}$. *[1]*

(iii) The values of $\Delta H^{\ominus}$and $\Delta S^{\ominus}$ for this reaction at 298 K are $\Delta H^{\ominus} = -196$ kJ and $\Delta S^{\ominus} = -188$ J K^{-1}. State and explain what will happen to the spontaneity of the reaction if the temperature of the reaction is increased. *[2]*

7. (a) Explain why

(i) the first ionization energy of magnesium is lower than that of fluorine. *[2]*

(ii) magnesium has a higher melting point than sodium. *[3]*

(b) Discuss the acid-base nature of the period 3 oxides. Write an equation to illustrate the reaction of one of these oxides to produce an acid, and another equation of another of these oxides to produce a hydroxide. *[5]*

(c) (i) Draw a Lewis structure of a water molecule, name the shape of the molecule and state and explain why the bond angle is less than the bond angle in a tetrahedral molecule such as methane. *[4]*

(ii) Explain why water is a suitable solvent for ethanol, but not for ethane. *[2]*

(d) Predict and explain the order of the melting point for propanol, butane and propanone with reference to their intermolecular forces. *[4]*

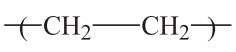
8. (a) Identify **one** example of a strong acid and **one** example of a weak acid. Outline **three** different methods to distinguish between equimolar solutions of these acids in the laboratory. State how the results would differ for each acid. *[5]*

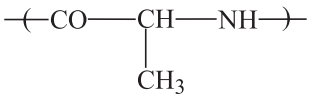
(b) State the name used to describe substances that can act as an acid and a base. Use equations to illustrate how HCO_3^- can behave both as an acid and base. *[3]*

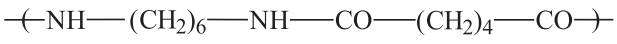
(c) Vinegar has a pH of approximately 3 and some detergents have a pH of approximately 8. State and explain which of these has the higher concentration of H^+ and by what factor. *[1]*

(d) Describe the composition and behaviour of a buffer solution. *[3]*

(e) Given the structures of the repeating units of the polymers below, identify the monomers from which they are formed.

(i)  *[1]*

(ii)  *[1]*

(iii)  *[2]*

(f) Describe the essential differences between the structures of monomers that form addition polymers and the structures of monomers that form condensation polymers. *[2]*

(g) Many organic compounds can exist as isomers. Draw and name an isomer of ethanoic acid, CH_3COOH. *[2]*